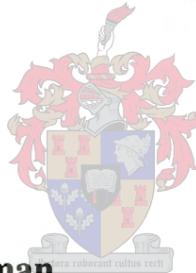


**USING GIS FOR OPTIMAL LOCATIONS OF
AUTOMATED TELLER MACHINES (ATMs): THE CASE
OF STELLENBOSCH**

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**Thesis presented in partial fulfilment of the requirements for the degree of Master
of Science at the University of Stellenbosch**



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March 2001

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

DECLARATION

I the undersigned hereby declare that the work contained in this thesis is my own original work and has not been previously, in its entirety or in part, been submitted at any University.

J. N. WAMBUGU

ABSTRACT

Automated teller machines (ATMs) are a very important part of our daily lives. They are the key to accessing our bank accounts. Where they are located can determine how easy or difficult it is to access our bank accounts. ATMs are primarily designed to serve customers and should therefore be accessible and convenient to the customers. Hence, the question of where the ATMs should be located is a prime issue to both the customer and the bank.

A geographical information system (GIS) is a tool that can be used to assist in answering questions about locations. It provides a means of determining optimal locations for any spatially referenced object. Against this backdrop, this study was undertaken to develop a method with which GIS can be used to find optimal locations for ATMs, taking Stellenbosch as a case study.

Firstly, it was necessary to understand current factors affecting ATM locations, both locally and internationally. An extensive literature survey was conducted to gain an understanding of problems relating to locating ATMs. Interviews with bank officials were conducted to help understand more fully the problems and the current procedures used in locating ATMs. Obtaining the public's perception of ATMs was also paramount to this study. A household questionnaire survey was conducted in Stellenbosch to ascertain how customers feel about the current location of ATMs in Stellenbosch.

Secondly, GIS was considered and evaluated as a tool to find optimal locations for ATMs. This involved discussing the capabilities of GIS and the various options that banks may have available. Thirdly, the ability of using GIS to find optimal sites was tested by applying GIS to Stellenbosch. Having done this, GIS was then used to find additional ATM sites. The results provide a basis for banks to locate ATMs in general.

Keywords: GIS, ATMs, location, optimal locations, location-allocation, models, MINDISTANCE, MAXCOVER, MAXATTEND, MINDISTPOWER.

OPSOMMING

Outomatiese tellermasjiene (OTMs) speel 'n baie belangrike rol in ons lewens vandag aangesien ons die meeste van ons banktransaksies deur middel van 'n OTM doen en ons bankrekening sodoende kontroleer. Die OTMs se primere doel is om 'n diens aan bank kliente te lewer, dus is dit uiters belangrik om liggings te identifiseer wat gerieflik en toeganklik is vir die kliënte en die bank.

'n Geografiese inligtingstelsel (GIS) kan gebruik word om vrae in verband met bestaande en beplande liggings vir OTMs te beantwoord. Die stelsel kan optimale liggings identifiseer vir spesifieke doeleindes, byvoorbeeld OTMs, ens. Teen hierdie agtergrond is hierdie studie onderneem om 'n metode te ontwikkel waarmee GIS aangewend kan word om optimale liggings vir OTMs te vind, met Stellenbosch as 'n gevallestudie.

Ten eerste was dit nodig om die huidige faktore met betrekking tot die liggingskeuse vir OTMs, beide in die buiteland en die binneland, te ondersoek. 'n Uitgebreide literatuursoektog is geloods om die probleme wat gepaard gaan met die bepaling van die keuse van 'n OTM ligging, te bestudeer. Onderhoude is gevoer met amptenare van verskillende banke om die probleme rondom die kies van OTM-plasings te verstaan. Kliënte is ook genader vir hulle idees, benodighede en probleme oor OTM-liggings in Stellenbosch.

Tweedens is GIS geëvalueer as 'n moontlike stelsel om die beste liggings vir OTM'e te bepaal. Dit het 'n bespreking van die vermoëns en voordele van GIS behels, sowel as 'n oorsig van beskikbare opsies vir die bank. Die vermoë om met die gebruik van GIS addisionele liggings vir OTMs in Stellenbosch te identifiseer, is daarna getoets. Die resultaat bied aan banke 'n keuse van alternatiewe liggings vir die plasing van OTMs.

Sluitelwoorde: GIS, ATMs, ligging, optimale ligging, ligging-toesegging, modelle, MINDISTANCE, MAXCOVER, MAXATTEND, MINDISTPOWER

ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to those who assisted me in this research. In particular, I would like to relay my thanks to:

- Mr. PJ Eloff, my supervisor, for his advice and assistance;
- Prof. HL Zietsman, my co-supervisor, for his great guidance;
- Rachel Muthoni (BA Hons) for editing this report;
- The bank employees of ABSA, FNB, Boland Bank and Nedbank who were very co-operative during the bank interviews;
- The residents of Stellenbosch who were willing to take part in the exercise;
- Dr. Makame Mmbarawa for his valuable support throughout the study; and
- My parents without whom this study would not have been conducted.

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1. LOCATING ATMs

Automated teller machines (ATMs) are an important aspect of our lives and their location can influence how often or not we use the ATMs. It is therefore important that their location be discussed in great detail. This study therefore, endeavours to discuss the locational aspects surrounding ATMs, presents the associated problems and provides a means by which optimal location of ATMs can be found.

1.1 PROBLEM FORMULATION

For any retail outlet to succeed it is important that it be located in a suitable area. Getting the optimal location is a tricky process and is influenced by many factors. The following section examines why location is an important aspect of retail development and looks at the problems surrounding locating any retail outlet and in particular ATMs.

1.1.1 The Importance of Location

Location is often considered as one of the most important factors leading to the success of a business venture. Businesses derive profits from a good location. This is true whether a small coffee shop with a local clientele or a multinational network of factories with distribution centres and a worldwide chain of retail outlets (ESRI 1998). Various factors should be considered when locating any retail outlet. Davies and Harris (1990) suggest a checklist to be used to identify an optimal site. This includes: the nature and size of the population, the number of people passing the site, available car parking space, visibility of the site and the nature of any legal requirements. Munroe and Nurani (1999) provide a means by which retailers should adopt locating facilities. This include analysing the market coverage, site evaluation or adopting location-allocation modelling. In financial terms, location translates to capital, investment and return - all in one (Barrath 1998). In locating a bank, the most important factor is site evaluation. This encompasses where a bank's customers live, shop, work, travel and conduct transactions (Barrath, 1998).

Location is described as the key to keeping operation costs low and accessibility high. Starting up a business requires a large initial investment, therefore, a good location is very important for the success of any business. Furthermore, an established business may continue to face location decisions as the market changes. Changes in the market

and in demographic patterns may necessitate the need to change locations, provide additional locations or remove existing locations (ESRI 1998).

1.1.2 Location of ATMs

Automated teller machines (ATMs) are important banking facilities. They play a central role in our day-to-day activities. With most banks closing over weekends and holidays, ATMs ensure that consumers have access to their bank accounts 24 hours a day. But what happens when an urgent matter arises and there is no ATM nearby? One may be forced to travel many kilometres in search of an ATM. This is undesirable, as ATMs should be easily accessible.

Consumers are increasingly demanding the ability to conduct financial business at their convenience and at their preferred location (Morrall 1996). This calls for banks to locate ATMs for customers' convenience. Banks too, benefit from well-located ATMs. Transactions performed at an ATM cost about half as much as the same transaction performed inside a bank, both to the customer and the bank (Wright 1999). The cost of providing teller services continues to rise and this impacts on a banks' costs (Porter 1996). In addition, ATMs present a good opportunity to promote products and services. Advertisements that are lodged in the system may appear on the screen as a transaction is being processed. To take advantage of these benefits, an ATM must be placed in a location that is visible, secure and inviting. Some institutions have made their ATM environment even more appealing by playing music or installing their ATMs in entertainment surrounds (Wright 1999).

On the other hand, locating an ATM brings up a major issue and concern for all banks and customers; namely security. While ATMs should be located in areas accessible to all, they should also ensure customer safety. According to Wright (1999, p. 34), "...the ideal location is one that is placed within a triangle of safety, where there is high activity and/or visibility from three sides..." Peterson (1998, p. 43) stresses that "On one side, there should be fast-moving traffic so that in criminals' minds, they could be handcuffed in a heartbeat. On the other side there should be slow-moving traffic, so that criminals need to wait for traffic to pass by. And on the other side, there should be residential property, which could provide a consistent supply of eyewitnesses".

The severity and occurrence of ATM crime has continued to rise in SA and is a concern to both the banks and their customers (Dammon 1999).

Consequently, a need arises to determine the best possible location of ATMs, which are convenient, accessible and ensure customer safety. The **aim** of this study therefore is to develop a method for using GIS to determine the optimal location for ATMs while at the same time taking into consideration the viability of existing ATMs in Stellenbosch.

Considering the importance of ATMs in our modern banking system, the objectives of this study are to:

1. Investigate the criteria currently used for locating ATMs;
2. Determine the viability of existing ATM locations in Stellenbosch;
3. Develop a method for using GIS to determine optimal location for ATMs; and
4. Apply a GIS for locating additional ATM sites in Stellenbosch.

Having identified the problem surrounding ATM locations, it was important to understand the existing literature that addresses ATM locations and retail outlets in general. A variety of literature exist that address location of retail outlets and a discussion of what emerges from this literature is discussed below.

1.2 PERSPECTIVES FROM THE LITERATURE

Retail location has been more closely linked with consumer tastes and preferences than to population growth. In Britain for example, population changes have had little influence on retail growth since population growth has been slow (Wrigley and Lowe 1996). Levy et al 1996 addresses some of the characteristics that affect the retail environment. These include the changes in the demographic structure of the population, changes in income population and consumer preferences. A whole new science of 'geodemographics' has evolved in recent years, that studies the relationship between consumer demand, demographic structure of the population, and characteristics of residential areas (Guy 1994). Current studies focus on the underlying links between the growth in retail development and geodemographics (Guy 1994).

Guy (1994) refers to Brown (1992) who sees retail location decisions as taking place in three stages: first, decisions about whether to operate in a particular geographical region; second, decisions concerning whether to operate in a particular shopping centre or retail area; third, 'site' decisions relating to a particular premises. Three scales emerge here in identifying a retail location: the geographical region, the particular shopping area and the particular site.

Dunne et al 1995 observes that once a location decision has been made, it can't easily be changed. A retailer can easily adjust the other elements of the retail mix, that is, prices, promotions, customer services, product assortment and display. However, location cannot be easily adjusted. Albert (1998) also agrees that changing a site once the purchase has been done is an expensive and difficult option. Identification of a suitable retail location is therefore a very important aspect of retail development.

Many authors are of the opinion that site selection and evaluation are two primary activities required to identify a suitable retail location. According to Ghosh and McLafferty (1987), this encompasses an evaluation of the local demographics, traffic flow and accessibility, retail structure, site characteristics, and legal and cost factors. Jones and Simmons (1990) identify two key factors in site selection. These are: *situational analysis* which involves an analysis of the spatial extent of the market, temporal changes, household characteristics and competition and *site evaluation*, which involves the site constraints, local access, parking, visibility and nearby attractions.

The growth of retail development has taken different forms. According to Guy (1994), these can be grouped into free-standing stores, focused centres (neighbourhood centre or district centre), retail parks, infill development, shopping malls, speciality/festival centres and ancilliary retailing. The types of shops found in any of these retail developments range from food, drink and confectionery shops, clothing and leather stores, household goods to other non-food goods and services (Jones and Simmons, 1990). The latter now include specialised services such as banking, cinemas and consultancies.

A recent trend in the banking sector, however, is to distribute the products and services to customers (Morrall 1996). Banks are faced with the challenge of delivering services beyond the traditional bank branches. ATMs have therefore emerged as an effective method by which banks are able to reach their customers and provide services, just as if they were visiting a bank.

While there is a lot of literature on retail location and retail development (Brown, S 1992, Davies, G and Harris, K 1990, Ghosh, A and McLafferty, SL 1987, Guy, C 1994, Jones, K and Simmons, J 1990, Levy et al 1996, Wrigley, N and Lowe, M (eds) 1996) little attention has been given to specific retail location of banks and ATMs. Much of the existing literature on ATMs such as, Cullinan 1993, Joseph 1995, Lewis 1992, Morgan 1997 and Peterson 1998, focus on ATMs and crime or the increasing advent of offering customers the flexibility of using their ATM cards to pay for many other goods and services. The locational aspects are neglected.

Having a literature review helped in understanding the problem surrounding ATM locations. The next section now presents the study area and the methodology used in conducting the research.

1.2 RESEARCH FRAMEWORK

In order to conduct the research study, various elements were incorporated. This included understanding the study area, identifying the type of data to be used in the study, defining the procedures followed for collecting the data, defining the methods of interpretation of the data and finally identifying the software systems employed. A discussion of each of these elements follows below.

1.3.1 Background to the Study Area

The study was conducted in the built-up part of the municipal area of Stellenbosch (Figure 1). Stellenbosch Municipality is located in the Wineland District Council of the Western Cape, 50km from Cape Town. It lies on the banks of the Eerste River and is surrounded by the mountains of the Jonkershoek valley to the West, the Stellenbosch and Helderberg mountains to the south and the Simonsberg mountain to the north. The history of Stellenbosch dates back to 1679 when Simon van der Stel, who named the town after himself, founded it. It first grew as a Dutch settlement, but

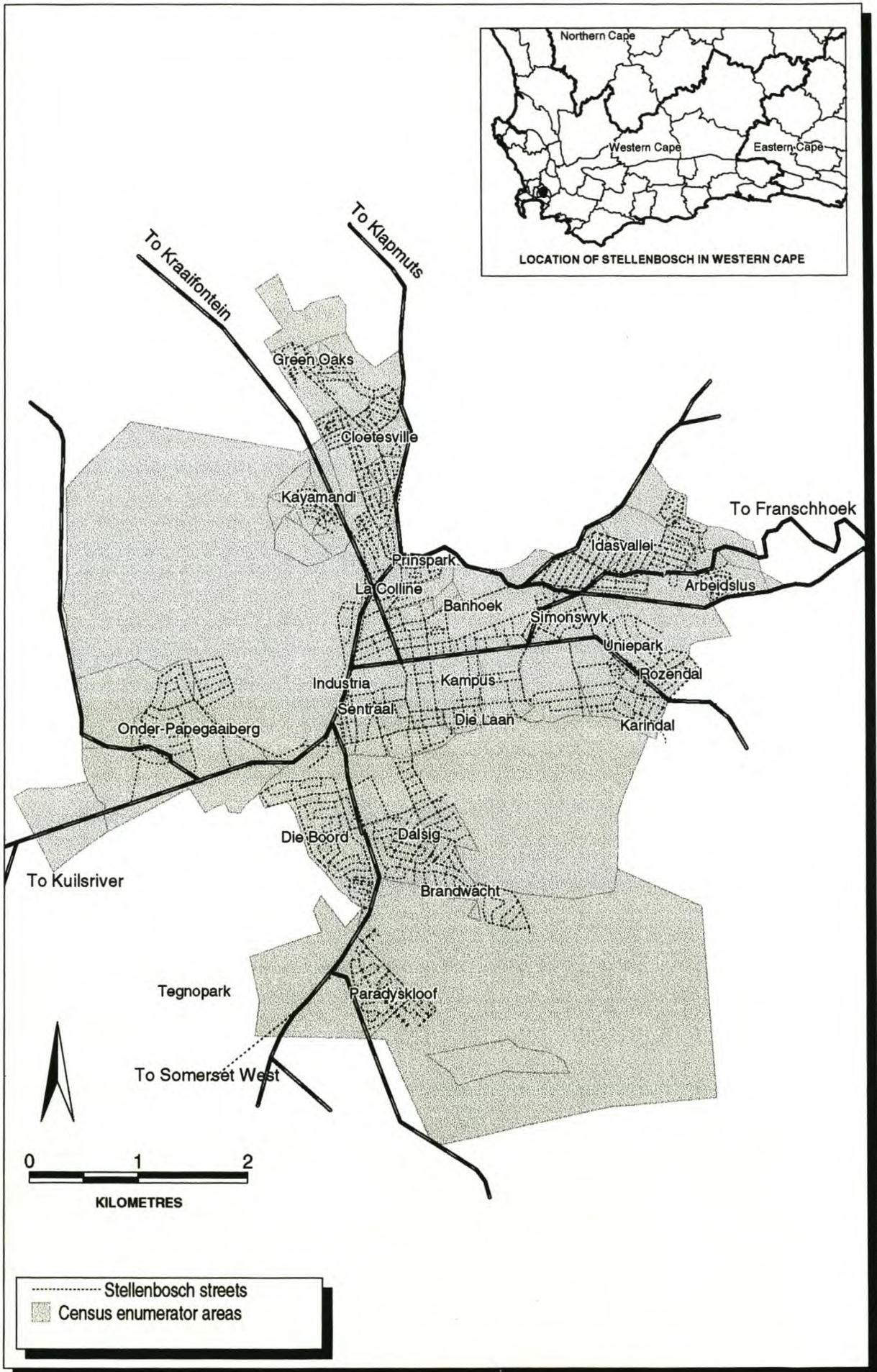


Figure 1: Stellenbosch, the study area

plots were later given to colonists from the Netherlands, Germany and France (Schwager 1992). They owned slaves who came from West Africa, Madagascar, various Indonesian islands or India. Initially, they farmed wheat but vineyards were later introduced. By the end of the 18th century, the wine industry in Stellenbosch was growing fast and this later became a major farming activity in the Stellenbosch area. In the late 19th century and 20th century, Stellenbosch began to grow as a university town (Fourie and Crouse 1998). The growth of the University of Stellenbosch dates back to the opening of the Stellenbosch Gymnasium in 1866. Out of the Gymnasium, the 'Arts Department' was established and it became the Stellenbosch College. This name was later changed to Victoria College in 1887, which in turn acquired university status in 1918 to become the University of Stellenbosch. However, it was only after the Second World War, that the impact of growth was felt when the total population, the university community and the town's boundary began to expand rapidly (Schwager 1992).

By 1995, the population of greater Stellenbosch stood at 67,850 with 61,640 staying in the built-up municipal area, which is the focus of this study (Figure 1). When the 1996 Census was conducted, the population of greater Stellenbosch stood at 85,111 (Statistics South Africa, 1996).

1.3.2 Data collection

The research problem required collecting both primary and secondary data. The procedures followed are discussed in turn.

1.3.2.1 Primary data

The primary data needed for this study was obtained through interviews and questionnaires.

Interviews: Formal interviews were deemed suitable for this study. Structured questions, which address the objectives of the study, were prepared beforehand. These were kept as concise as possible so as not to consume too much time from the bank representatives. Five of the major banks in Stellenbosch were approached for an interview, that is First National Bank, ABSA Bank, Nedbank, Standard Bank and Boland Bank. Standard Bank declined to give any information. The local office had to

seek approval from their head office in Johannesburg but the head office did not respond to the application. Once the banks were informed of the purpose of the study and indicated a willingness to meet the researcher, appointments were made. A formal interview was conducted in the bank's premises with the interviewer ready with structured questions. The bank's representative did not have to write anything as the interviewer took all the notes during the interview. The information gathered from the interviews provided an understanding of the criteria used for locating existing ATMs and the problems experienced in operating the ATMs at the chosen locations.

Questionnaires: Household questionnaires were administered in the major neighbourhoods of Stellenbosch during the month of July 1999. These questionnaires sought to obtain information on which ATMs the customers visit and their opinions about the present locations of ATMs. English and Afrikaans versions of the questionnaire were drafted. Based on the 1995 population figures obtained from Stellenbosch Municipality, the built up municipal area of Stellenbosch has 13,997 households distributed among various neighbourhoods (Figure 2). Initially, a 2% sample of the total number of households was taken and 279 questionnaires prepared.

Thirteen neighbourhoods in Stellenbosch, whose average household size exceeded 300, were identified to take part in the exercise. The total number of questionnaires were divided proportionately according to the number of households in each neighbourhood. These were distributed through a random sampling procedure where the researcher chose households randomly but in each neighbourhood. In the initial procedure, the researcher approached a dwelling, introduced herself and requested the residents to take part in the survey. However, this procedure proved futile, as most of the residents were suspicious and unwilling to participate. Another methodology had therefore to be devised. The sample size was increased to 2.5% and 350 questionnaires prepared. These were then dropped in the post-boxes on Wednesday and Thursday to give residents a three-day period in which to complete the questionnaires and then collected over the weekend. Though the return rate of this procedure was quite low, 43%, it proved a more practical method than the previous one and 151 questionnaires were successfully completed and collected. This represents a coverage of 1.08% of the total number of households in Stellenbosch.

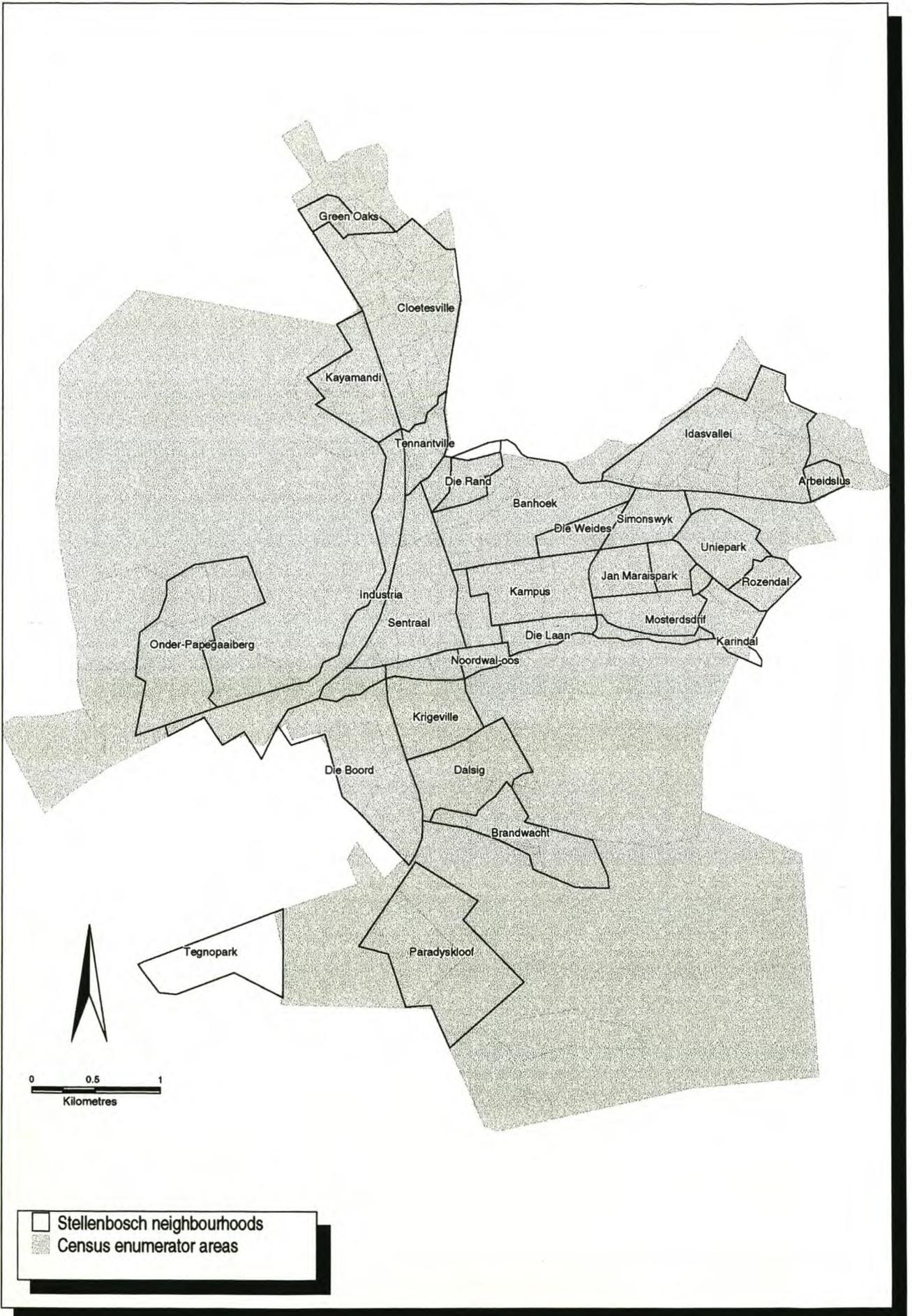


Figure 2: The neighbourhoods of Stellenbosch

From the questionnaire feedback, the table below shows the total number of households that were sampled from each neighbourhood.

Table 1: Number of households sampled from each neighbourhood in Stellenbosch

NEIGHBOURHOOD	NO. OF HOUSEHOLDS SAMPLED
Kayamandi	19
Cloetesville	18
Idasvallei	15
La colline	13
Dennesig	11
Simonsvyk	9
UniePark	7
Rozendal	8
Town Centre	6
Dalsig	10
Die Boord	11
Paradyskloof	13
Onder Pappegaaiberg	11

1.3.2.2 Secondary data

These were obtained through a literature review. The purpose of the literature review was to develop an understanding of the retail market and location strategies. ATMs form an important component of the retail market. It was therefore important to understand the principles behind retail location. A literature study was hence conducted to investigate current locations of ATMs both internationally and in the South African context. The recent trends in locating ATMs were also identified. The literature helped in understanding the problems experienced with current locations of ATMs and what measures banks are taking to address the problem.

A variety of data was also collected for input into the analysis for identifying current location of ATMs and finding new optimal sites. This data, which came in digital format, was available from the Department of Geography and Environmental Studies, University of Stellenbosch. It included the current road and street network of Stellenbosch and its neighborhoods. The 1996 census data was also available from the Department in digital format and contained information on the census enumerator

areas of Stellenbosch together with the income and population levels of each of the enumerated areas.

1.3.3 Software systems employed

Results obtained from the questionnaires were summarised in tables and graphs in Microsoft Excel to assist in their interpretation. The GIS software packages used were Arc/Info and ArcView 3.1. Optimal locations of ATMs were found using the Unix version of Arc/Info, and more precisely, the location-allocation module available within Arc/Info. The sites identified were displayed in Arc/View 3.1. Results obtained from these locations were tabulated and graphed using Microsoft Excel. However, due to the unavailability of ArcView, the final set of maps was printed in MapInfo 4.1.

1.3.4 Research report outline

- Section 1 gives an introduction to the problem, the aims of the research and what has emerged from the literature studied. It also gives a general background of the study area and discusses the methodology used in the study by outlining the data collection procedures.
- Section 2 discusses the literature. It describes factors affecting the location of ATMs both internationally and in South African. It specifically addresses procedures followed for locating ATMs and identifies more recent trends in the field. Problems experienced at the ATM locations are also outlined.
- Section 3 analyses the current situation of ATMs in Stellenbosch. It assesses how ATMs are used in Stellenbosch and compares this usage against the various ATM sites. Customers' opinions on the present location of ATMs in Stellenbosch are discussed and the accessibility of present ATM locations to customers is evaluated.
- Section 4 determines how GIS can be used to find optimal locations for ATMs. Various location-allocation models available in GIS are introduced and a discussion follows on how they can be applied. The GIS models are applied to Stellenbosch to find additional optimal sites. Subsequently, these optimal sites are compared with existing ATM sites.

- Section 5 presents the conclusion and gives a summary of the findings. Lastly, recommendations and areas requiring further research are discussed.

ATMs are a vital part of our daily lives and customers need to live in the knowledge that they have access to their bank accounts whenever the need arises. It is therefore paramount that ATMs be located in areas convenient to their customers. The next section investigates the circumstances surrounding current location of ATMs, both internationally and locally. It looks at the growing need for ATMs and the recent procedures used in locating ATMs.

2. A REVIEW OF THE CURRENT ATM SYSTEMS

Understanding the current ATM situation both in South Africa and internationally is paramount as it presents the problems surrounding ATM locations. This section therefore addresses the need for ATMs, the current procedures used in locating ATMs and the increasing rate of crime associated with ATM locations.

2.1 THE GROWING NEED FOR ATMs

Banks are faced with a big challenge: to bring their financial services to their customers. To the majority of people, formal banks are seen to be denying them opportunities (Cullinan 1993). The most effective delivery of services is now considered to go beyond the traditional bank branch (Morrall 1996). ATMs are therefore emerging as an alternative to traditional bank branches. More and more bank services can now be performed at ATMs without customers having to travel many kilometres to reach a bank branch. While initially transactions at ATMs were limited to cash withdrawals, these have now increased to include cash and cheque deposits, funds transfers and account enquiries. ATMs can also be located in several places and are thus able to reach a wider audience at lower costs.

Gutek and Welsh (2000) address the advantages associated with ATMs. One is that they provide a uniform service to all. The machine is always there thereby providing a constant service. In addition, they see ATMs as bringing a service to more people at lower costs and can create new service products through the use of technology. ATMs are also found to be a way to free humans from boring and unpleasant work and they solve the problem of not enough workers (Gutek and Welsh 2000).

Morrall (1996) points out that 66% of customers in the United States want to do business during the week before 08:00 and after 16.00. They also desire access to their accounts on Saturdays and Sundays. In addition, about 72% of households are dual wage earners and they don't have time to go to the bank during working hours. This calls for reliable ATMs, which can be easily reached by customers.

In South Africa, banks are faced with the challenge to ensure that financial services reach the masses (Cashmore 1993). This includes delivering financial services to the

remotest areas of the country. Lack of proper financial services in remote areas has led to high incidences of fraud (*The Economist 1996*). The most common form in rural areas is pension fraud. At present South African pensioners are mostly paid by cheque. In remote villages where there are no banks within easy reach, pensioners have to cash their cheques at a local shop, paying a commission for the privilege. Some elderly people lose money when their cheques are stolen. Provincial governments, which pay the pensioners, also lose because many people make fraudulent claims (*The Economist 1996*). There is therefore a need to provide ATM services not only in our urban areas but also in the rural areas.

2.2 CURRENT PROCEDURES FOR LOCATING ATMs

Traditionally banks located ATMs only where there was a bank branch. However, with the exception of Boland Bank, ATMs are now located in diverse areas. Table 2 presents some of the criteria used by banks to locate ATMs. Boland Bank will only place an ATM where there is a bank branch (Brenda Nicole, personal interview, 1999). First National Bank (FNB), Nedbank and ABSA Banks all carry out surveys of the potential areas to identify whether there is a demand for an ATM. The banks individually appoint a specialized research team to determine possible areas to locate an ATM. Factors taken into consideration include the traffic flow, probable competition and accessibility in order to service the ATMs. In most cases, customers and businessmen request an ATM in a specific area and a team of experts is then sent to survey the proposed area.

ABSA specifically issues a questionnaire to be completed by the business owners who request the ATM. The questionnaire seeks information regarding matters such as, whether they will be competing with any other financial institution, the area which the ATM will service, the population density, whether ABSA is receiving exclusive rights to install an ATM, streets or entry routes which favour the proposed area, after-hours activity, expected client flow and visibility of the ATM. Boland Bank also places emphasis on the visibility of the ATM and the direction of the sun (Brenda Nicole, personal interview 1999). Nedbank emphasises the competition and will therefore not locate an ATM where there is a strong competition from other banks (Alphonza Pienar, personal interview 1999).

Table 2: Criteria used to locate ATMs in Stellenbosch, July 1999

	ABSA	BOLAND	FNB	NEDBANK
Team of experts to survey area	✓		✓	✓
Location only in Bank branches		✓		
Security	✓	✓	✓	✓
Traffic flow	✓		✓	✓
Direction of the sun		✓		
Competition	✓		✓	✓
Accessibility to bank officials	✓		✓	✓
Questionnaire	✓			
Population density	✓			
After – hours activities	✓			
Expected client flow	✓			
Visibility of ATM	✓	✓		

2.3 MORE RECENT TRENDS IN LOCATING ATMs

Many banks are now realizing the need to have their financial services reach a majority population where the environment is both safe and convenient to the customers. Consequently, new channels of financial delivery are being developed and these are discussed below.

2.3.1. Mobile banking

To counteract problems of providing financial services in rural areas, several international banks have introduced mobile banking. A mobile ATM, complete with all the facilities of the static one, is mounted on a vehicle. The unit can then be used for any type of transaction such as normal cash withdrawal, cash deposits, social security benefits and pensions. In South Africa FNB is one such bank which has introduced a mobile ATM strapped to a truck. The mobile ATM visits different villages on a fixed day each month. These mobile ATMs were especially introduced to combat pension fraud in rural areas. Since launching the mobile services in 1993

fraudulent pension claims had reduced by 15-20% by June 1996 (*The Economist*, 1996).

ABSA has also introduced a wireless ATM that can be used in very remote areas (Brown 1996). Theoretically customers on a lonely road in the middle of a desert can use the wireless ATM. However, the usability of the ATM is limited by the fact that it still needs a conventional power source until an alternative is found. In Randburg Waterfront in Johannesburg, however, the wireless ATM is successfully being used where it operates through a small cellular modem with a large satellite dish next to it for back-up (Brown 1996).

2.3.2 Banking in 24-hour shops

Round the clock banking in convenience shops is a popular choice for many banks when locating ATMs. Since ATMs provide a 24-hour service, many banks choose to locate them in areas where customers shop 24-hours a day. Some of these 24 hour shops are also located at petrol stations. Locating ATMs in these 24-hour shops provides customers with the convenience of drawing money in a safe environment to purchase fuel and to shop anytime.

ABSA and Boland Banks have introduced ATM cards which are accepted to purchase fuel at petrol stations, do convenience shopping at selected Caltex Star Shop service stations and to withdraw cash (*The Star* 1996). This means customers don't have to withdraw cash thereby giving motorists trouble-free buying when they stop at a service station.

2.3.3 Locating ATMs in police stations

In 1995, banks in Anne Arundel County between Washington D.C. and Baltimore in the United States, experienced a series of ATM robberies (Morgan 1997). The banks realized that they needed to locate ATMs in safe places which any potential robber would avoid. Consequently, they considered places where a customer would feel safe while using an ATM. The optimum location was found to be at or near a police station. The county then installed ATMs in all its police stations. In the first year it was observed that the practice of locating ATMs at police stations paid off. ATM crimes in the county decreased to one incident in 1996 and one in 1997, both incidents

occurring at non-county ATM sites (Morgan 1997). The county reported crime-free transactions at police stationed ATMs. Based on its success this initiative is being replicated in several cities in the US. South Africa can learn from this project to ensure customer safety at ATM sites.

2.3.4 Paynet system

A service offered by South African banks in conjunction with Pick 'n Pay supermarkets is the Paynet system. The system allows consumers to perform transactions with their ATM cards at Pick 'n Pay tills. The transactions include paying for their purchases, cash withdrawals, combined purchase payments and cash withdrawals and third party payments (Joseph 1995).

2.4 ATMs AND CRIME

Location of ATMs brings another phenomena into play, crime. Many customers visit ATMs for cash transactions and this provides a good opportunity for criminals to attack unsuspecting clients. The following section therefore addresses the increasing rate of crime and the steps being undertaken to curb this crime.

2.4.1 The rise of ATM-related crimes

The police and financial institutions agree that the severity of ATM crime has increased dramatically, with murder becoming a common occurrence (Lewis, 1992). Most of the crimes occur when criminals obtain customers' PINs (Personal Identification Numbers) enabling them to steal from their accounts. The most common ploy is card swapping where canny thieves watch the customer type in the code, distract him/her and then swap the card (Bearzi 1999). Another popular trick is to insert matches into the machine slot so that the customer thinks the card has been "swallowed". A person standing nearby offers the customers a cell-phone to cancel the card. The call goes through to an accomplice posing as a bank employee. Once the customer has left, satisfied that the card has been cancelled, the thieves extract the card with tweezers and plunder the account (Bearzi 1999). Some customers also naively disclose their PINs to criminals who pretend to be of help (Damon 1999).

In 1998, in South Africa, conmen and conwomen preying on unsuspecting ATM-users cost all the banks in the Western Cape and their clients approximately R31

million and the problem appears to be getting worse (Damon 1999). According to statistics released by the Banking Council of South Africa (Cosab), individual banks lose about R31-million per year to ATM-related crime (*The Star 1998*). This is mainly through theft, vandalism and other abuse of ATMs. In 1998 Standard Bank customers in the Western Cape lost R2,5 million to theft at ATMs. South African banks are already spending in excess of R500 million per year on security, which is much more than that spent in other countries (*The Star 1998*). South African banks spend between R2 million and R8 million a year on repairing vandalized machines, which ultimately affects clients' pockets (Damon 1999).

Stellenbosch has only had one reported incident of a violent attack at an ATM (Amanda Knoetze, personal interview 1999). ATM crime in the town takes the form of vandalized machines. Almost all the banks reported that their ATMs are vandalized frequently and that they have to spend thousands of Rands annually to repair them. The ATM machines are vandalized at least once to twice a month. However, in the case of ABSA ATMs the machines are vandalized more frequently, almost daily. This is mainly the ATMs located in the centre of town, i.e. in Eikestad Mall and Plein Street where there is a lot of activity and many users.

2.4.2 The fight against ATM crime

To counteract ATM crime internationally, more states and cities are passing laws and regulations requiring financial institutions to take reasonable steps to ensure the safety of ATM users. In the USA for example, tough legislation was introduced which requires banks to video tape everyone at or near an ATM around the clock. The legislation also demands that banks build enclosed ATM lobbies with at least one transparent wall and with doors that open only after a personal identification number (PIN) has been punched in (*The Economist 1992*). The New York City Council passed an ATM law requiring surveillance cameras at every ATM location and full-time security guards or electronic door locks. The electronic door locks countercheck the bank cards of people entering the ATM vestibule against the bank's central records (Lewis 1992).

In Cape Town, a joint effort by Business Against Crime, the city Council, the Western Cape province and the police have introduced closed-circuit cameras in the city to

monitor criminals (Heard and Kammies 1998). These are linked to a central control room where staff monitor suspects in an area with a 2 km radius within the CBD. This initiative is proving to be very helpful at monitoring activities near ATMs.

There is also a growing call on banks to allocate security guards to watch over each ATM site especially in the evenings and over weekends (*Cape Times 1999*). Many ATMs are switched off after office hours due to increased crime thereby inconveniencing many customers. Providing security guards at ATMs would scare off potential criminals.

Individual banks are also taking initiatives to control ATM crimes. Standard Bank for example, has taken the fight against ATM bandits to the streets by employing 'takkie' squads who are deployed to trouble spots once criminal trends have been identified. Nedcor, which includes Nedbank, Permanent and Peoples Bank, refer to their ATM crime-fighters as SWAT teams. They too have taken the battle to the streets of Gauteng and have installed time switches at ATMs located in high-risk areas to close them down after office hours.

First National Bank's future plans include the possibility of acquiring ATMs that will recognise a customer's eye. Other strategies undertaken include installing cameras, positioning guards, offering "protective" walls between users and the public, emergency telephones at selected stand-alone ATMs and electronic banking halls.

The location of ATMs has emerged as a very important factor to banks. Banks are continually faced with the challenge of locating ATMs in areas which will be most convenient to their customers. But are customers happy with the present location of ATMs? Are there problems associated with the current location of ATMs? These questions are answered in the next section. Taking the Stellenbosch example, the following section examines customers' feelings towards the current location of ATMs in the town and the accessibility of these ATMs.

3. SUITABILITY OF CURRENT ATM SITES IN STELLENBOSCH

The location of ATMs is now seen as a very important aspect in accessing our bank accounts. It is therefore important to understand customers' attitudes towards current location of ATMs. This section introduces the current ATM sites in Stellenbosch (July 1999), the ATM users and discusses the general feelings of customers towards the existing location of ATMs in Stellenbosch. Having done this, the accessibility of these ATM sites is addressed.

3.1 PRESENT LOCATION OF ATM SITES IN STELLENBOSCH

To determine where ATMs in Stellenbosch are located on the map, a base map was obtained from the Stellenbosch Municipality containing property locations and the ATMs were identified on these properties. Of importance to this study is the location of ATM sites and not the number of ATMs. This is because the aim of the study is to determine the accessibility of ATMs to customers and not how many customers an ATM can handle. An ATM location may therefore have more than one ATM, either belonging to one bank or to several banks. It is possible also that customers only visit ATMs that are aligned to their banks. This is because of the high charges incurred when customers visit ATMs not belonging to their respective banks.

Consequently, it was important to distinguish the location of the different bank's ATM sites. The ATM locations are therefore based on the location of each banks' ATM sites. Hence, several ATM sites in this study may fall at one place because they belong to different banks. For example, Neelsie Student Centre has more than five ATMs. These ATMs on the other hand belong to only three banks – ABSA, FNB and Standard bank. Therefore, Neelsie Student Centre was found as an ATM site for ABSA, FNB and Standard Bank. Figure 3 shows the location of ATMs in Stellenbosch at the time the study was undertaken, that is July 1999. It also shows the ATMs falling within the Stellenbosch CBD.

Based on the possibility that customers only visit ATMs aligned to their banks, the analysis was also done on a bank by bank basis. First, all the banks' ATMs were taken

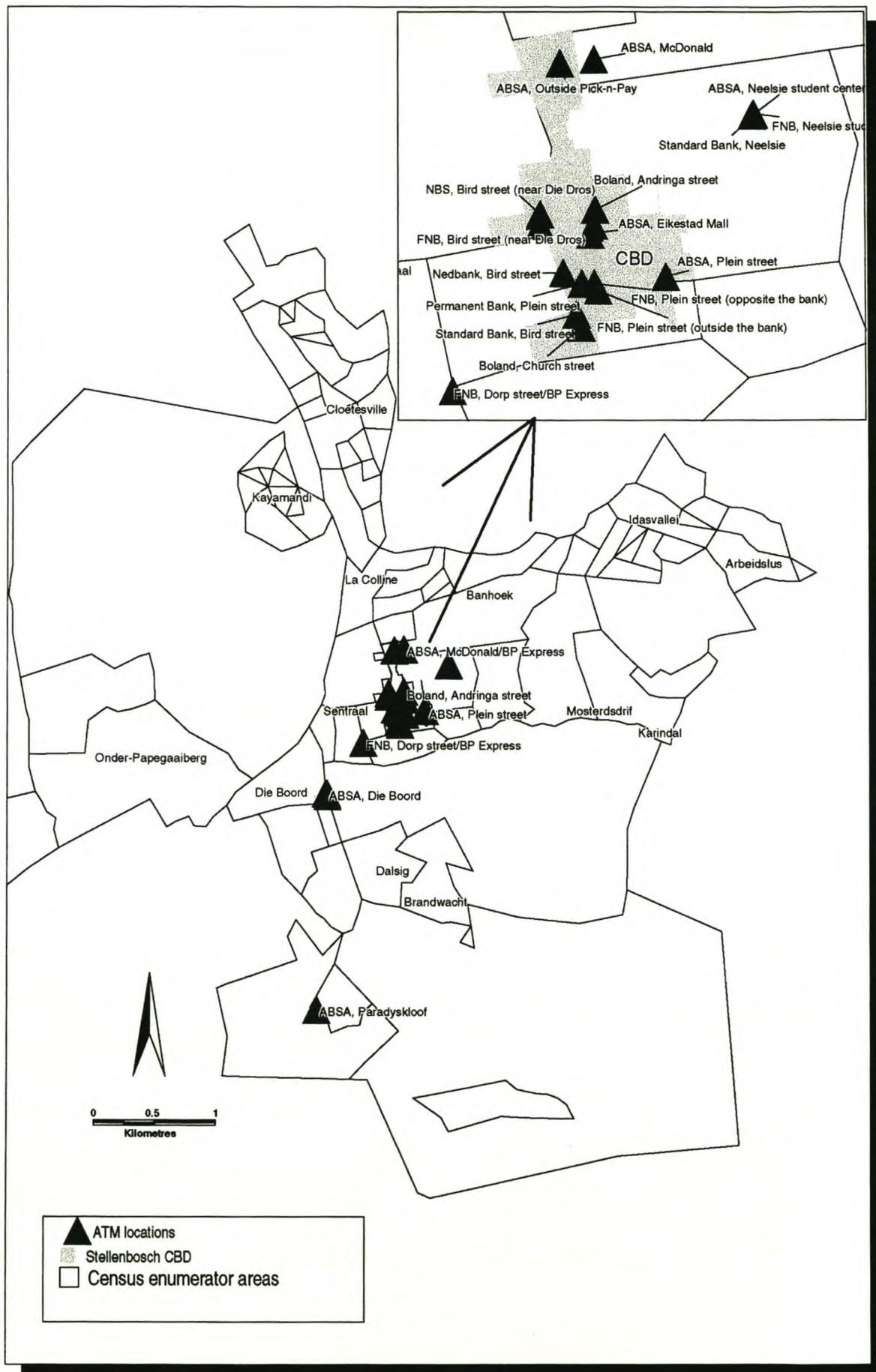


Figure 3: Location of ATM sites in Stellenbosch, July 1999

into consideration as a possibility also exists that some customers may use any ATM irrespective of the bank, and then individual bank analysis was done.

3.2 USING ATMs IN STELLENBOSCH

ATMs have various users and the frequency of their usage differs among the respondents interviewed. The occupational profile of the respondents is presented below together with the frequency of the ATM usage and the most and least visited ATMs in Stellenbosch.

3.2.1 Occupational profile of respondents

ATMs in Stellenbosch mainly attract student and working category clients. Of the one hundred and fifty one respondents to questionnaires distributed in Stellenbosch, fifty five were students. This represents 36.4% of the total number of respondents. Sixty five respondents were from the working category group and this represents 43% of the total respondents. Combined, the students and the working category represent four out of five respondents. A small number were housewives (11.9%), and a much smaller number were private businesspeople (5.3%), and pensioners (3.31%).

3.2.2 Frequency of ATM use

The frequency of ATM use in Stellebosch ranges between 1-12 times a month (Figure 4). 18% of the respondents interviewed visited ATMs 1-2 times a month, 38% visited the ATMs 3-4 times a month, 25% visited ATMs 5-8 times, 16% visited 9-12 times a month and only 3% of the respondents visited the ATMs more than 12 times a month.

Figure 5 shows the usage of ATMs by the respondents in each category group. Among the students interviewed, 45% of them visited ATMs 3-4 times a month, 20% visited ATMs 5-8 times a month, 18% 1-2 times a month and the least number of students, 2%, visited the ATMs more than 12 times a month. In the working people category, 32% of the respondents visited ATMs 3-4 times a month, 26% visited the ATMs 5-8 times a month and an equal number of the respondents, 18%, visited the ATMs 1-2 times and 9-12 times a month. The least number of the respondents in this group, 3%, visited the ATMs more than 12 times a month. Among the housewives interviewed, 33% visited ATMs 3-4 times a month, 28% visited the ATMs 5-8 times a

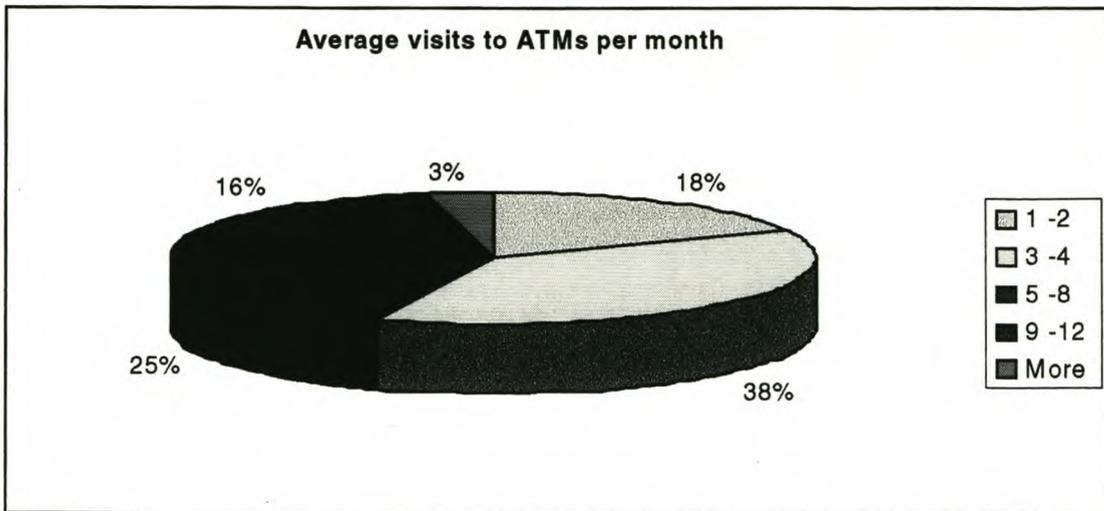


Figure 4: Average visits to ATMs in Stellenbosch by the respondents, July 1999

month, 22% visited 9-12 times while 17% visited 1-2 times a month. Private business people were classified separately as they explained they were in private business thereby making it difficult to group them in any of the other categories. Among this group, 50% visited the ATMs 5-8 times a month, 25% visited the ATMs more than 12 times while an equal number of the respondents in this group, 13%, visited the ATMs 3-4 times and 9-12 times. Lastly, among the pensioners, the majority of them, 60%, visited ATMs 3-4 times a month while the rest, 40%, visited the ATMs 1-2 times a month.

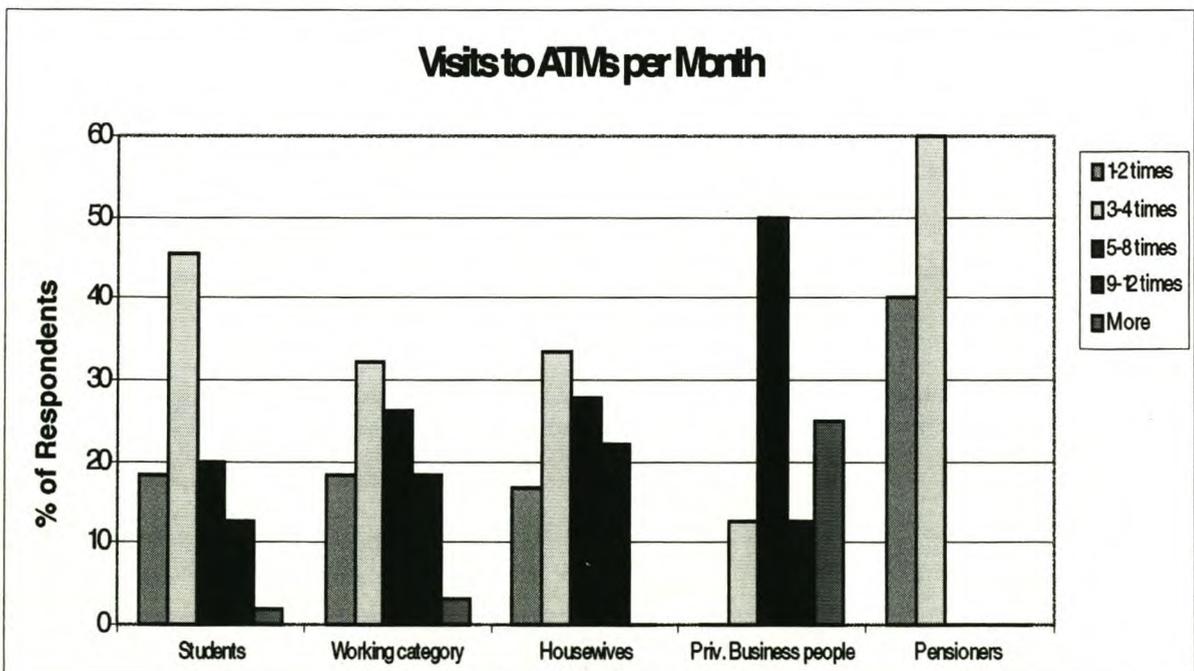


Figure 5: Frequency of ATM use in Stellenbosch, July 1999

3.2.3 Spatial use of ATMs in Stellenbosch

The spatial usage of ATMs in Stellenbosch is expressed in terms of the total responses and not respondents. This is because people visit more than one ATM site. Hence, the number of ATMs visited by each respondent was added and the total summed up for all the respondents. While there were 151 respondents, the total responses from the respondents to ATM visits were 468. The figures cited are therefore an expression of the percentage of the ATMs visited in relation to the total responses.

Figure 6 shows the percentage of the total number of responses from each ATM site while Figure 7 demonstrates the spatial distribution of the ATM usage by identifying the ATM sites and the total response for each site.

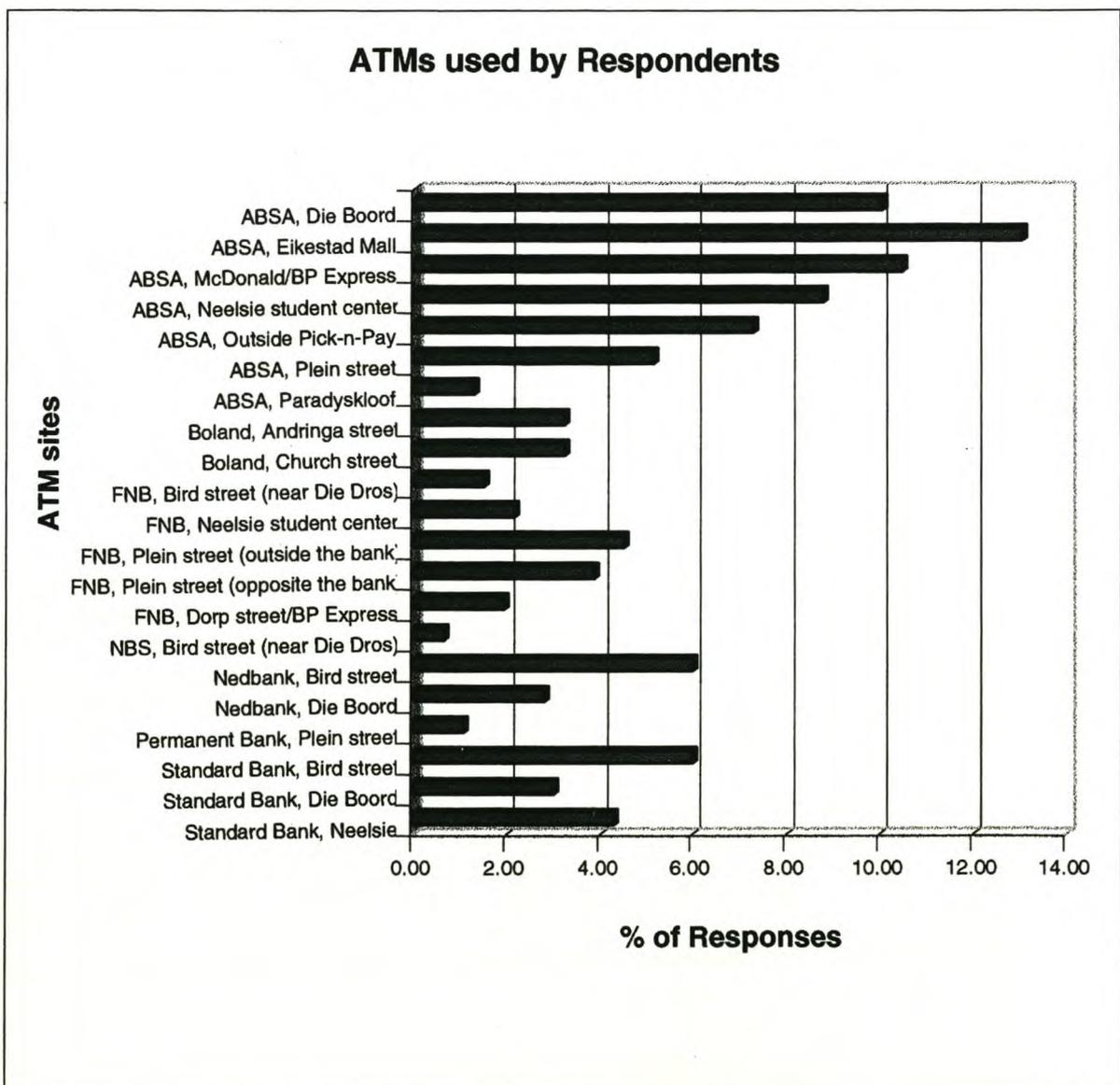


Figure 6: ATMs visited by respondents in Stellenbosch, July 1999

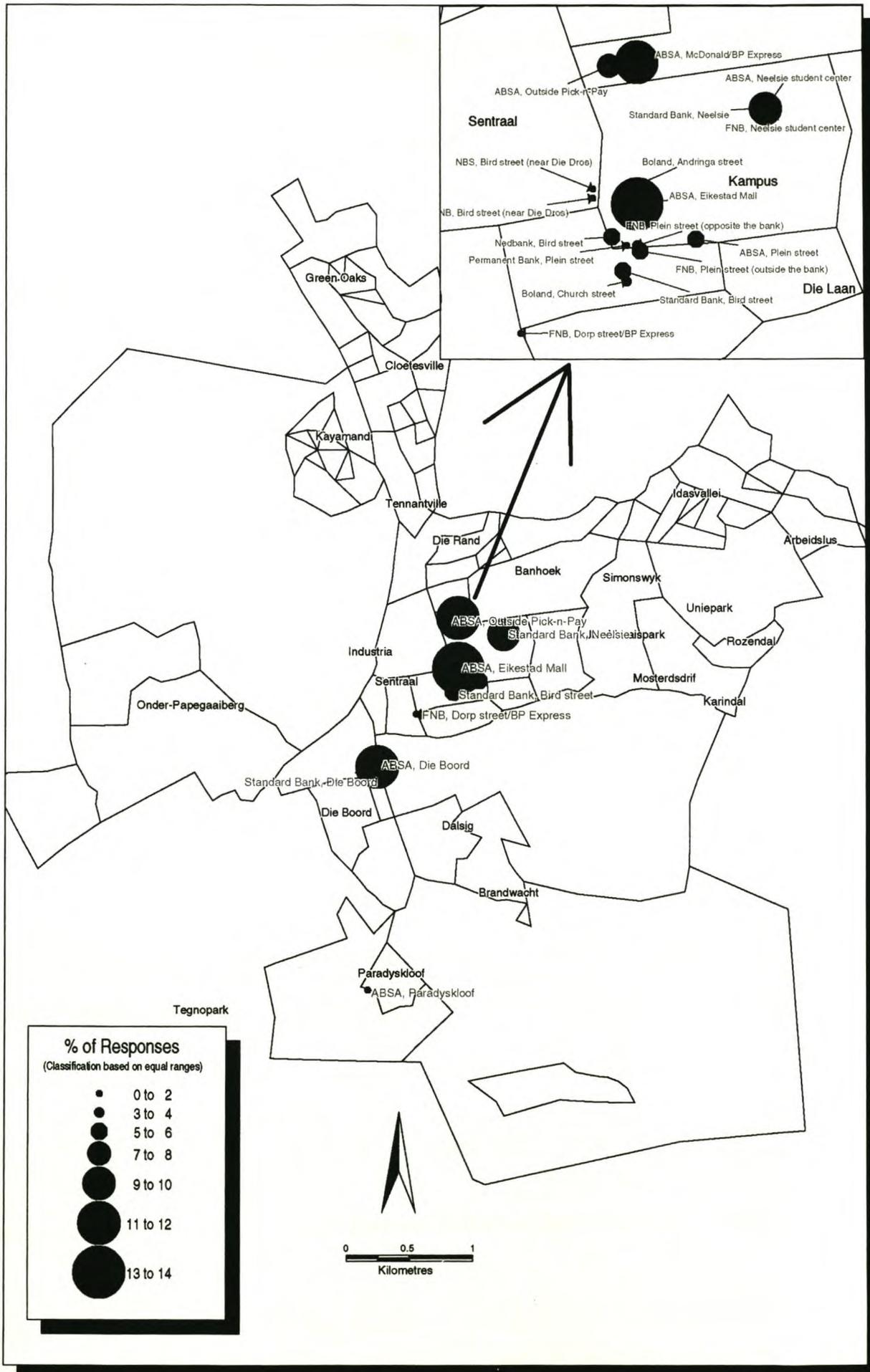


Figure 7: Spatial use of ATMs by respondents, July 1999

From Figures 6 and 7 the most visited ATM site in Stellenbosch is ABSA ATM site at Eikestad Mall. Thirteen per cent of the total responses reported a visit to these ATMs. This could largely be attributed to the fact that there are several ABSA ATMs at Eikeistad Mall and are found both on ground and first floor. Eikeistad Mall is also a major shopping complex and is centrally located in Stellenbosch town. The many ABSA ATMs gives customers the convenience of choosing which ATM to use thus reducing crowding at the ATMs. Ten and a half per cent of the total responses came from respondents who visit the ABSA ATM at McDonald's, while ten per cent came from respondents who visit the ABSA ATM at the shopping complex in Die Boord. The ATM site at McDonald's is situated near a 24-hour shop and an eating outlet and is therefore likely to be used by customers visiting the shop and/or those buying food from McDonald's as well as customers who are buying fuel. The ABSA ATM at Die Boord is located in a shopping complex and is therefore also a convenient site for shoppers.

From Figure 6, six percent of the total responses came from respondents who visit Boland ATMs. There are only two Boland ATM sites in Stellenbosch and the proportion of customers reporting visits to these ATM sites is equal. Of the five FNB ATM sites in Stellenbosch, the most widely visited is at Plein Street - outside the Bank. About four and a half percent of the responses came from respondents who visit this ATM site. This can be attributed to the fact that it is near the bank and is also centrally located. Another FNB ATM site, which is almost opposite the bank, attracts a slightly lesser patronage, namely three point nine percent. The least visited FNB ATM is that at Bird Street, near Die Dros. This ATM site is slightly hidden and is therefore not very visible to passing customers.

The most widely visited Nedbank ATM is that at Bird Street, next to the bank. There are three Nedbank ATMs in Stellenbosch, and this is probably the most convenient as it is located next to the bank on a major street in Stellenbosch. Another Nedbank ATM site is located at Die Boord where many people go to shop but attracts a lesser patronage than the one at Bird Street. The least visited Nedbank ATM is that at Permanent Bank – which is a branch of Nedbank. This may be due to the fact that the branch has fewer customers.

Most Standard Bank customers visit the ATM site at Bird Street, next to the bank. About six percent of the responses came from respondents who visit the ATMs located on this site. Another four point three percent came from respondents who visit Standard bank ATMs at Neelsie and about 3 percent from those who visit Die Boord. The least visited ATM is NBS at Bird Street where only three out of one hundred and fifty one respondents reported a visit to this ATM site.

Having identified the frequency of ATM usage in Stellenbosch, it was important to understand customers' opinions on the current location of the ATMs they use. This is the next focus of this study and is tackled below.

3.3 SATISFACTION LEVELS OF CURRENT ATM LOCATIONS

Of key importance to this study is understanding customers' attitudes towards the present location of ATMs. This was obtained through questionnaires where customers were requested to indicate how they feel towards the location of the ATMs they use. For simplicity purposes so that customers clearly understood what the question demanded, the expressions "happy" and "not happy" were used in the questionnaire requesting customers to tick the appropriate one that best describes their feelings towards the location of the particular ATM they use. The ensuing results are discussed below.

3.3.1 Opinions about the present location

Most customers questioned are content with the present location of ATMs. Figure 8 shows the percentage of respondents who said they are happy or not happy with the particular ATM site, while Figure 9 identifies these ATM sites and also shows customers' opinions about their present location.

On average, 81% of the total responses showed satisfaction with the location of ATMs while 19 % expressed dissatisfaction (see average figures in Figure 8). A location which showed a high level of customer satisfaction is that at Paradyskloof where all the respondents who use the ABSA ATM at this site reported contentment. Another location, Die Boord, also reported a high level of customer satisfaction. All the customers who use the ABSA ATM at this site were satisfied with its location and 90% of the customers who use the Standard Bank ATM were satisfied.

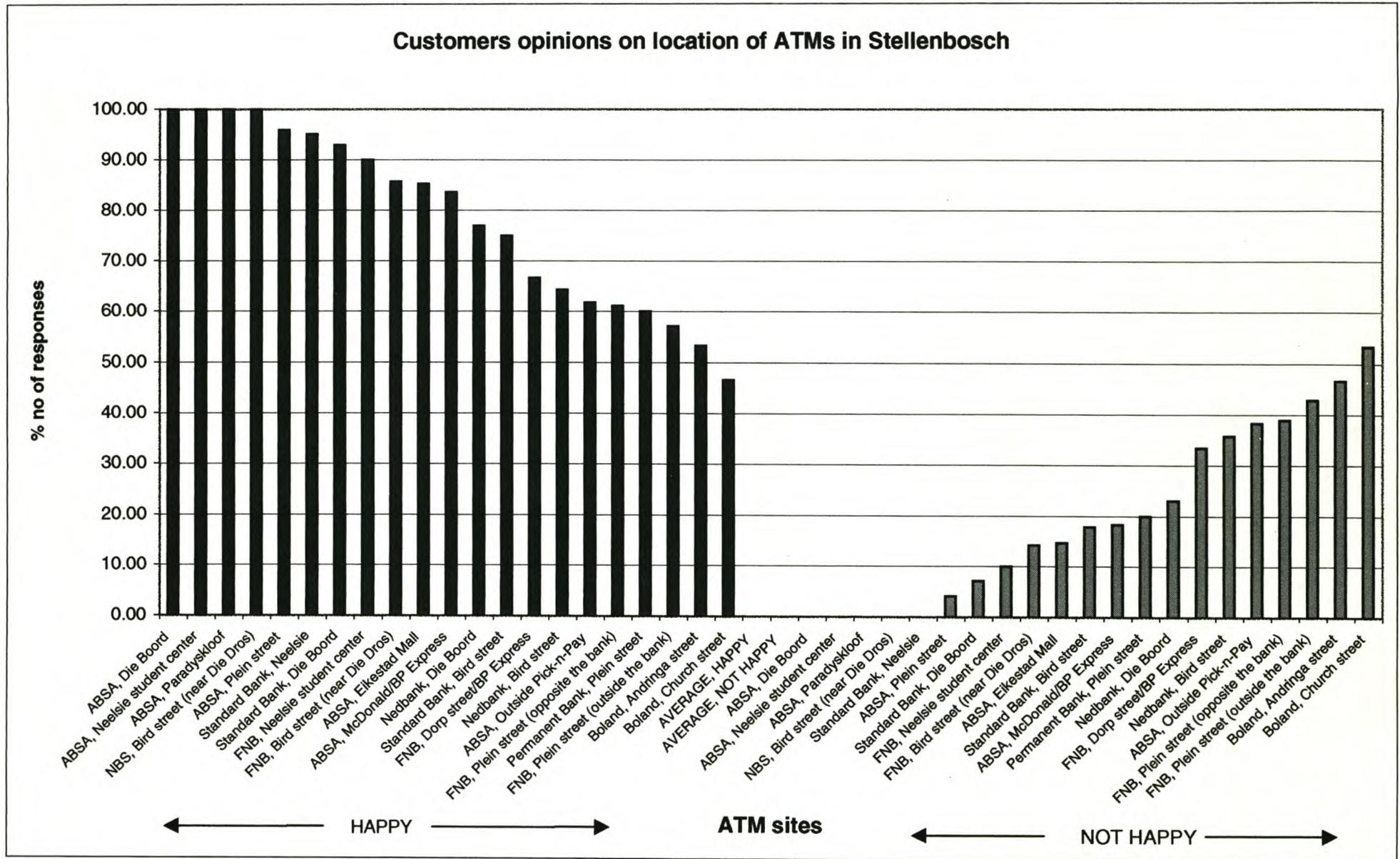


Figure 8: Customers opinions on the location of ATMs in Stellenbosch, July 1999

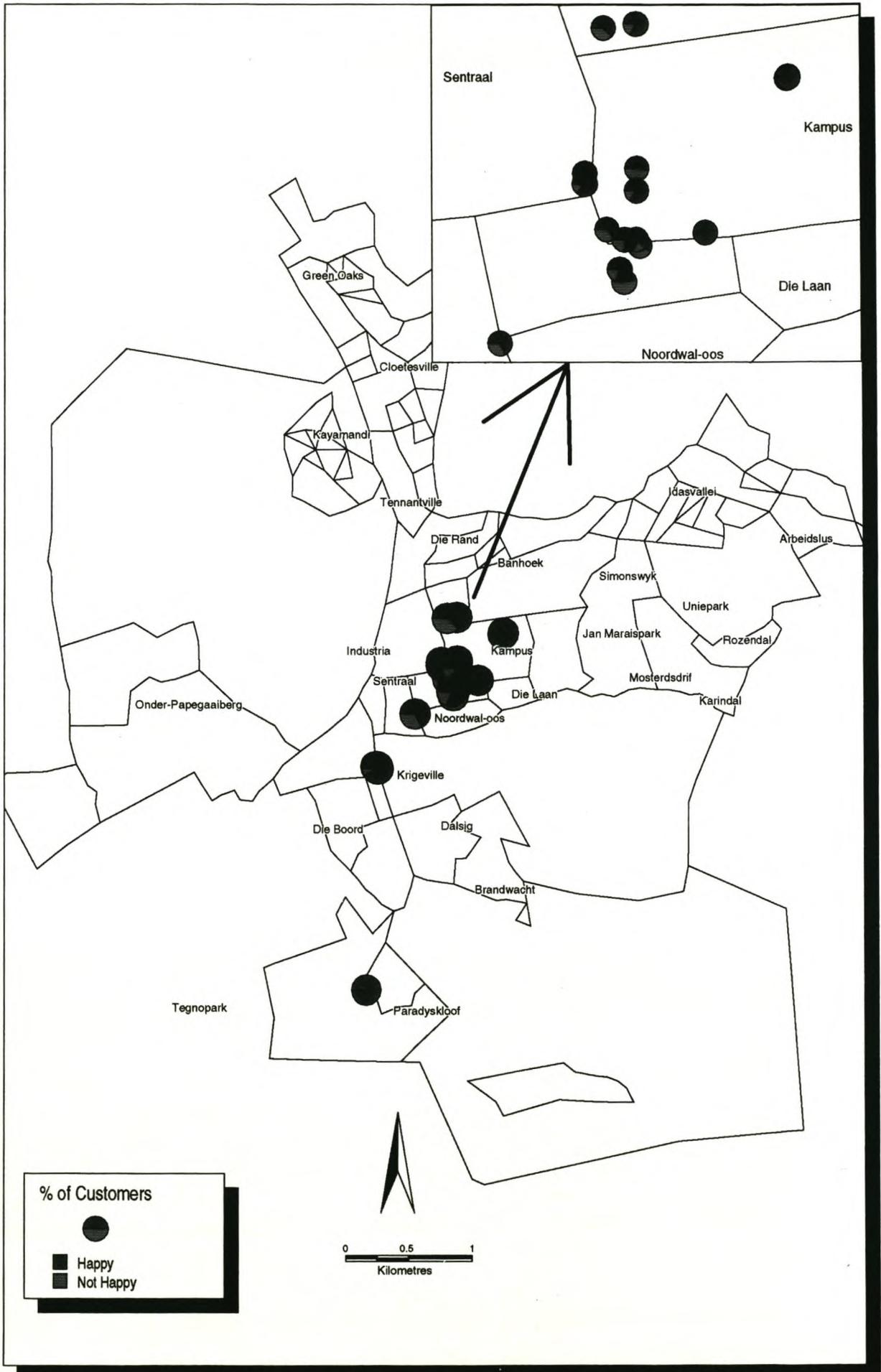


Figure 9. Customers opinions on the current location of the ATMs they use in Stellenbosch, July 1999

Likewise, Neelsie Student Centre also had a high level of customer satisfaction where all the customers who use the ABSA ATMs at this site were satisfied and more than 90% of the customers who use the Standard Bank and FNB ATMs were satisfied.

The least satisfied customers were those who use the ATMs around the town centre. The ATMs in this area include Boland Bank where less than half (46%) of Boland customers who use the ATM at Church Street were satisfied with its location and slightly more than half (53.5%) of those who use the Boland Bank ATM at Adringa Street were satisfied with its current location. About 57% of FNB customers who use the ATM on Plein street outside the bank are happy with its location and 61% who use the FNB ATM opposite the bank are happy with its location.

3.3.2 Reasons for customers' attitudes towards existing location of ATMs

Various reasons can be attributed to customers being satisfied or not satisfied with the location of ATMs. Figure 10 demonstrates this. Of the 425 responses, more than 20% indicate contentment with the location of ATMs because of the latter's closeness to where the respondents shop. Another 12% show contentment with the location of ATMs because they are situated close to where the respondents work and also because the ATMs are located in a safe environment. Few respondents (7% of responses) felt they are happy with the location of ATMs because they are close to where they live. About 9% of the total respondents expressed satisfaction with the ATMs because the ATMs are located in areas with plenty of parking space.

Of those customers not satisfied with the location of the ATMs many, about 24% of the responses, are not satisfied because the ATMs are situated far from where they live (Figure 11). Another 17% of the total responses indicated that the ATMs are situated in areas where there is not enough parking space and that there are long queues at the ATMs. Few of the respondents, 1% of the total responses, expressed an opinion that the ATMs are far from where the respondents shop or from eating outlets. The main factors contributing to customer dissatisfaction with the location of ATMs is the fact that the ATMs are situated far from where they live, that there is not enough parking space and there are long queues at the ATMs. This represents 58% of the total responses.

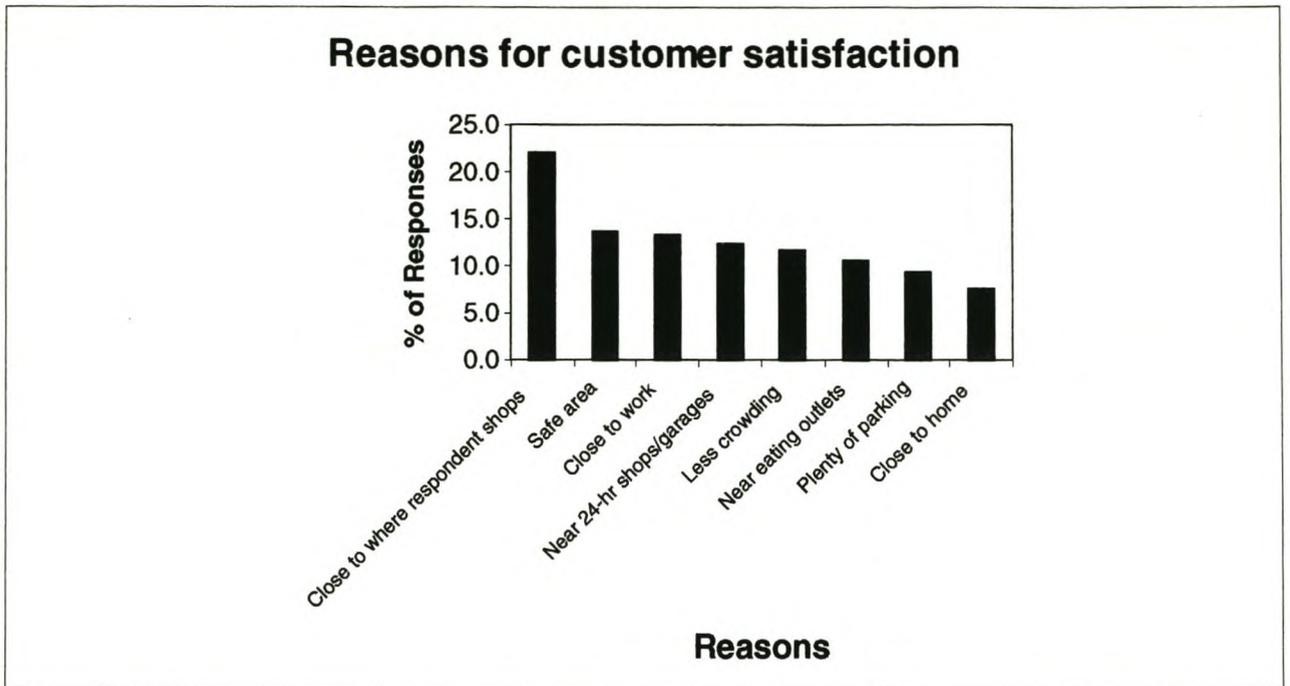


Figure 10: Reasons why customers are satisfied with the present location of ATMs in Stellenbosch, July 1999

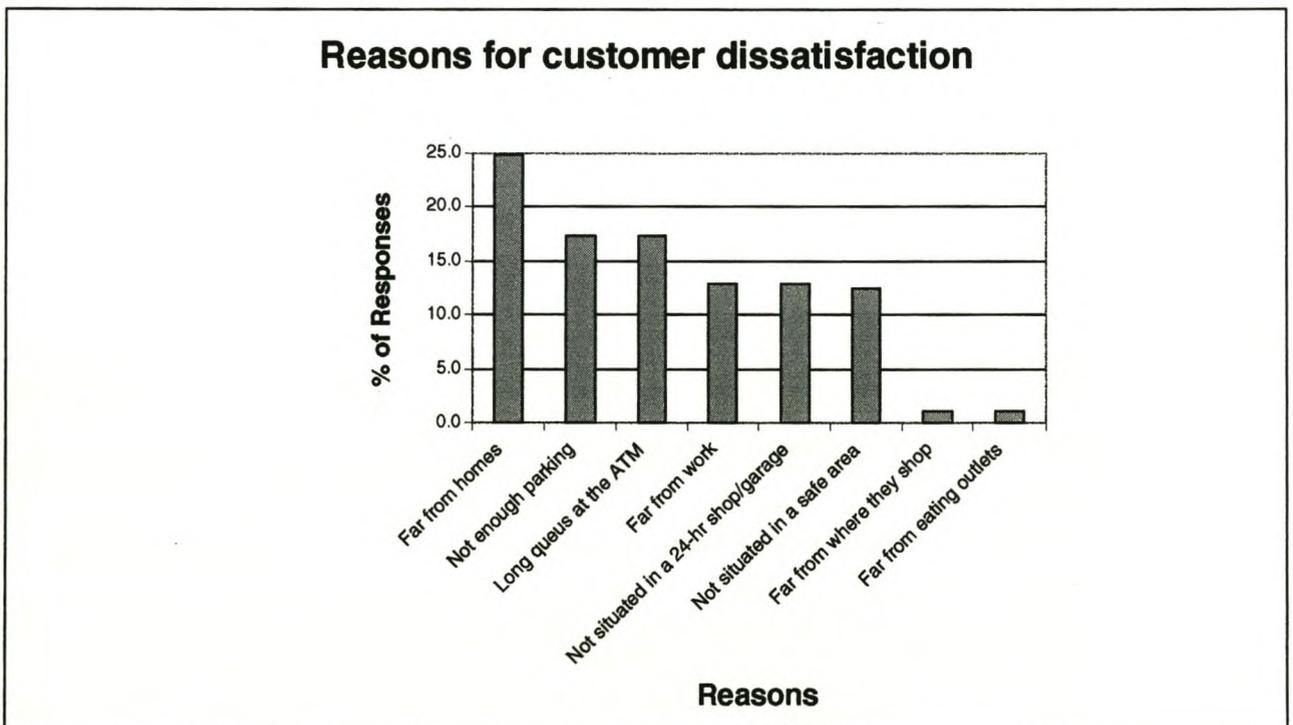


Figure 11: Reasons why customers are not satisfied with the location of ATMs in Stellenbosch, July 1999

Various reasons have been given that explain why customers are satisfied or not satisfied with the current location of ATMs in Stellenbosch. However, the question of accessibility still remains unanswered. The next section therefore examines how accessible these ATMs are to customers.

3.4 ACCESSIBILITY OF PRESENT ATM LOCATIONS TO CUSTOMERS

The following section is based on a proximity analysis done on the ATMs in order to determine their accessibility to customers. This was done with the help of GIS. First, it was necessary to identify the demand for ATMs and then perform an analysis to find the accessibility of these ATMs to customers. The procedures used and the ensuing results are discussed below.

3.4.1 Calculating demand for ATMs

The first step in assessing suitability of current ATM sites was to determine the current demand for ATMs. Calculating the demand for ATMs was a tricky process. Ideally, banks would want to invest in areas deemed profitable to the bank. This means targeting a profitable clientele. The best possible way of determining a profitable clientele is through income assessment. Though it is possible that there is no linear relationship between population income and demand for ATMs, it is however the best possible method of measuring demand. Hence, demand for ATMs in Stellenbosch was calculated based on the 1996 census data. The census data provides income levels of the population per enumerator area (EA). This means demand could only be calculated per EA. The number of people in each income category per EA was multiplied with the mid-values of the income categories. These were added up to give the total income for an EA in Rands. Since the demand had to be a single point in an EA, it was plotted at the centroid of each EA, (see Figure 12). Suitability of present ATM sites and their optimal locations could then be found in relation to the spatial distribution of the demand.

3.4.2 Accessibility of current ATMs to customers, July 1999

To determine how accessible ATMs are to customers, each of the ATMs as mapped in Figure 3 was buffered with multiple rings representing various distances. The buffered distance ranged from 500 – 4500m with a distance value of 500m between the rings. The resulting layer showing the different distance zones was overlaid with

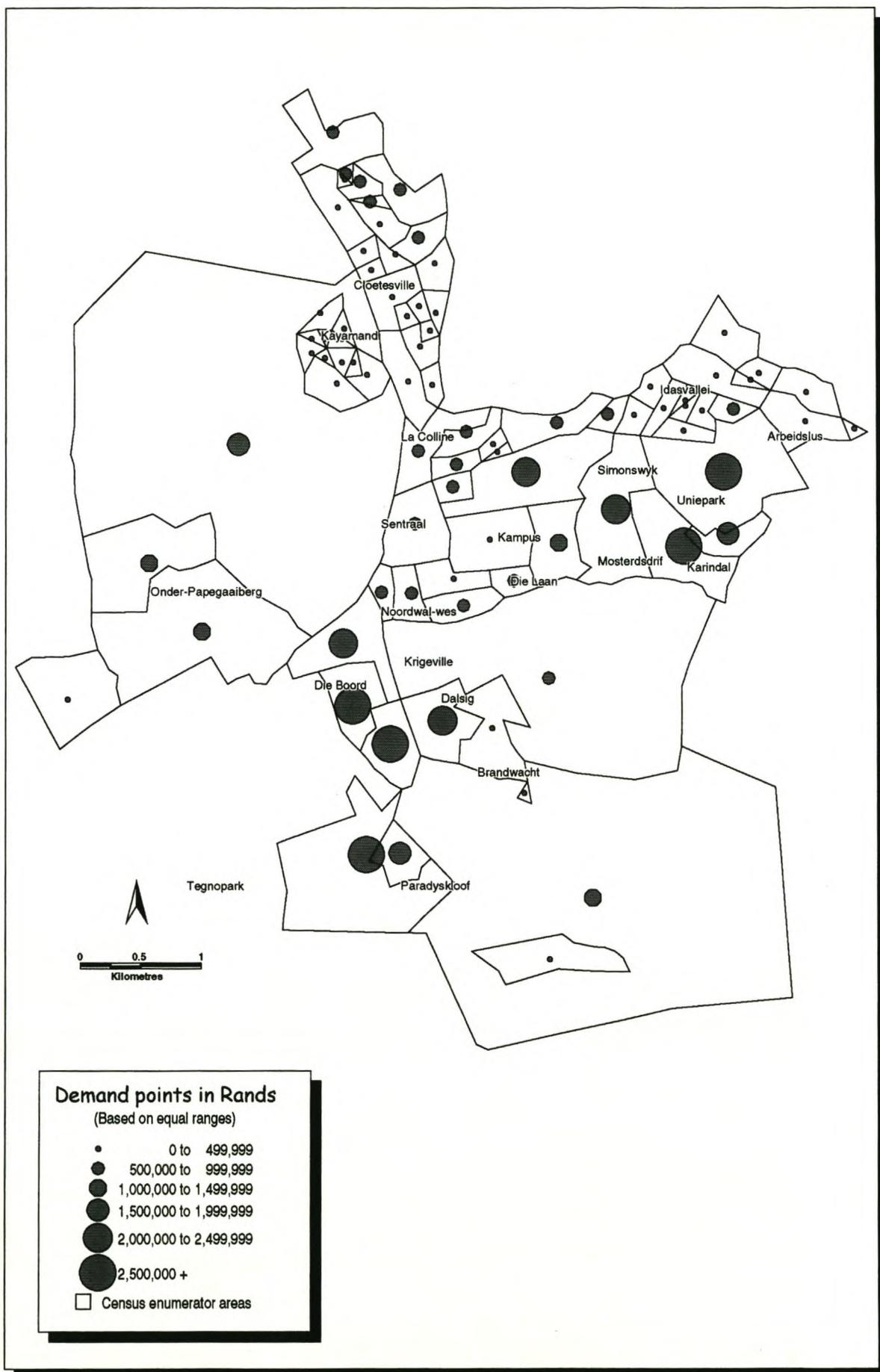


Figure 12: Location of ATM demand points in Rands in Stellenbosch, July 1999

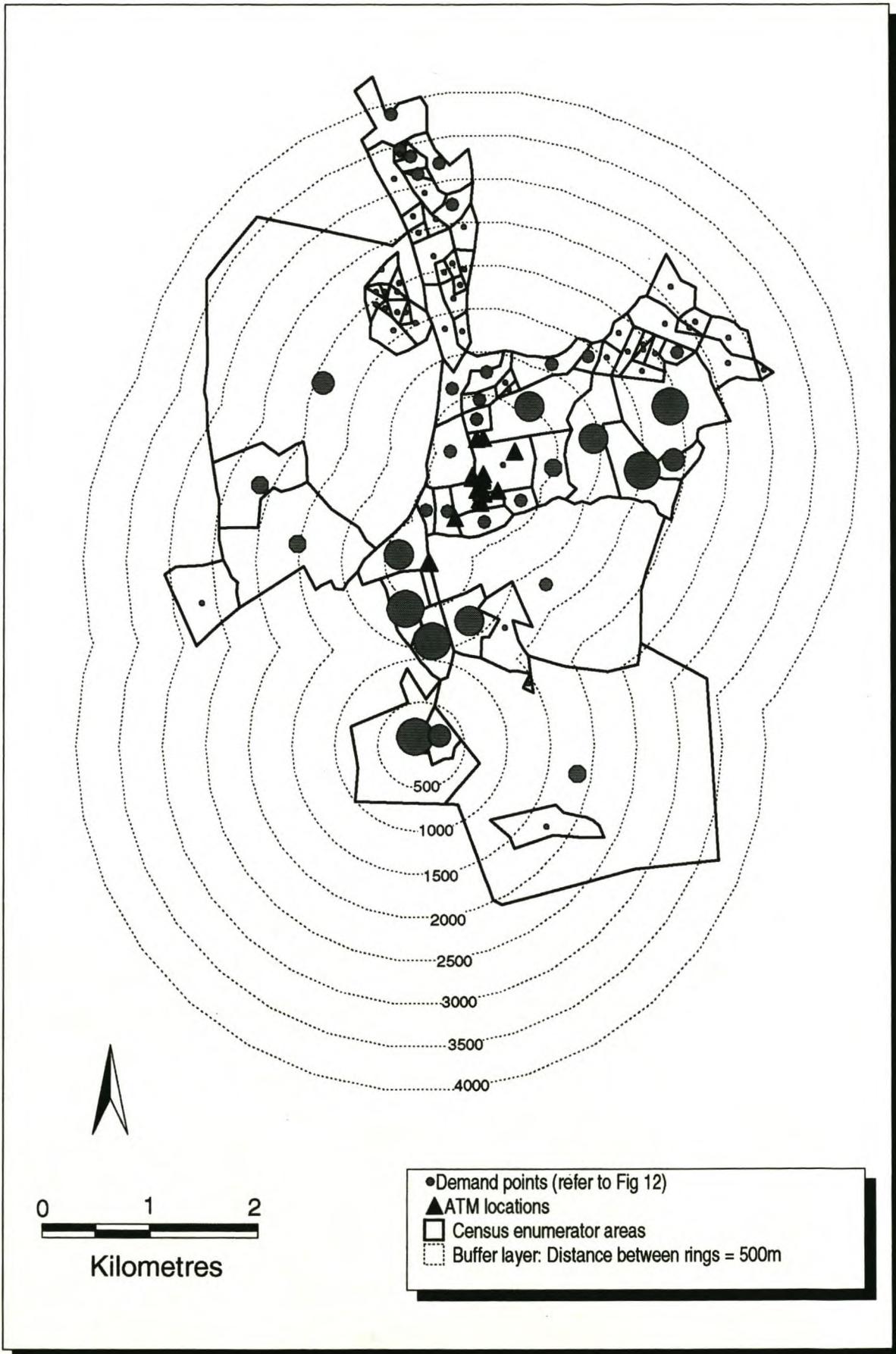


Figure 13: Location of demand points within distance zones from ATM locations in Stellenbosch

both the population distribution of Stellenbosch and their total demand. Figure 13 shows where demand points lie within certain distances from all the ATMs. The rings are drawn from each of the ATM locations.

Each of the specific buffered distance thresholds was selected and the centroid of the EAs which fell within this distance band was selected to give an indication of the population and demand lying within specific distances. This was done using the 'select by theme' option of ArcView. The total population within the various distance threshold was calculated to give the number of people the ATMs serve at specific distances. The same procedure was also applied to determine the total demand served by the ATMs at specific distances. The results were then tabled in Excel and graphs created - Figures 14 and 15 show the population and demand results respectively and table 3 shows the actual figures. The percentage of the population and demand served at increasing distances is summarized in figure 16.

In Figure 14 and Table 3 it can be observed that at a distance of 500m the ATMs are only within a population of about 6316 and at 1000m, a population of about 12533. At a distance of 2500m, the total population reached is 39,581 while the whole population of 51,994 is within a distance of 4000m.

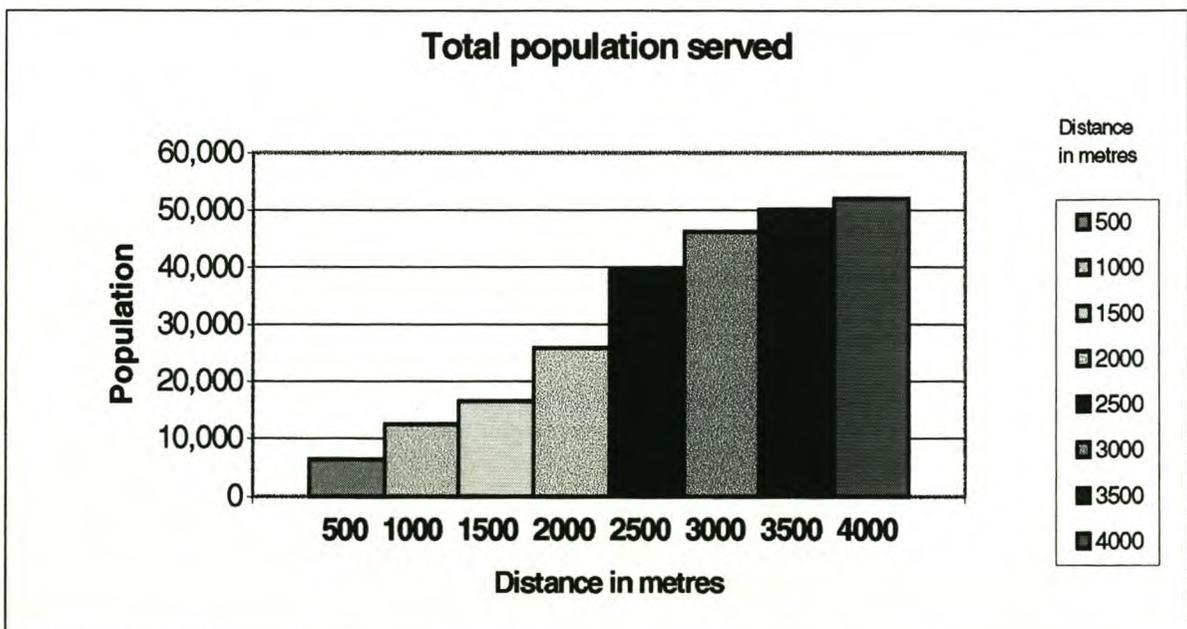


Figure 14: Population within specific distances from all the ATMs in Stellenbosch, July 1999

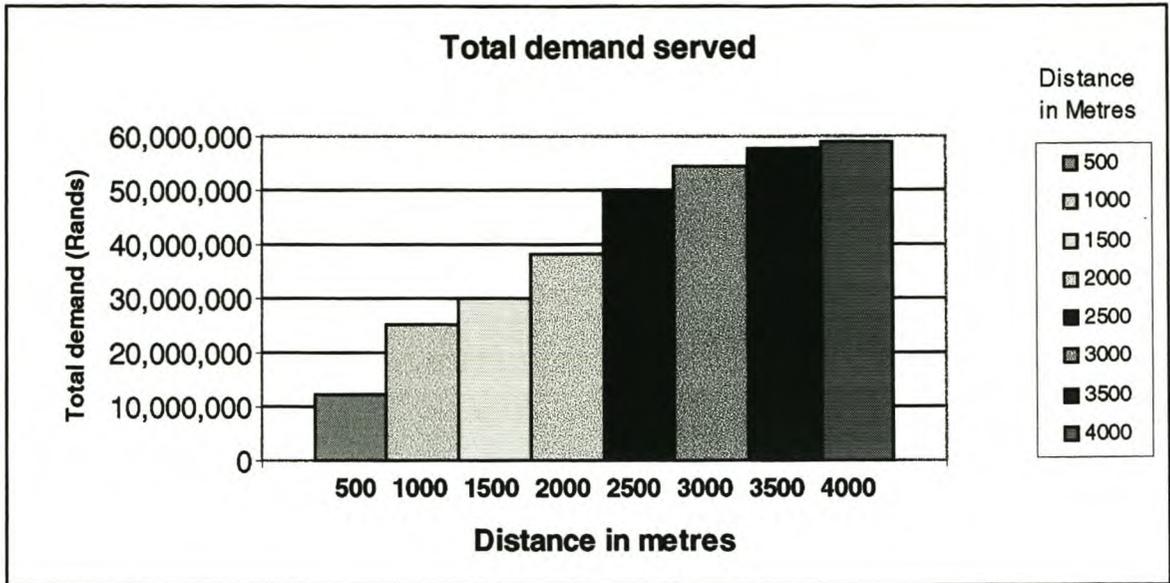


Figure 15: Demand within specific distances from all the ATMs in Stellenbosch, July 1999

Table 3: Population and Demand within the various distances from ATMs in Stellenbosch, July 1999

Distance in metres	Population	Demand (Rand)
500	6316	12244715.00
1000	12533	25094954.50
1500	16559	29944516.50
2000	25723	37970049.50
2500	39581	49731626.00
3000	46091	54200876.50
3500	50042	57547269.50
4000	51994	58886608.50

In Figure 16, less than 5% of Stellenbosch population live within 500m from an ATM and slightly less than 10% within a distance of 1Km. Half of the population (50%), lives within 2.5 and 3Km from an ATM. Looking at demand, about 5% of the total demand is reached at a distance of 500m with slightly more than 10% of the total demand lying within a distance of 1Km. 50% of the demand lies within a distance of slightly more than 2.5Km.

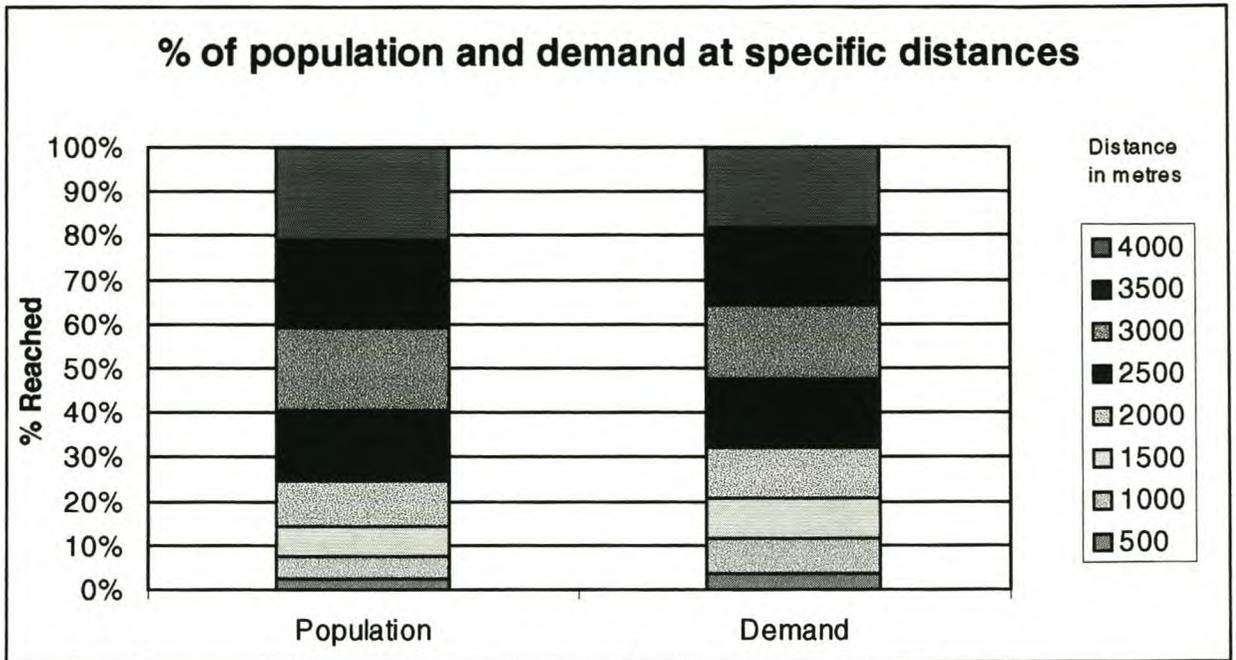


Figure 16: Percentage of the total population and demand within specific distances from the ATMs in Stellenbosch, July 1999

3.4.3 Accessibility of the respective banks' ATMs to customers

The location of each ATM of the various banks was extracted from the ATM coverage as discussed in 3.1. This was done using the 'query builder' in ArcView 3.1. Shapefiles containing the location of ATMs for each of the five banks were created. Each of these coverages was buffered using multiple rings with a width of 500m. The total population and total demand lying within each of these distance thresholds were calculated. Figures 17 to 21 show the location of the individual banks ATM locations and the demand points falling within the various distance zones. The rings are drawn around each of the respective banks' ATM locations.

Figure 17 shows the location of ABSA ATMs and the demand points falling within the different thresholds from the ATMs. ABSA bank has seven ATM locations. Four of these ATM sites are located within the CBD, a fifth one at Neelsie Student Centre, while another ATM site is located farther away at Die Boord shopping centre. The seventh ATM site is at the BP garage in Paradyskloof. ABSA ATMs are fairly well distributed. With four ATM sites in the Stellenbosch CBD, the next closest ATM is at Neelsie Student Centre which is about 480m from the ATMs at Eikestad Mall or 400m from the ATM at the McDonald/Bp Express garage. The ATM site at Die

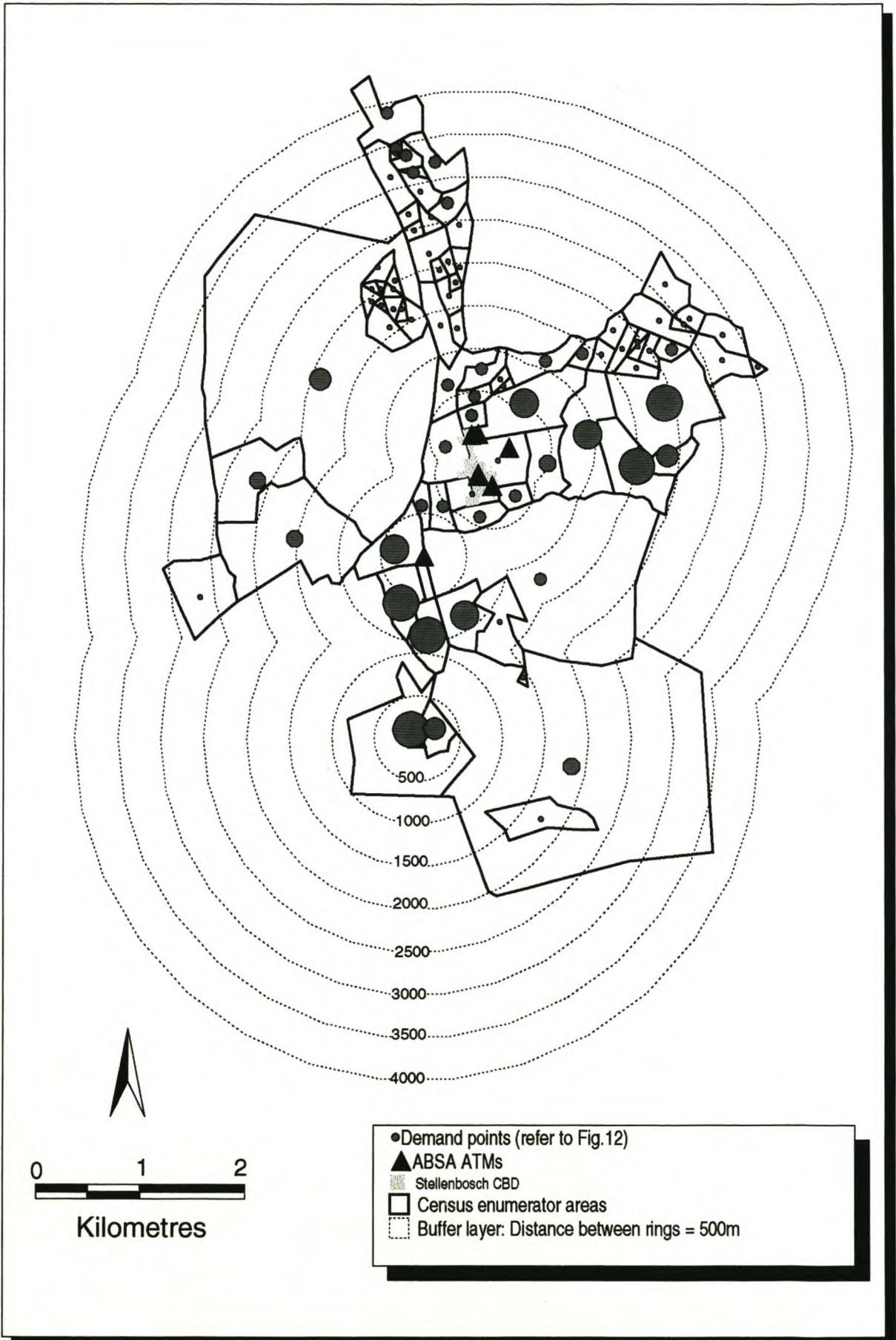


Figure 17: Location of demand points within distance zones from ABSA ATMs, July 1999

Boord shopping centre is about 1.1 Km from the Eikesatd ATMs. The total population and total demand lying within the different distances from these ATMs were calculated. These are presented graphically in Figure 22 and 23.

Figure 18 shows the location of Boland Bank ATM sites. Boland Bank has only two ATM sites located in the CBD next to the bank branches. This is in line with Bolands' policy that their ATMs can only be located next to their bank branches. The total population and total demand lying within the different distance thresholds were calculated and results presented in Figure 22 and 23.

FNB has five ATM sites as shown in Figure 19. Three of these sites are in the CBD, one on Bird Street and two next to the Bank branch on Plein Street while a fourth ATM site is slightly farther away from the CBD at the BP garage in Dorp Street, about 430m from the FNB ATMs located on Plein street. The fifth ATM site is at Neelsie Student Centre. Likewise, the total population and total demand lying within the different distance thresholds were calculated. The results from this analysis are also presented graphically in Figure 22 and 23.

Nedbank and Standard Bank have three ATM sites each as shown in Figures 20 and 21 respectively. Two of Nedbank ATM sites are in Stellenbosch CBD while another ATM site is located at Die Boord shopping centre. Unlike the other banks, which have some of their ATM sites near each other, Standard Bank ATM sites are located relatively far from each other. One ATM site is located in the Stellenbosch CBD, the second ATM site is located about 700m from there, at Neelsie Student Centre, and the third ATM site at Die Boord shopping centre which is about 950m from the Standard bank ATM site at the CBD. Both the total population and the total demand lying within the specific distances from the ATMs were calculated for the two banks. The results are presented in Figure 22 and 23.

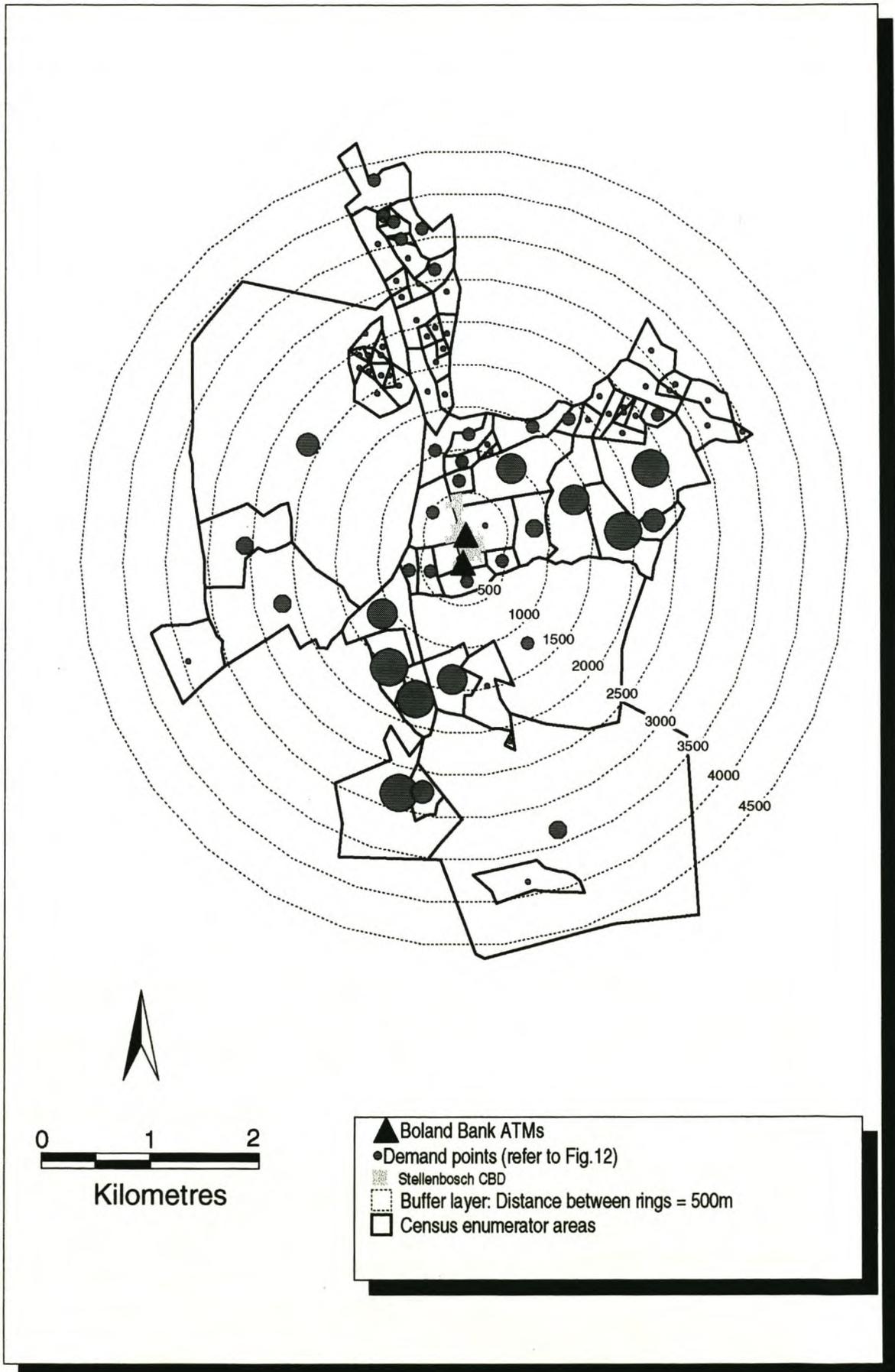


Figure 18: Location of demand points within distance zones from Boland Bank ATMs, July 1999

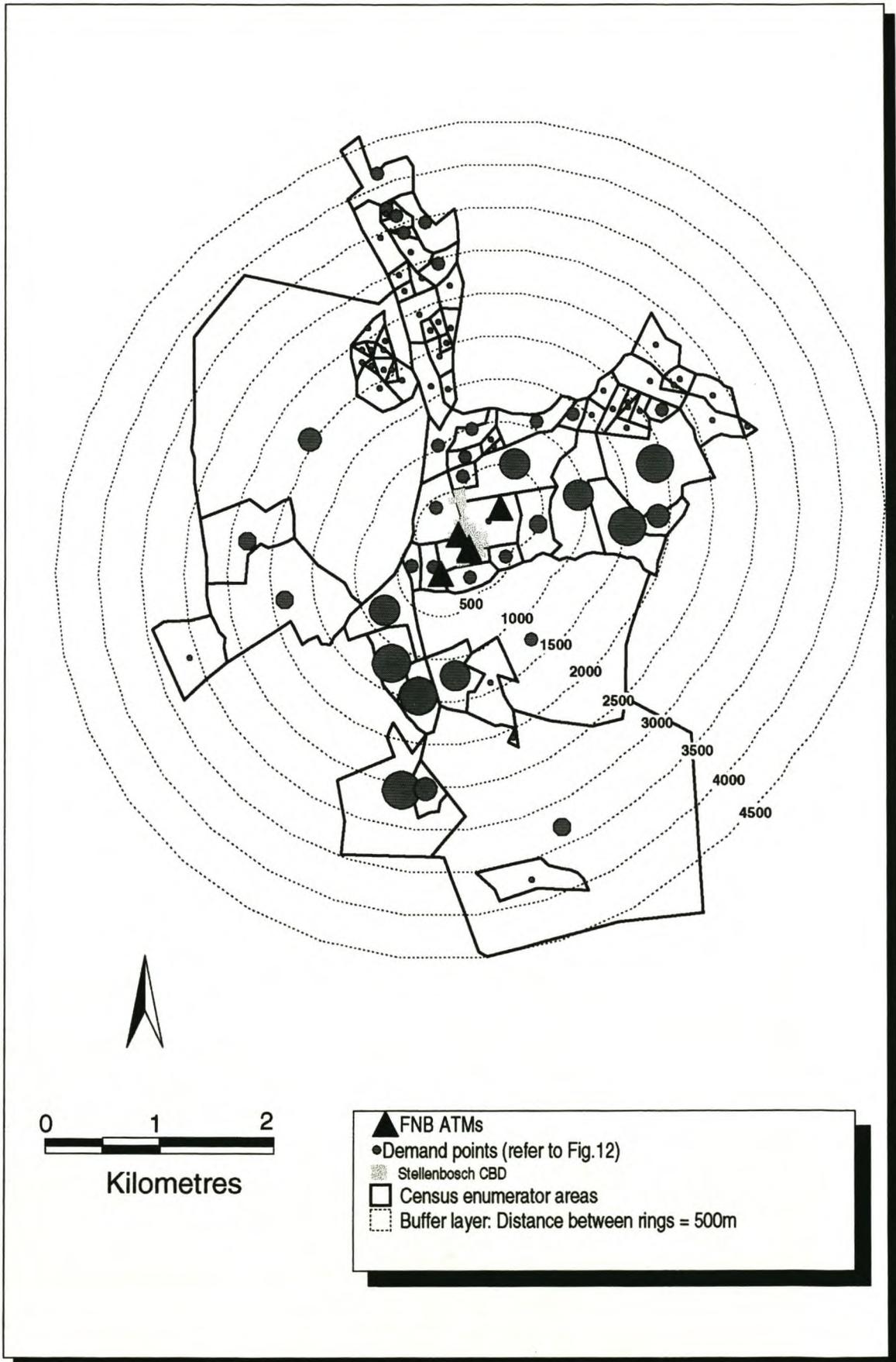


Figure 19: Location of demand points within distance zones from FNB ATMs, July 1999

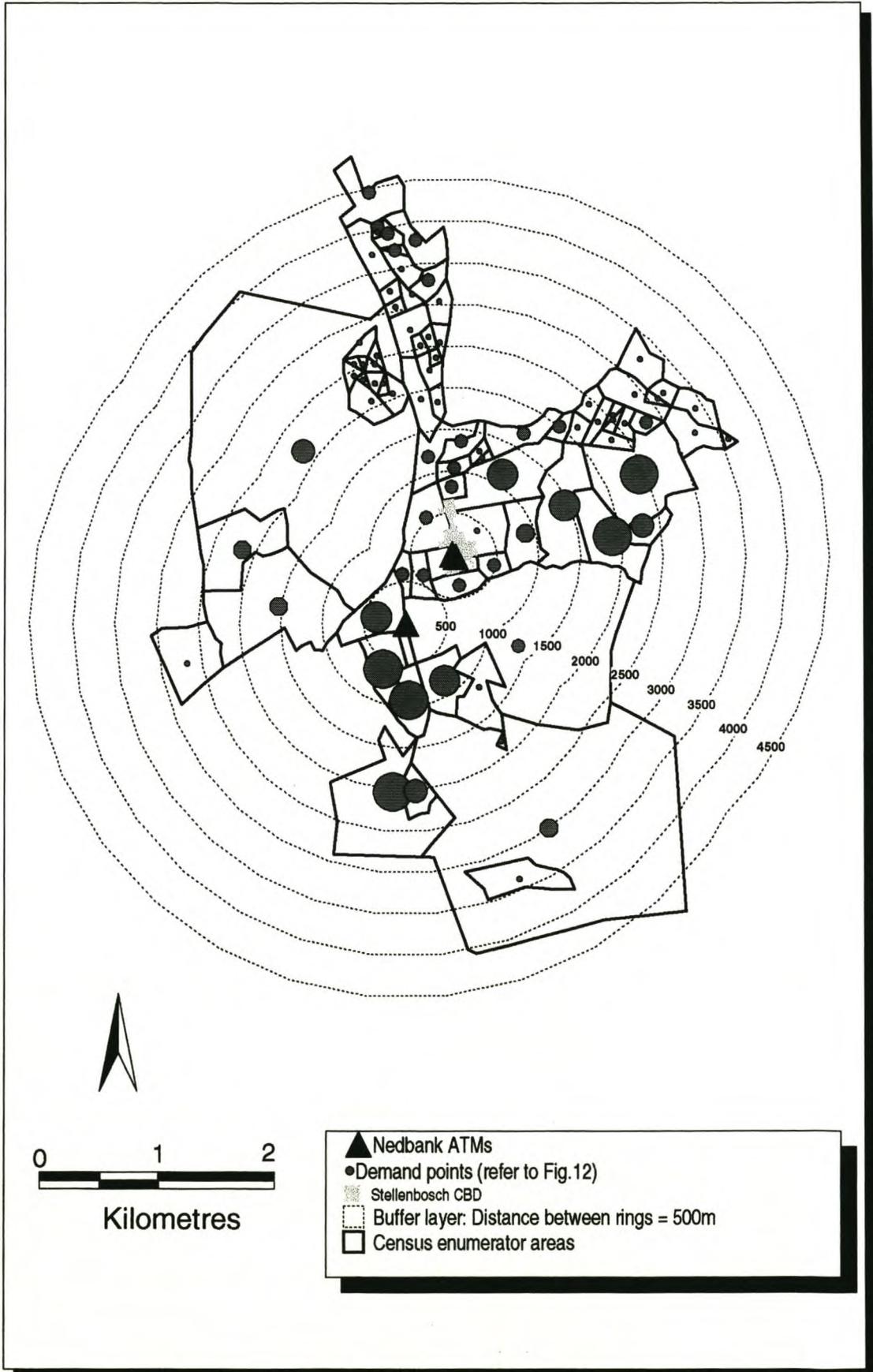


Figure 20: Location of demand points within distance zones from Nedbank ATMs, July 1999

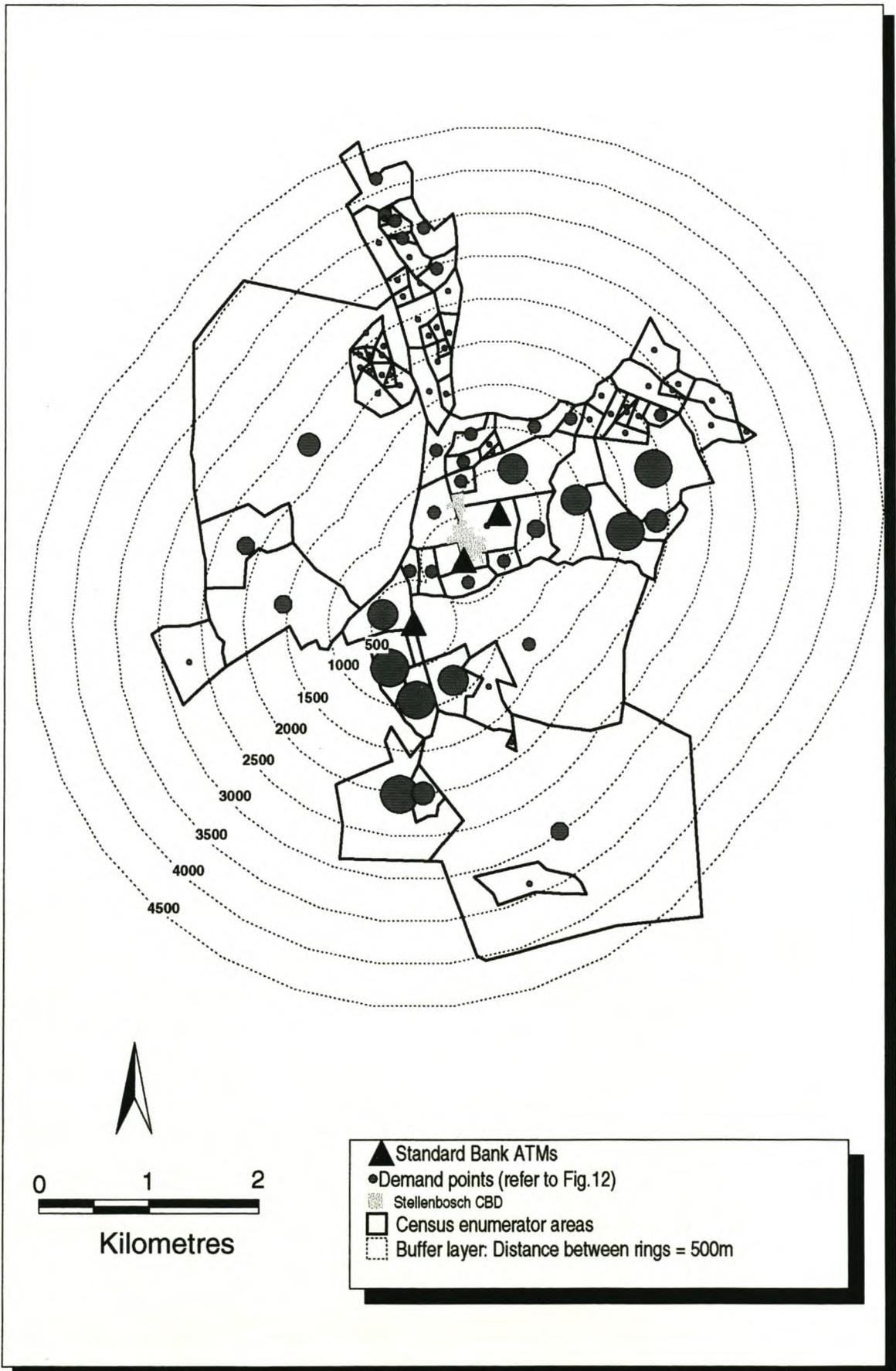


Figure 21: Location of demand points within distance zones from Standard Bank ATMs, July 1999

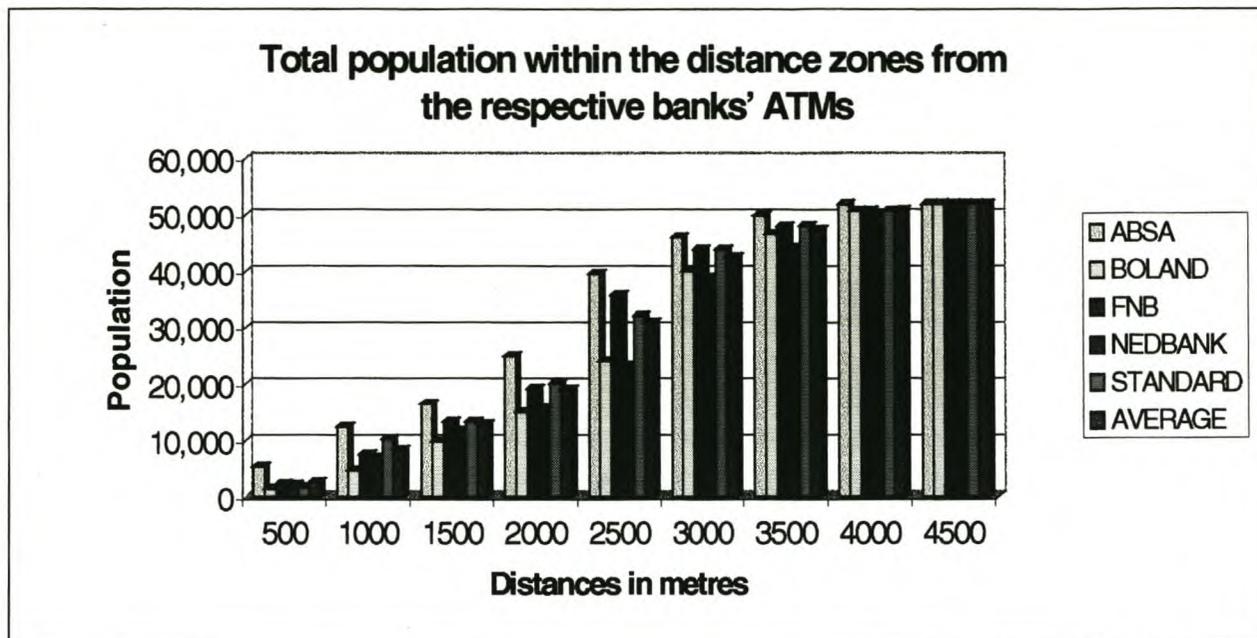


Figure 22: Total population within the distance zones of the respective banks' ATMs in Stellenbosch, July 1999

From Figure 22 ABSA ATMs are found to be within a larger number of customers in every distance zone than any of the other banks. At a distance of 500m FNB, NEDBANK and Standard Bank are all situated within an almost equal number of customers but as the distance increases to 2000m, Standard Bank ATMs are more accessible than the other banks. However, from a distance of 2500m, FNB is situated within more customers. The average population within a distance of 500m from all the banks ATMs is 2684. Only ABSA ATMs are situated within a population greater than the average. At a distance of 2500m, the average population situated within the banks' ATMs is 31,007. ABSA, FNB and Standard Bank ATMs are situated within a population that is greater than the average population reached whereas Boland Bank and Nedbank ATMs are situated within less than the average population. The percentage of the total population that each bank can potentially serve within specified distance zones is summarized in Figure 23.

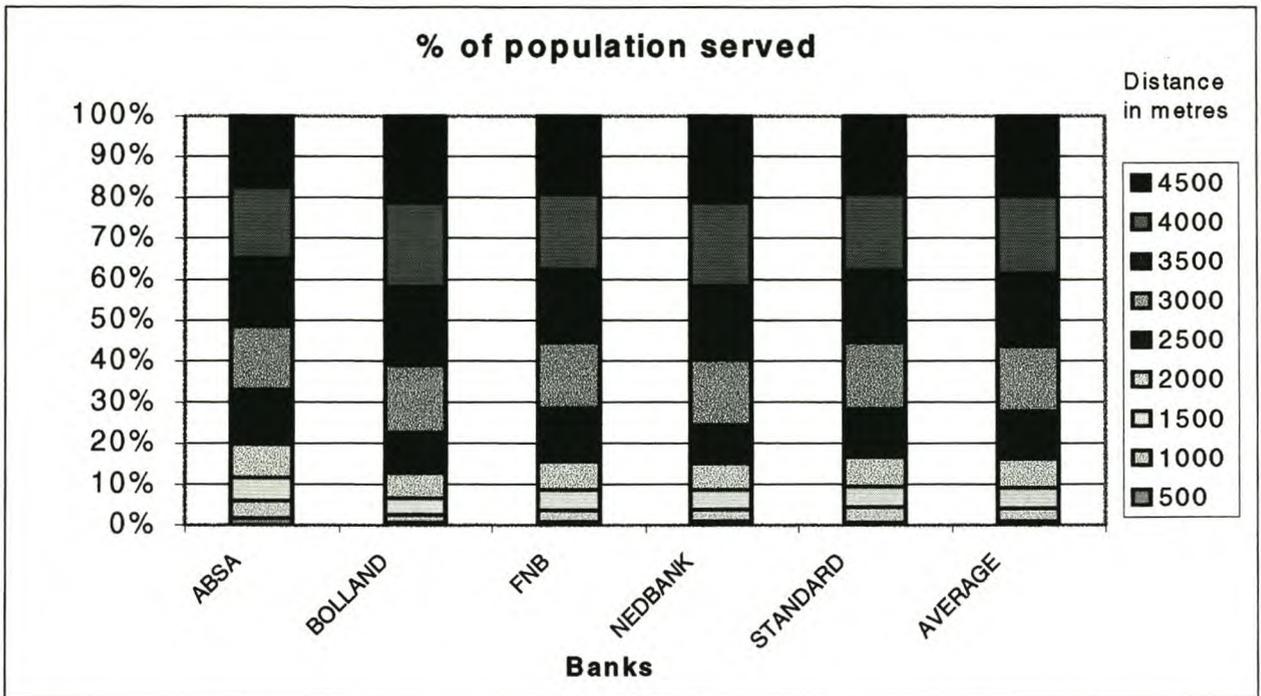


Figure 23: Percentage of population within the distance zones from the respective banks' ATMs in Stellenbosch, July 1999

It can be observed from Figure 23 that ABSA ATMs are within a higher percentage of the population at various distances than any of the other banks. Thirty four percent of the population of Stellenbosch is within 2500m from an ABSA ATM, 23% from a Boland Bank ATM, 28% from an FNB ATM, 25% from a Nedbank ATM and 28% from a Standard Bank ATM. The average population within the ATMs at the same distance is 28%. At a distance of 3500m, ABSA lies within 65% of the total population, while Boland Bank 57%, FNB 62%, Nedbank 58% and Standard bank about 63% of the population. The average population within this distance zone from the ATMs is 62%. Boland Bank and Nedbank are therefore within less than the average population at a distance of 3500m. One can conclude that ABSA ATMs are more accessible to customers than any of the other banks' ATMs.

The total demand within the distance zones from each of the banks' ATMs was also calculated. Figure 24 gives a comparison of the demand lying within the specific distances from each of the five bank's ATMs. The percentage of the total demand was also calculated and is presented in Figure 25. As with the population, ABSA is within

a greater demand than the other banks at the various distances. At a short distance of 500m, the demand within this zone from ABSA ATMs is more than twice the demand within the same zone from any one of the other bank's ATMs. At the same distance, ABSA is within a demand of about R10,000,000 while Boland Bank is within a demand of about R2,500,000, FNB about R3,900,000, Nedbank about R4,700,000 and Standard Bank about R3,800,000. ABSA ATMs are effectively within the total demand of R58,886,609 at a distance of 4000m whereas for the other banks the total demand is only within a distance of 4500m (Figure 24).

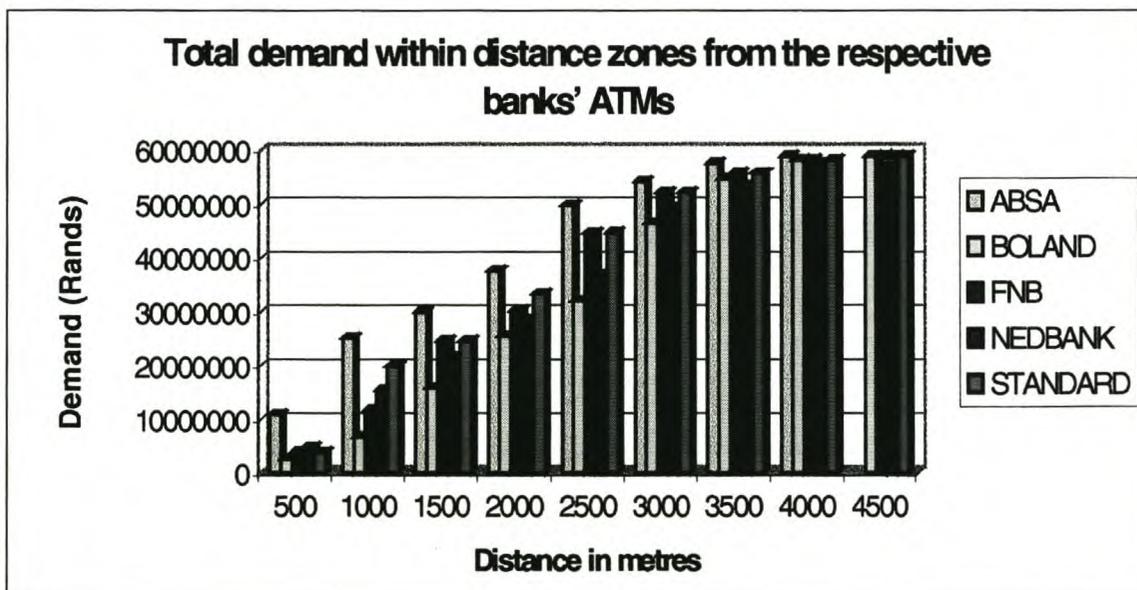


Figure 24: Total demand within distance zones from the respective banks' ATMs in Stellenbosch, July 1999

From Figure 25 it can be observed that at a distance of 1500m ABSA is within 17% of the total demand while Boland Bank is almost within half of this, about 9%. At the same distance, FNB is within 12% of the demand, Nedbank about 13% and Standard Bank 15%. The average demand within this distance zone is about 13%. At a longer distance (2500m), ABSA is within 40% of the total demand and Boland Bank about 28%. FNB serves about 34% of the total demand at the same distance, Nedbank about 32% and Standard Bank about 35%. The average demand at the same distance is about 34%.

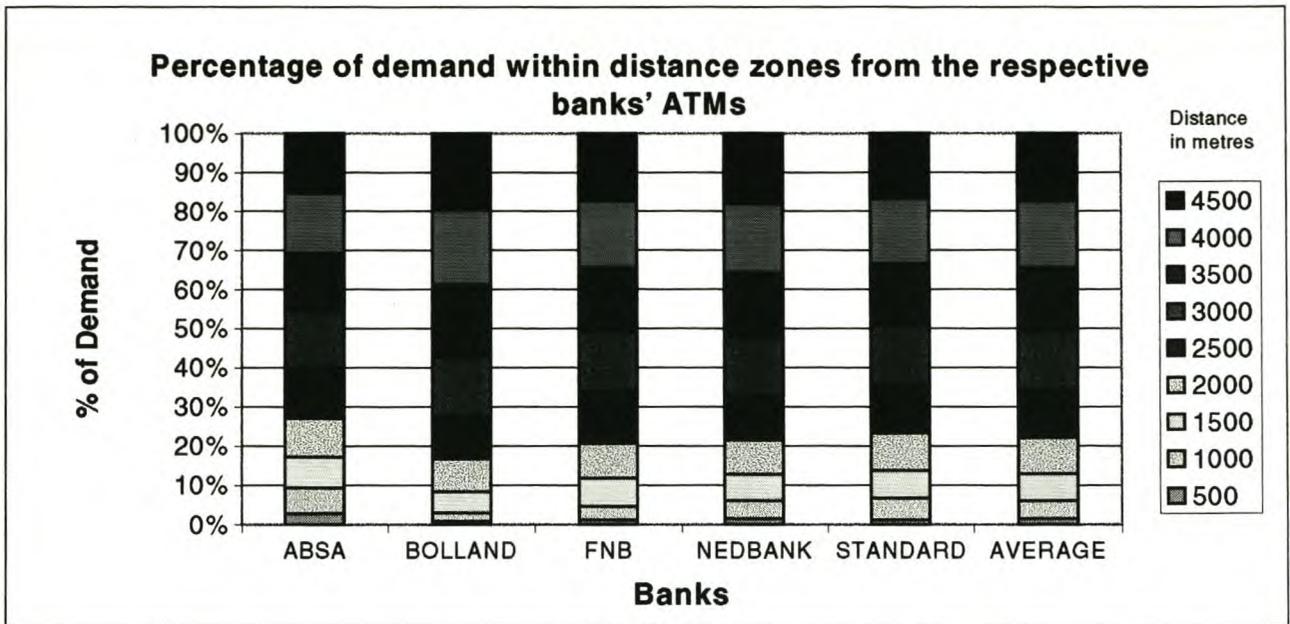


Figure 25: Percentage of demand within distance zones from the respective banks' ATMs in Stellenbosch

From these observations, it can be deduced that ABSA is within a greater population and demand than any of the other banks at the same distances. In some instances such as at a distance of 1500m, ABSA is within more than twice the demand within other banks' ATMs. One reason for this is the fact that ABSA has more ATMs than any of the other banks. ABSA ATMs are also more widely represented.

The next closest bank that is within a high demand at shorter distances of less than 2500m is Standard bank while FNB is within a higher demand at distances more than 2500m. Boland Bank is within a much smaller demand (about 32,019,790) than any of the other banks at the same distance, which is about 28% of the total demand. This can be due to the fact that Boland Bank has only two ATM sites, both of which are located in Stellenbosch CBD. In many cases, ABSA, FNB and Standard Bank show that they are within a population and demand that is higher than the average from all the banks' ATMs at various distances while Boland Bank and Nedbank ATMs are within less than the average population and demand from the ATMs.

Having identified the accessibility of ATMs to customers, the next step was to assess the need for more ATMs in Stellenbosch. Do customers require more ATMs? Which

banks' customers expressed the most need for more ATMs? And what are the reasons why customers need more ATMs? These questions are answered in the next section.

3.4 ADDITIONAL REQUIREMENTS FOR ATMs

While many respondents are satisfied with the present location of ATMs, the majority (64.2%) of respondents, felt that there is a need for more ATMs for all the five major banks. In total there were 119 responses or incidents where the respondents felt either one or more banks should add more ATMs. These responses are expressed as percentages of the total responses received for each bank (see Figure 26).

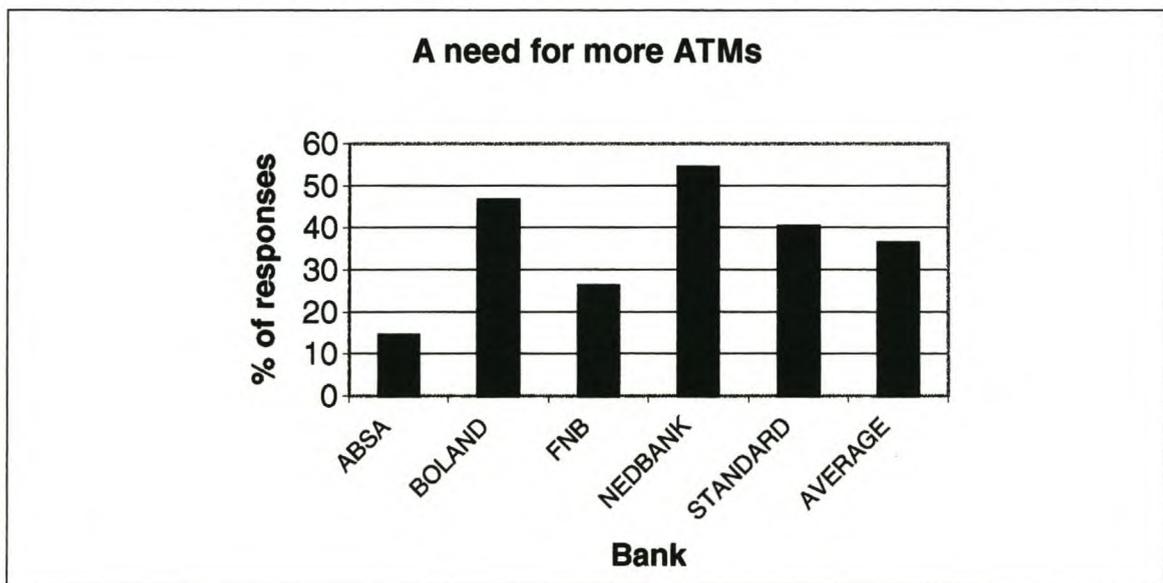


Figure 26: The need for more ATMs in Stellenbosch according to customers, July 1999

The greatest need for more ATMs was indicated by Nedbank customers; 54% of their responses expressed a need for more Nedbank ATMs. Many Boland Bank customers (47%) also felt a need for more ATMs. ABSA bank clients expressed the least need for more ATM sites. This can probably be explained by the several ABSA ATM sites available. On average, 36% of the responses felt a need for more ATMs. Boland Bank customers, Nedbank and Standard Bank customers reported more than the average number of responses who expressed a need for more ATMs while ABSA and FNB customers had less than half the average number of responses who requested a need for more ATMs.

Various reasons were given by customers who wanted more ATMs. The most common reason is that customers would like more ATMs located closer to where they live; some 24% of the total responses indicate this notion (see Figure 27). Another 22% of the responses indicated a need for more ATMs to be located near the shops where the respondents do their shopping. A small proportion of total responses (6.6%) expressed a wish for more ATMs to be located near eating outlets. This shows a general satisfaction with the number of ATMs located near restaurants. Hence, one can conclude that customers are generally content with the number of existing ATMs although some would like more of them.

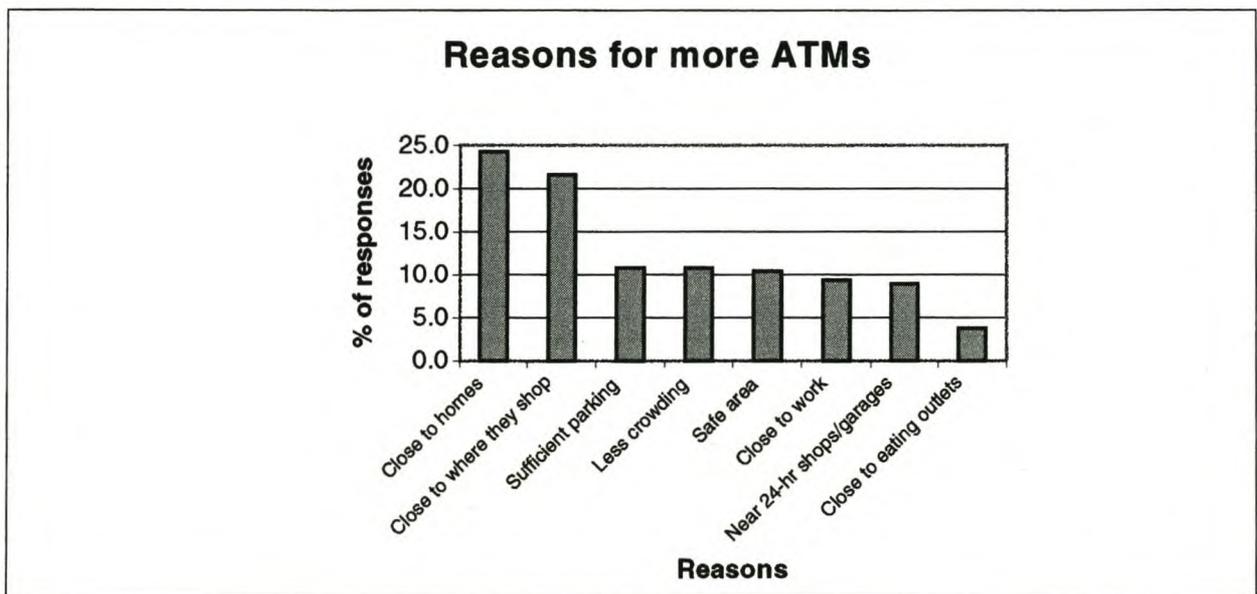


Figure 27: Reasons why customers would like more ATMs in Stellenbosch

The key reasons why customers are satisfied or not with the present location of ATMs have been identified. Many of the respondents, however, are satisfied with the present location of ATMs but feel there is a need for more ATMs. The location of these additional ATM sites is the next problem addressed by this study. The following section, therefore, introduces GIS as a tool for solving locational problems. It examines the options within GIS that can be used to find additional ATM sites in Stellenbosch. The GIS is then applied to find additional optimal sites and the results are presented.

4. USING GIS TO DETERMINE OPTIMAL LOCATIONS FOR ATMs

The following section addresses how GIS can be used to find optimal locations given a set of demand. Having done this, it applies the GIS to find additional ATM sites in Stellenbosch. The results obtained from the additional ATM sites are compared with current ATM sites. Finally, the suitability of these new sites identified by the GIS are addressed and compared with customers' wishes.

4.1 CAPABILITIES OF THE GIS

A GIS is defined as a set of tools for analyzing spatial data. It is an information system that is designed to work with data referenced by spatial or geographic coordinates (Clarke 1997). A GIS database is any database with a geographic variable as a defining variable (Smith and Webb 1997). GIS has proven to be a powerful tool capable of storing, retrieving at will, transforming and displaying spatial data from the real world (Clarke 1997). It is characterized by a great diversity of applications. These set out to answer six generic questions, that is location, condition, trend, routing, pattern and modelling (Clarke 1997). The location question involves querying a database to determine the type of features, which occur at a given place. Condition questions involve finding the location of sites, which have certain characteristics. Trend analysis involves monitoring how things change over time. Routing performs calculations to determine the best route between places, while the patterns question allows description and comparison of the distribution of phenomena. Modelling allows models of the world to be evaluated. GIS proves to be a powerful tool in answering these questions.

Of prime importance to this study is the question of location. With a GIS it is possible to find optimal locations given a set of demands. Taking the population's income as demand, GIS will be used here to determine the optimal locations of ATMs. The GIS functionality used for this task is the location-allocation module of Arc/Info. This is a powerful module designed to solve location-allocation problems and assign facilities for which a demand exists. It simultaneously determines the location of facilities and the allocation of demand to those facilities and exists within the location-allocation models,

which have different optimization criteria. The goal of the models is to locate facilities so that they can supply the population or demand in the most efficient manner.

4.2 LOCATION-ALLOCATION MODELS

This section introduces the location-allocation models available in GIS that are used to solve locational problems. It gives an overview of their capabilities and then goes further to explain the different types of models available and how they function.

4.2.1 Overview

Munroe and Nurani (1999) observe that retail location-allocation problems revolve around selecting locations for multiple facilities to achieve some objective regarding the demand allocated to the facilities. Location-allocation is the process of determining the best or optimal location for one or more facilities so that the service or good is accessible to the population or demand in the most efficient manner (ESRI 1998). There are six location-allocation models available in Arc/Info each designed to solve a different type of problem. The acronyms for these models are: MINDISTANCE, MAXATTEND, MINDISTPOWER, MINDISTANCE – constrained, MAXCOVER and MAXCOVER – constrained. The models optimize efficiency by simultaneously determining the spatial configuration of the facilities (location) and assigning the people (or demand) to the facilities (allocation) (ESRI 1998). The models can be grouped into three categories according to the general type of problems they solve. The three groups are set out briefly below

4.2.1.1 Private Sector Location models

The private sector's objective is to minimize cost and maximize efficiency. This is especially the case with warehouses whose success lies with their capabilities to reduce costs but at the same time provide an efficient service to retail stores. Ideally warehouses should be located in areas that are accessible to all the retail outlets and hence reduce transportation costs. To do this they have to be centrally located in an area that will as much as possible reduce the transportation costs while at the same time ensuring all the

retail outlets are reached. This category model employed here is the MINDISTANCE model.

4.2.1.2. Public sector location models

The purpose of the public sector is to provide equitable service while maximizing efficiency (ESRI 1998). Locating a retail outlet would apply here as it seeks to reach out to as many people as possible within a given constraint (such as distance) while at the same time making it convenient for everyone. In this case the facilities are located in areas that will maximize the demand. Location of public services such as libraries, schools, hospitals and post-offices are also applied here. These models seek to locate facilities in areas where the majority of the population (or demand) is found. The models applied in this case are MAXATTEND, MINDISTPOWER and MINDISTANCE - constrained.

4.2.1.3 Emergency models

In this group the objective is to serve as many people as possible within a given period of time and distance. It entails the location of emergency services such as fire stations, ambulance centres and police stations. The goal is to provide the service as quickly as possible to the surrounding population. Two such models are MAXCOVER and MAXCOVER – constrained.

4.2.2 The MINDISTANCE model

The objective of this model is to determine the location of a given number of facilities so that the total distance travelled from all demand points is minimized. Consequently, the facilities are located at the weighted centre where the total average distance to this point is minimized. This location tends to be centrally located where the majority of the demand is, that is, the median location (ESRI 1998). The model applies primarily to private sector problems where the goal is to minimize transportation costs and maximize profitability by reducing total travel costs. A company that operates a set of retail stores would want to keep travel costs low when distributing resources. The MINDISTANCE model treats the retail outlets as demand points and locates the desired number of

facilities such that the total distance travelled is minimized. Individual accessibility is not the issue rather the overall cost reductions.

4.2.3 The MAXATTEND model

This model seeks to locate facilities closer to where there is a high density of demand. It is based on the behavioural assumption that the likelihood of attendance decreases linearly with distance and seeks to maximize the amount of demand that the facility can service within a specified distance (ESRI 1998). The assumption is that a demand that is close to a facility is more likely to travel to that facility than one that is farther away. It uses a distance-decay function where demand that is within that threshold distance from a candidate location is considered and demand outside that threshold distance has no influence. The result is that the facility is located nearest the highest density of demand locations.

4.2.4 The MINDISTPOWER model

Like the MINDISTANCE model, the MINDISTPOWER model also locates facilities at the locations that minimize the total weighted distance, but subject to a power function, for example squared or cubed. The power function tends to pull the facilities towards demand points that are farther away. A power function is applied to the distance to exaggerate its influence. The larger the distance exponent, the more exaggerated the effects of distance will be. The result is that it indirectly equalizes the distances that individual demand points must travel to their nearest facility, producing a pattern that maximizes equity of service.

4.2.5 The MINDISTANCE constrained model

Like the MINDISTANCE model, this model also seeks to locate facilities so that the total distance travelled is minimized. However, the MINDISTANCE-constrained model imposes a distance constraint so that no individual will travel more than a certain distance to its closest centre. The purpose is to put a maximum distance constrained on any customer to travel to the facility. By imposing a distance constraint, facilities tend to move away from the weighted centre of demand towards outlying demand. However, all

demand points will now be within a distance threshold. It is a suitable model for locating facilities where the objective is to ensure that no demand points are more than a specified distance from their nearest service centre.

4.2.6 The MAXCOVER model

This model seeks to maximize the population covered within a desired distance or time threshold. The facilities are located so that the population covered is maximized within that specific distance (ESRI 1998). A distance threshold is therefore applied which defines the surrounding area that a facility should serve. The goal is to maximize the amount of demand that can be covered within a certain distance.

4.2.7 The MAXCOVER constrained model

Like the MAXCOVER model, this model also locates facilities in order to maximize the population covered within a certain distance. However, it also ensures that a larger population is covered within a second, larger distance. The facilities are located so that demand points not covered within the first distance threshold are covered in the second distance threshold (ESRI 1998). There may be fewer demand points covered within the first threshold but all demand is guaranteed to be covered within the second threshold.

The above models provide an option with which one can use depending on the goal of locating a facility. The following section consequently addresses how these models can be applied in Stellenbosch to find optimal location for ATMs.

4.3 APPLYING THE GIS FOR LOCATING ADDITIONAL ATM SITES IN STELLENBOSCH

GIS has been proven to have the capabilities of finding optimal locations. In this section therefore GIS is applied to find additional ATM sites in Stellenbosch. The models discussed above are brought into the Stellenbosch situation and a discussion follows on the steps taken to find additional ATM sites.

4.3.1 Introduction

Stellenbosch already has existing ATMs. It was therefore important to take this into consideration and then proceed to use the GIS to find additional ATM sites. First, the best possible location for an additional ATM site added to all the existing ATM sites, was determined. This would be an ideal situation for banks that want to add another ATM site which would not face any competition from the other ATM sites. However, while it is possible for banks to look at the competition using the GIS models discussed above, other factors such as security and traffic flow would need further analysis. The models applied here do not take such factors into consideration. Hence, optimal locations are based on the spatial relationship between banks and demand, the latter being the customers. The total demand reached from adding another ATM site is subsequently compared with the current demand served.

Thereafter the ATM sites for the individual banks were identified and GIS applied to locate an additional ATM site irrespective of the ATM locations of the other banks. This is also a practical situation because many customers prefer to visit only the ATMs that are aligned to their bank. This is because of the bank charges levied on customers who perform transactions at ATM not aligned to their bank. Locating an additional ATM site in this case did not take into consideration the location of ATM sites by other banks. Finally, the current demand served by individual banks was compared with the demand that would be served with an additional ATM site.

Assuming that ATMs are important to a large percentage of the population in Stellenbosch, four of the models discussed above were deemed suitable as they can take into account the whole of the Stellenbosch study area. In addition, banks also have different reasons for locating additional ATM sites. Therefore, the models found suitable were MINDISTANCE, MAXATTEND, MAXCOVER and MINDISTPOWER. To apply the models, the existing ATM sites were taken as fixed points and additional ATM sites sought. How each of these models was applied to the Stellenbosch situation is discussed below together with the results obtained.

4.3.1.1 The MINDISTANCE model

The objective of this model is to determine the location of a given number of facilities in order to reduce costs and maximize efficiency. The model is appropriate for banks wishing to locate their ATMs in areas accessible to all their customers. The ATMs would will be located at the weighted centre where the total average distance travelled is minimized.

4.3.1.2 The MAXATTEND model

This model seeks to locate facilities closer to where there is a high density of demand. The objective of the bank here would be to locate ATMs where a majority of the demand is located. In this case, the ATM sites are located where they are in close proximity to the greatest demand. This model requires as input a linear distance-decay function where demand that is within the specified distance is considered and demand outside that distance has no influence. The distance-decay value is calculated by applying a *beta* term to the distance value, where *beta* is a value x such that $x = 1/d$ and $d =$ the distance beyond which the demand has no influence on the ATM site. Stellenbosch has an average radius of 4500m and this was used as the distance to ensure all demand locations are incorporated into the location of ATM sites. The distance-decay value was consequently calculated by dividing $1/4500$ which gave 0.00022. The function is applied here to imply that as distance increases, the less the influence it has on location of a facility.

4.3.1.3 The MAXCOVER model

This model seeks to maximize the population covered within a desired distance. The facilities are located to ensure maximum coverage. Banks would use this model to locate ATMs in order to maximize the population within that distance. A numeric value is incorporated which specifies the maximum distance. To ensure all demand points are taken into consideration, the numeric value was taken to be 4500m, calculated as the average radius of Stellenbosch.

4.3.1.4 The MINDISTPOWER Model

This model minimizes the total weighted distance subject to a power function. The objective of the bank would be to exaggerate the large distances so as to locate facilities

closer to these far demands. The greater the distance, the greater the exaggeration. The model is appropriate for banks that want to locate ATMs to achieve an equitable distribution. A distance exponent of 2 was used. The result is that distances were doubled and ATM sites located at the weighted centres of these new distance values.

Having identified the models that can be applied to find optimal locations for ATMs in Stellenbosch, the next step was to use these models and find additional ATM sites. The next section present the process used to find the additional ATM sites

4.3.2 ARC/INFO COMMANDS FOR EXECUTING LOCATION-ALLOCATION MODELS

The UNIX version of Arc/Info was used in this study to find additional ATM sites. This was done for each of the banks and also for all the banks combined. The four models discussed above were applied in each case, thereby producing different sets of optimal sites. The following are the steps that were taken to find additional optimal ATM sites:

STEP 1. Convert the ATM Shapefiles to Arc/Info coverages

```
SHAPEARC <shape_file> <cover>
```

STEP 2. Find the location of the ATMs in the census (demand) coverage

```
NEAR <in_cover> <near_cover> {point}
```

NEAR determines the closest points to a selected set of points and hence identifies

the closest demand point to the current existing ATM sites. This acted as the existing ATM sites.

STEP 3. Update the locations of the ATMs in the demand coverage as fixed sites

Issue a value of 2 for current ATM sites, and 1 for the other demand points in the field of candidate_item. A value of 2 specifies that a site is a fixed site (that is, an ATM already exists there) and a value of 1 specifies that it is a candidate location for potentially locating ATMs.

STEP 4. Specify the coverage for site selection

LOCATECANDIDATE <cover> <poly | point> <demand_item>
{candidate_item}{supply_item}

<cover> - specifies the coverage containing the feature class for site selection together with the specified demand, in this case the population income coverage.

<point | poly> - specifies the feature class that contains the specified demand, in this case <poly>.

<demand_item> - the item that provides the demand at that location, in this case the total income per EA.

{candidate_item}- the item which indicates the candidacy of that location. A value of 0 indicates that it is not a candidate, 1 indicates that it is a candidate and 2, that it is a candidate with a fixed point, that is, an ATM has to be installed at that location or one already exists there. Here, the value of the candidate_item has already been specified in [Step 3](#).

STEP 5. Specify the criteria to be used for site selection

LOCATECRITERIA MINDISTANCE:

Specifies MINDISTANCE criteria

LOCATECRITERIA MAXATTEND <distance_decay>

Specifies the MAXATTEND criteria

<distance_decay> - the numeric value defining the distance-decay. In this case 0.00022.

LOCATECRITERIA MAXCOVER <max_distance>

Specifies the MAXCOVER criteria

<max_distance> - the numeric value defining the maximum coverage distance. In this case 4500m.

LOCATECRITERIA MINDISTPOWER <distance_exponent>

Specifies the MINDISTPOWER criteria.

<distance_exponent> - the numeric value that exaggerates the distances between the demand node and the centres. In this case 2.

STEP 6. Find additional optimal sites

LOCATEALLOCATE<out_allocation_file><out_centers_file>
<out_globals_file> {number_of_locations}

<out_allocation_file> - the INFO file to be created which will contain a list of all the demand nodes, the first and second closest ATM site and the respective distances

<out_centers_file> - the INFO file to be created which will contain a list of the centres chosen

<out_globals_file> the INFO file to be created which will contain information about the location-allocation scenario including, the location criteria, the number of centres chosen and the related INFO files.

{number_of_locations} – the number of ATM sites to be located. This depended on the number of ATM sites a bank has, plus an additional ATM site. For example, ABSA which has seven ATM sites was specified as eight the number of ATM locations – seven of which are fixed and the eighth one being the optimal additional ATM site.

Execution of the location-allocation commands is useful in many ways. Not only do they find the best optimal location given a set of demands, but the set of commands also identifies which centre a demand is allocated to and the distance from that demand to the nearest and second nearest centre. This information is contained in an output file, the <out_allocation_file>. The information contained can then be used for further analysis to identify whether customers visit their allocated centres and if not, what the possible reasons are. This is one of the key areas that banks may be interested in, that is, consumer behaviour. However, the output file, <out_centers_file> is the focus of this study as it contains the centres chosen, which in this case are the ATM sites. It identifies the point chosen as the optimal site and also includes the already existing ATM sites as fixed sites. The next section discusses these results and identifies the areas for additional optimal sites.

4.4 LOCATION RESULTS OF ADDITIONAL ATM SITES

This section discusses the findings of using the GIS to find additional ATM sites. First a discussion is done on the optimal site identified when all the banks' ATM s are taken together. Subsequently the results obtained from adding an ATM to the individual banks follows.

4.4.1 Introduction

The MINDISTANCE and MAXATTEND models produced the similar results. This can be attributed to the fact that Stellenbosch is a small area where demand is not widely spaced. Therefore the optimal locations for the ATMs are in areas where not only is the average distance travelled minimized, as with the case of MINDISTANCE model, but also in areas where there is a high density of demand, as with the case of MAXATTEND model. In addition, in the MAXATTEND model, the whole of Stellenbosch area was incorporated. The model requires an input which specifies the distance within which demands are considered. Demands falling outside this distance are not considered. However, Stellenbosch being a small town, the calculation was based on the assumption that all demand points were relevant in the allocation of ATMs. The MAXCOVER and MINDISTPOWER models produced different results and the results obtained from each of these models were compared.

4.4.2 All banks taken together

The optimal location for an ATM site to be added to all the existing ATM sites in Stellenbosch is shown in Figure 28 for each of three different models. (Notice that MINDISTANCE and MAXATTEND models produced identical results). For banks which wish to install an additional ATM using the MINDISTANCE (or MAXATTEND) model, the optimal location is in Uniepark. With the MAXCOVER model, which seeks to maximize coverage, the optimal location is in Green Oaks near Cloeteville, while the optimal location for an additional ATM site using the MINDISTPOWER is in Cloeteville. These are suitable locations for banks that do not want to place an ATM where there is competition from another bank. The bank would therefore take into consideration all the existing ATMs in Stellenbosch. The various demands available with

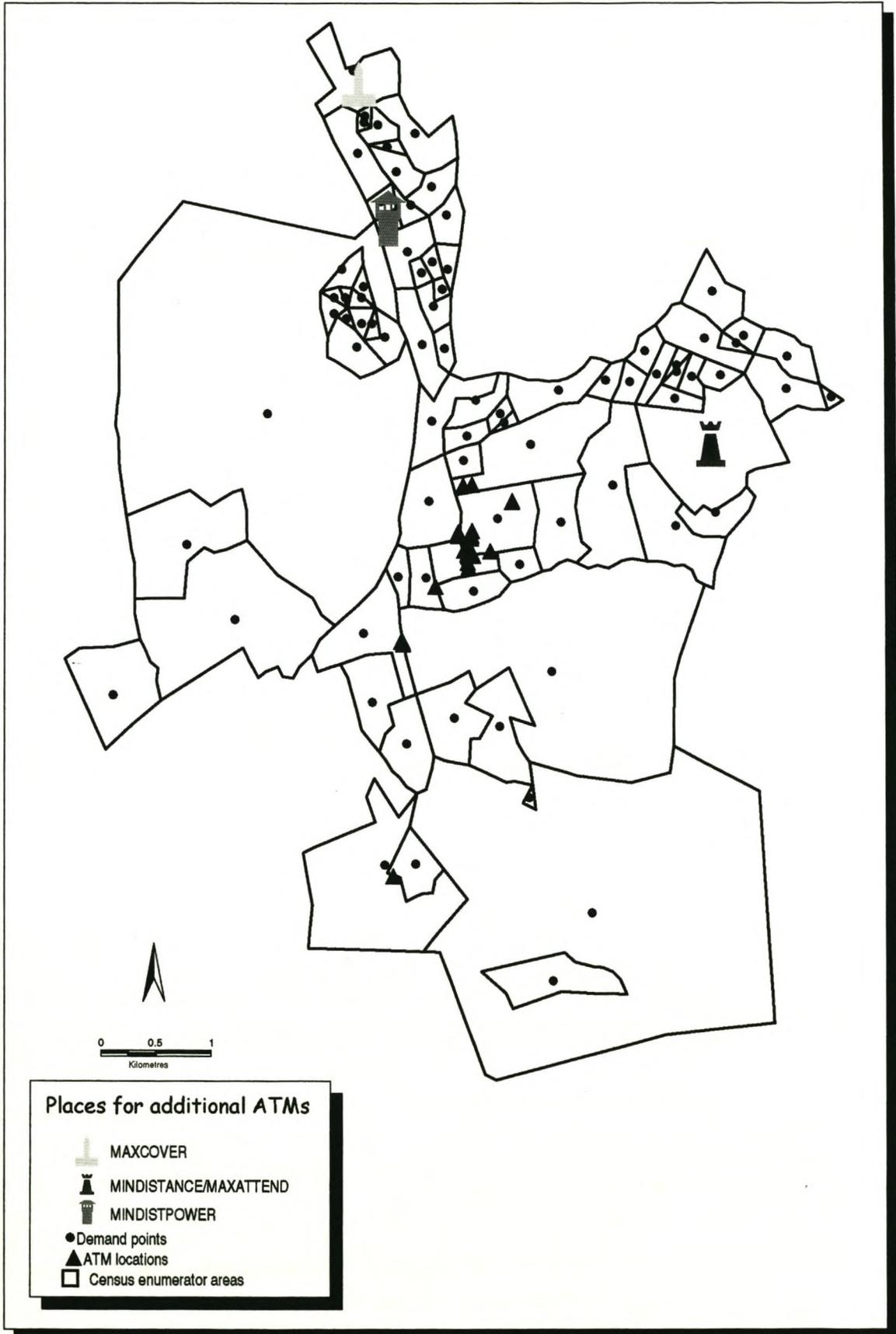


Figure 28: Location of ATMs in Stellenbosch according to location-allocation models

the additional ATM sites were calculated and compared with the present demand within the existing ATM sites at varying distances (Figure 29).

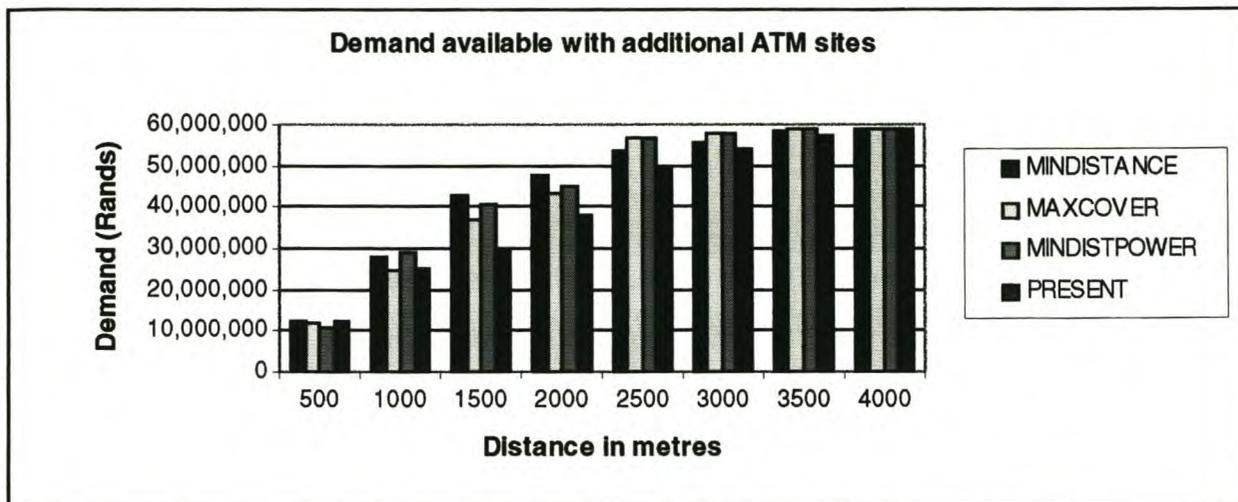


Figure 29: Total demand available with additional ATM sites in Stellenbosch according to location-allocation models

Additional ATM sites would contribute significantly and be available to a much greater demand than the present ATM locations. At shorter distances between 500m and 2000m the MINDISTANCE model would be within a greater demand than the other models. At longer distances, the other two models, MAXCOVER and MINDISTPOWER, perform better and are available to greater demands than that attained by the present ATM locations or by the MINDISTANCE solution. Hence, if the aim of the bank is to target customers in close proximity of existing ATMs, the best model to use is MINDISTANCE, but if the customers targeted live farther than 2km from existing ATMs, the best model to use is either MAXCOVER or MINDISTPOWER.

4.4.3 ABSA Bank

The optimal location for additional ABSA ATM is shown in Figure 30. According to the MINDISTANCE model, the best location for an additional ABSA ATM is in Uniepark, while the optimal location using the MAXCOVER model is in Green Oaks, near Cloetesville. If the aim of adding an ATM is to find a more equitable distribution, by

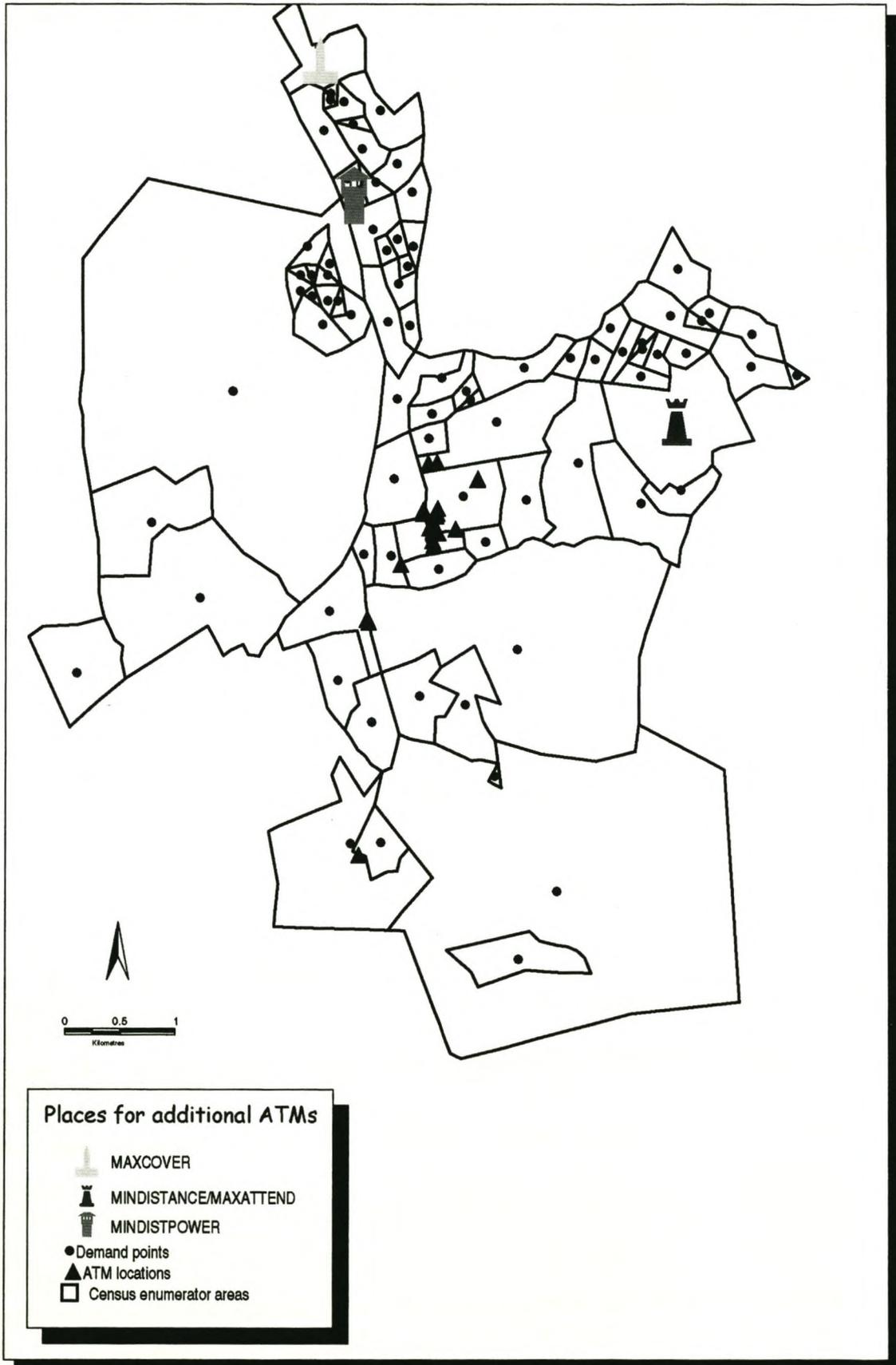


Figure 30: Location of additional ABSA ATMs in Stellenbosch according to location-allocation models

using the MINDISTPOWER model, the optimal location for another ABSA ATM is in Cloetesville. The total demand that would be available by locating an additional ABSA ATM site using each of the three models is compared (in Figure 31) with the current demand within ABSA ATMs. There are considerable differences with the addition of ABSA ATMs in terms of the demand available. At distances between 500m and 2000m from existing ATMs, the MINDISTANCE model is within a higher demand than any of the other models. Equally so, this demand is higher than the present demand within existing ABSA ATMs.

A significant difference occurs at a distance of 1500m where an additional ATM using the MINDISTANCE model is within a demand of about R42 million, the MAXCOVER model a demand of R36 million, while the MINDISTANCE model would be within a demand of about R40 million. The demand available at the present location of ABSA ATMs at this distance is about R30 million. At distances greater than 2500m the MAXCOVER and MINDISTPOWER models cover a higher demand than the MINDISTANCE model, with the present demand within ABSA ATMs being considerably less.

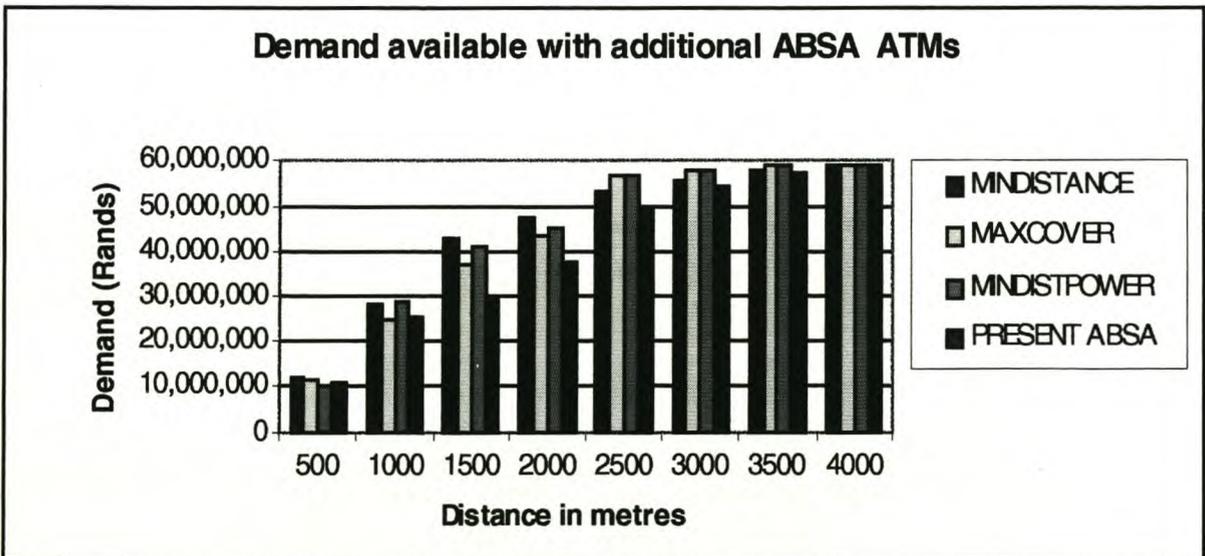


Figure 31: Demand available with additional ABSA ATM sites in Stellenbosch according to location-allocation models

4.4.4 Boland Bank

The optimal location for additional ATMs by Boland Bank using the models is shown in Figure 32. The best location using the MINDISTANCE model is in Cloetesville at Carriem Street and the best location using the MAXCOVER model is in Green Oaks, near Cloetesville. If the MINDISTPOWER is used, the best location for an additional Boland Bank ATM would be in Banhoek along the Helshoogte Road.

The total demand that would be available with the additional ATM sites was calculated and compared with the present demand available. The results are presented in Figure 33. There would be a considerable difference if more ATMs were added. At a distance of 500m, Boland Bank is presently within a demand of about R2,550,000. However, with one additional ATM site using the MAXCOVER model, the demand would be almost double to more than R4,600,000 and with the MINDISTPOWER it would be about R4,500,000. At distances between 1000m and 2000m the MINDISTANCE model would be within a greater demand than the other models, while at greater distances the MINDISTPOWER model would be within a greater demand.

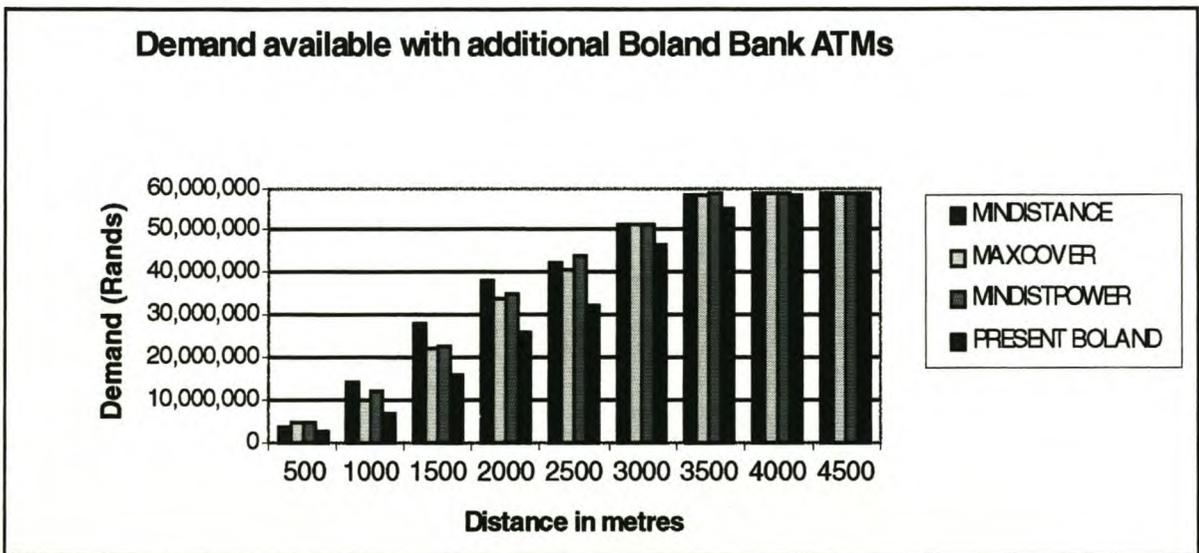


Figure 33. Demand available with additional Boland Bank ATM sites in Stellenbosch according to location-allocation models

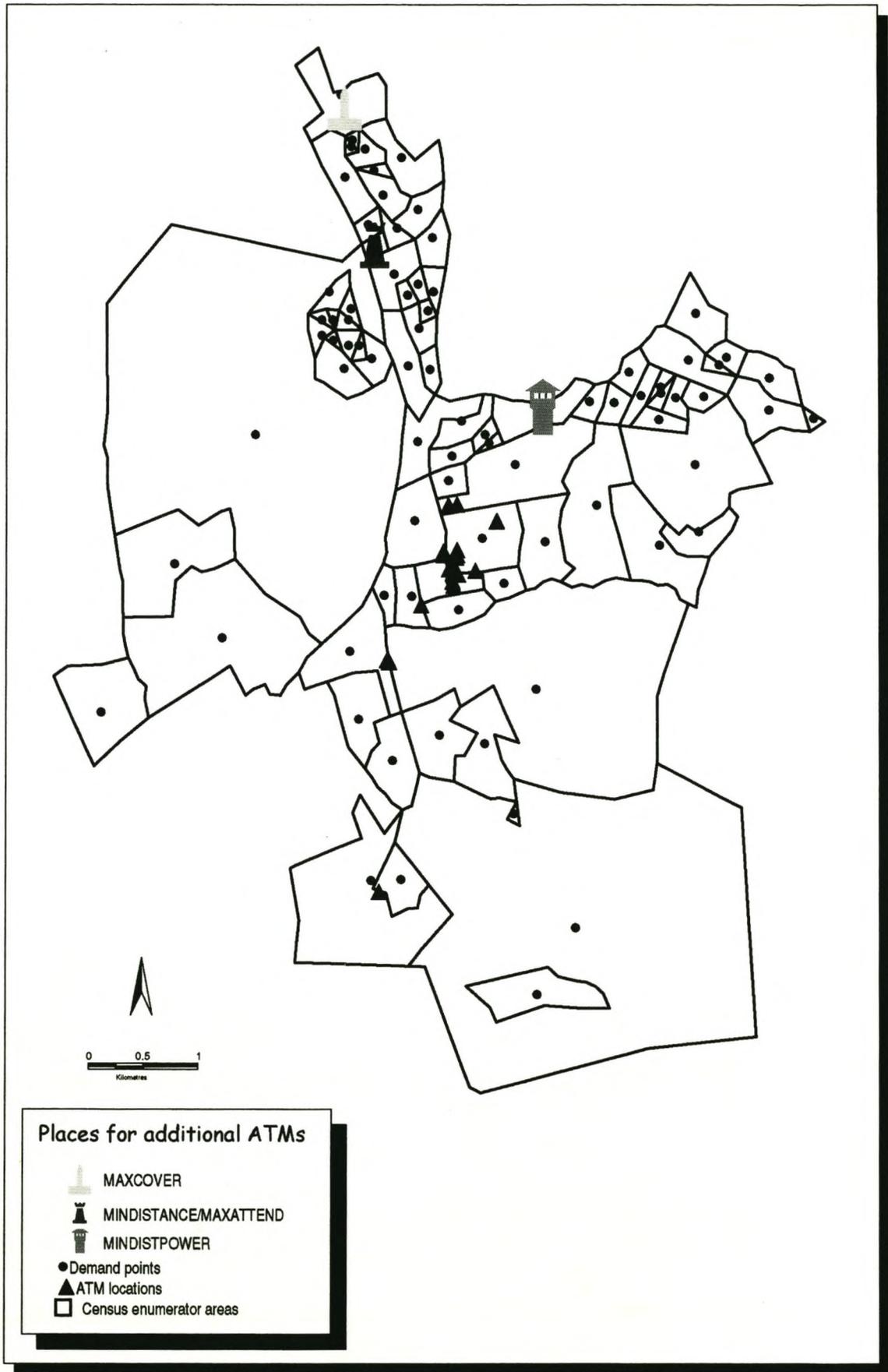


Figure 32: Location of additional Boland Bank ATMs in Stellenbosch according to location-allocation models

4.4.5 First National Bank (FNB)

FNB has five ATM sites in Stellenbosch. An additional ATM site using the MINDISTANCE model would best be located in Cloetesville at Carriem street (see Figure 34). If the bank’s purpose is to achieve maximum coverage by using the MAXCOVER model, the optimal location for another FNB ATM site would be in Green Oaks, near Cloetesville. The optimal site for an additional site using the MINDISTPOWER model would also be in Cloetesville at Carriem Street. Locating an additional FNB ATM site using either the MINDISTANCE or MINDISTPOWER models therefore yields the same results.

The total demand that would be available with the new additional sites was calculated and the results are compared in Figure 35. Both the MINDISTANCE and the MINDISTPOWER models cover the same demands across the various distance zones. Presently, FNB is within a demand of R3,954,000 at a distance of 500m. If an additional ATM site was added using the MAXCOVER model, the total demand covered would be more than R6,300,000, while in the case of the MINDISTPOWER and MINDISTANCE models it would be R5,250,000. At distances of 1000m, 1500m and 2000m the total demand covered by both the MINDISTANCE and MINDISTPOWER models would be about R2,065,000, R3,645,000 and R3,895,000 respectively, while the present demand covered at the same distances by FNB ATMs is R1,179,000, R2,457,000 and R3,025,000 respectively. The addition of FNB ATMs would, according to the models significantly add to the bank’s ability to draw on the demand.

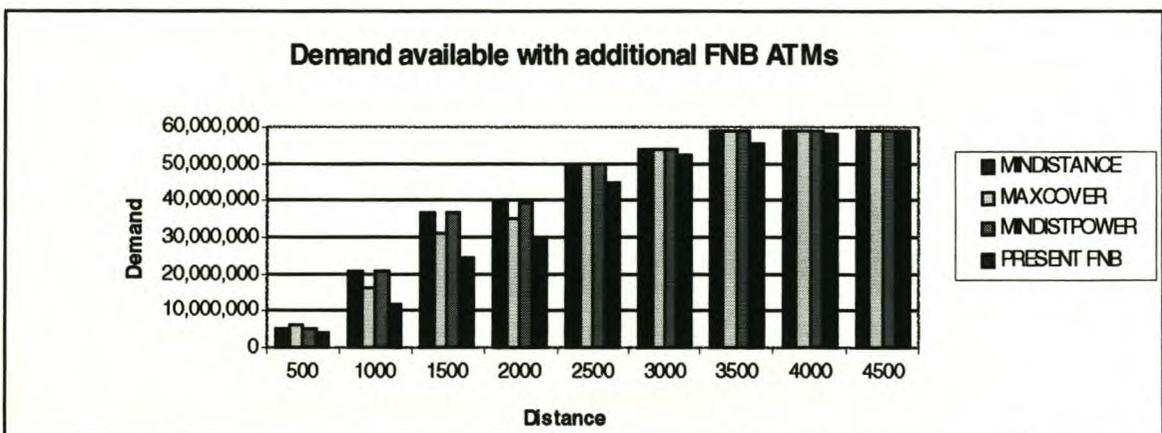


Figure 35: Demand available with additional FNB ATM sites in Stellenbosch according to location-allocation models.

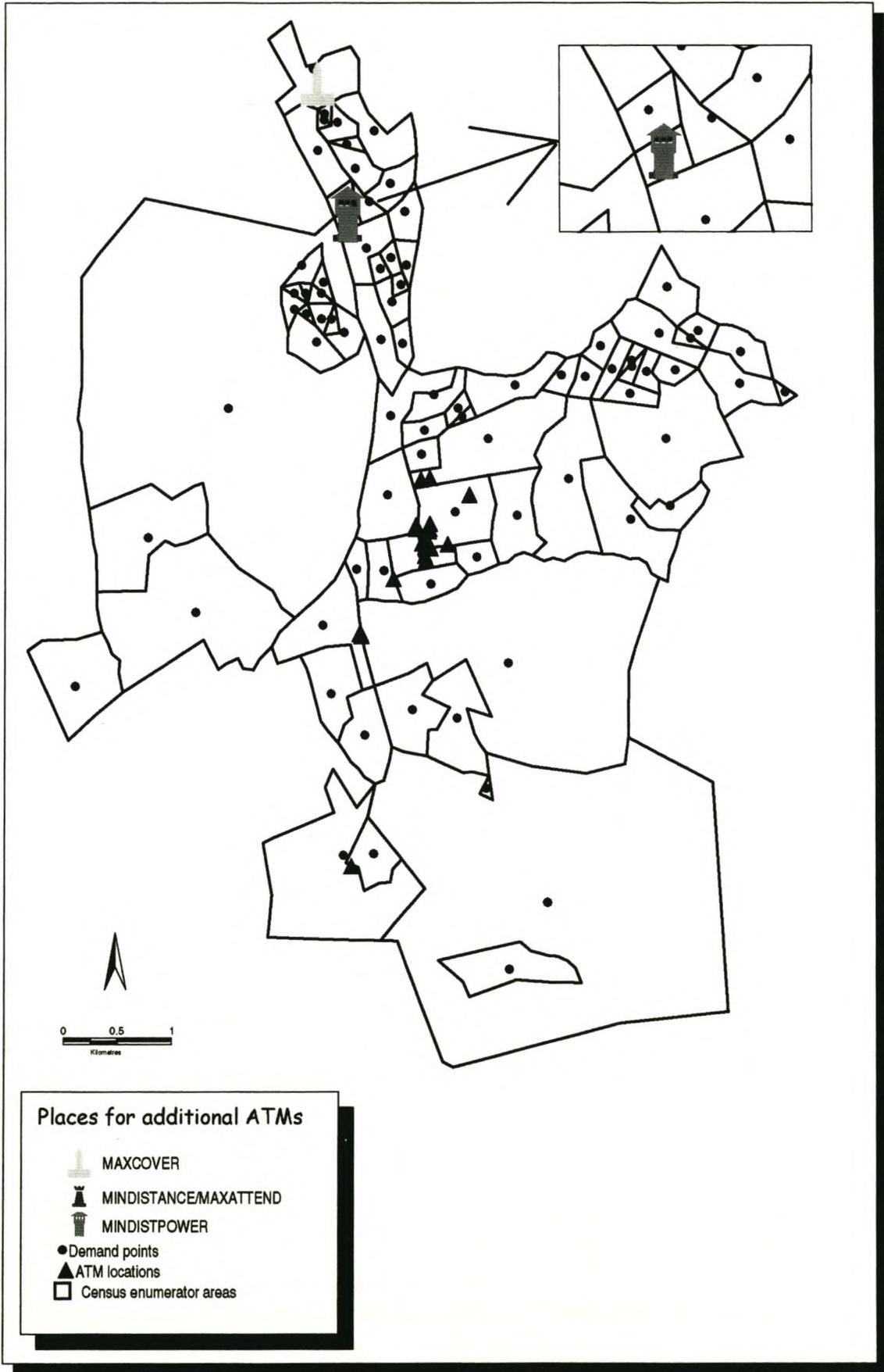


Figure 34: Location of additional FNB ATMs in Stellenbosch according to location-allocation models

4.4.6 Nedbank

Nedbank may also want to add ATM sites to their existing three sites. If the purpose is to minimize the total average distance travelled by customers, through using the MINDISTANCE model, the optimal location for another ATM site would be in Cloetesville, (see Figure 36). If using the MAXCOVER model, the optimal site would be in Green Oaks near Cloetesville, while if using the MINDISTPOWER, the optimal location would be in Banhoek on Helshoogte Road. On calculating the demand covered by adding another Nedbank ATM site it was found that there would be a considerable difference if more ATMs were added (see Figure 37). At a distance of 1500m, for example the current demand available to Nedbank ATMs is R2,165,000 whereas using the MINDISTANCE model, an additional ATM site would cover a demand of R3,354,000. With the MAXCOVER model the demand available would be R2,798,000 and with the MINDISTPOWER model it would be R2,859,000.

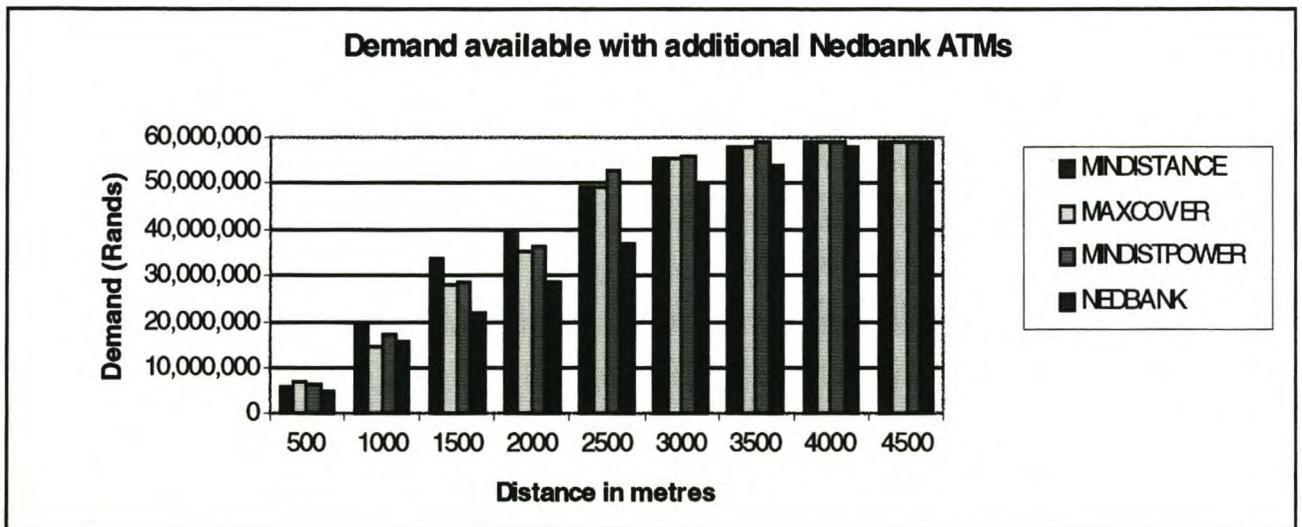


Figure 37. Demand available with additional Nedbank ATM sites in Stellenbosch according to location-allocation models.

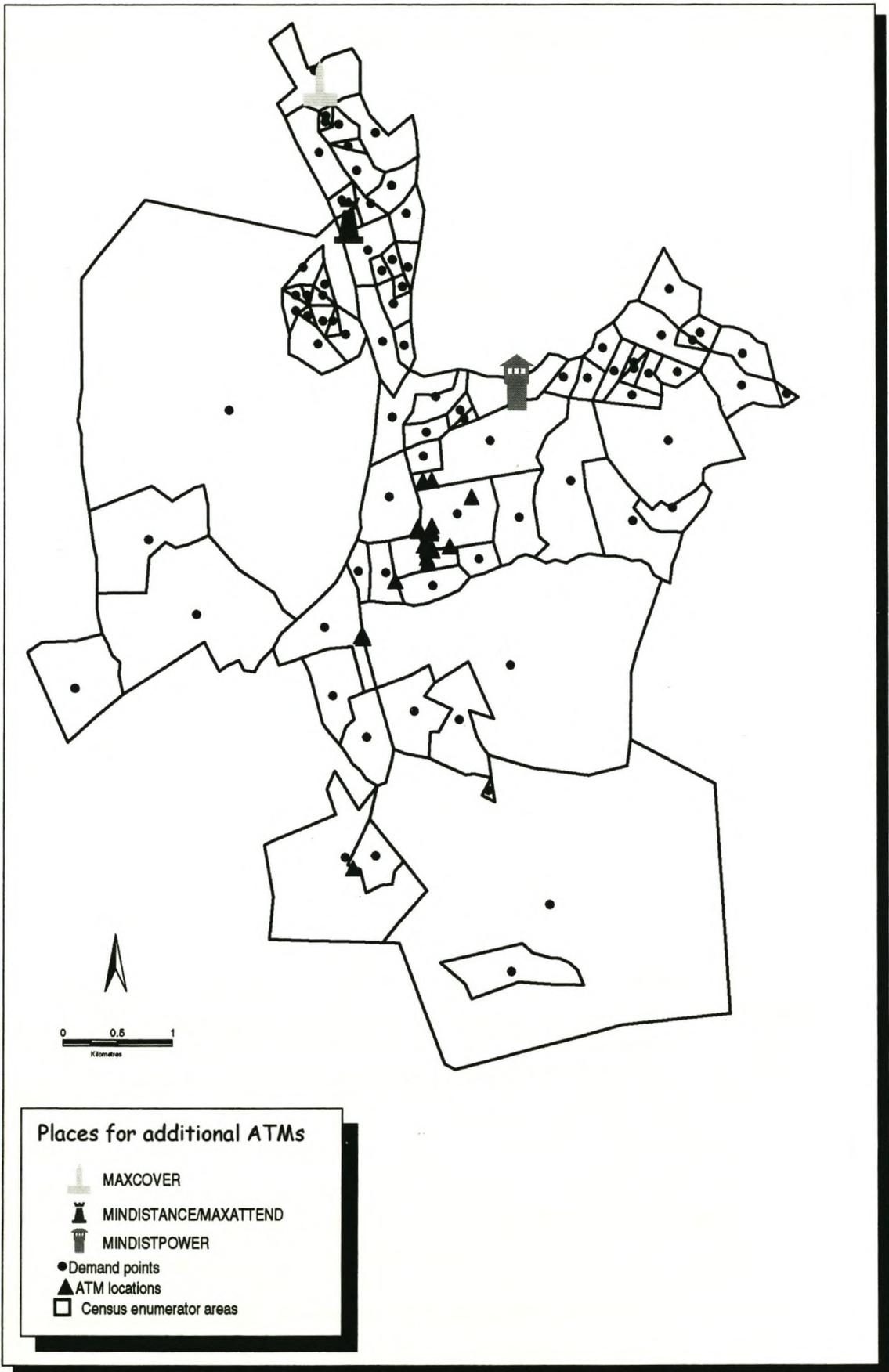


Figure 36: Location of additional NEDBANK ATMs in Stellenbosch according to location-allocation models

4.4.7 Standard Bank

Standard Bank has three ATM sites in Stellenbosch. Using the MINDISTANCE model, an additional ATM site would best be located in Cloetesville (see Figure 38). If using the MAXCOVER model, the optimal location would be in Green Oaks, near Cloetesville, whereas using the MINDISTPOWER, the optimal location would also be in Cloetesville at the same location modelled by MINDISTANCE.

The total demand that would be within these additional sites is compared in Figure 39. Like the other banks, additional Standard Bank ATM sites show considerable increase in the total demand covered. Both the MINDISTANCE model and MINDISTPOWER model would be available to the same demands at the various distances. At a distance of 500m, the MAXCOVER model would be available to a greater demand than the rest, namely R778,000, while the MINDISTANCE and MINDISTPOWER models would only be available to a demand of R672,000. At the same distance, the current demand covered by Standard Bank’s ATMs is about half that attained by the additional ATMs, that is R381,000. At distances of 1000m to 2000m the MINDISTANCE and MINDISTPOWER models outperform the MAXCOVER model, but the three models cover the same demands at distances of 2500m and farther.

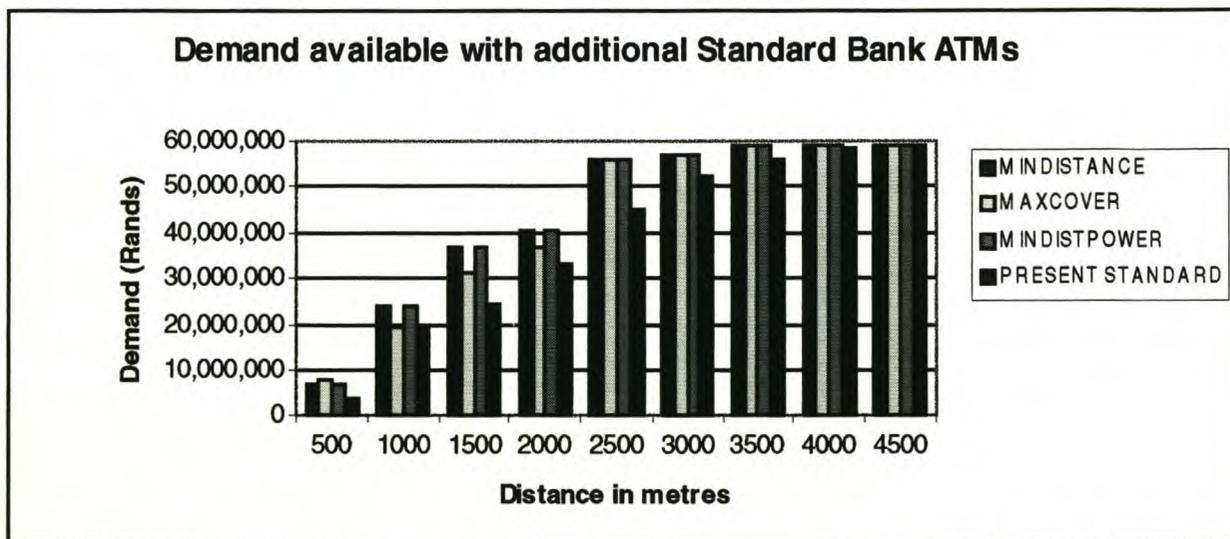


Figure 39. Demand available with additional Nedbank ATM sites in Stellenbosch according to location-allocation models.

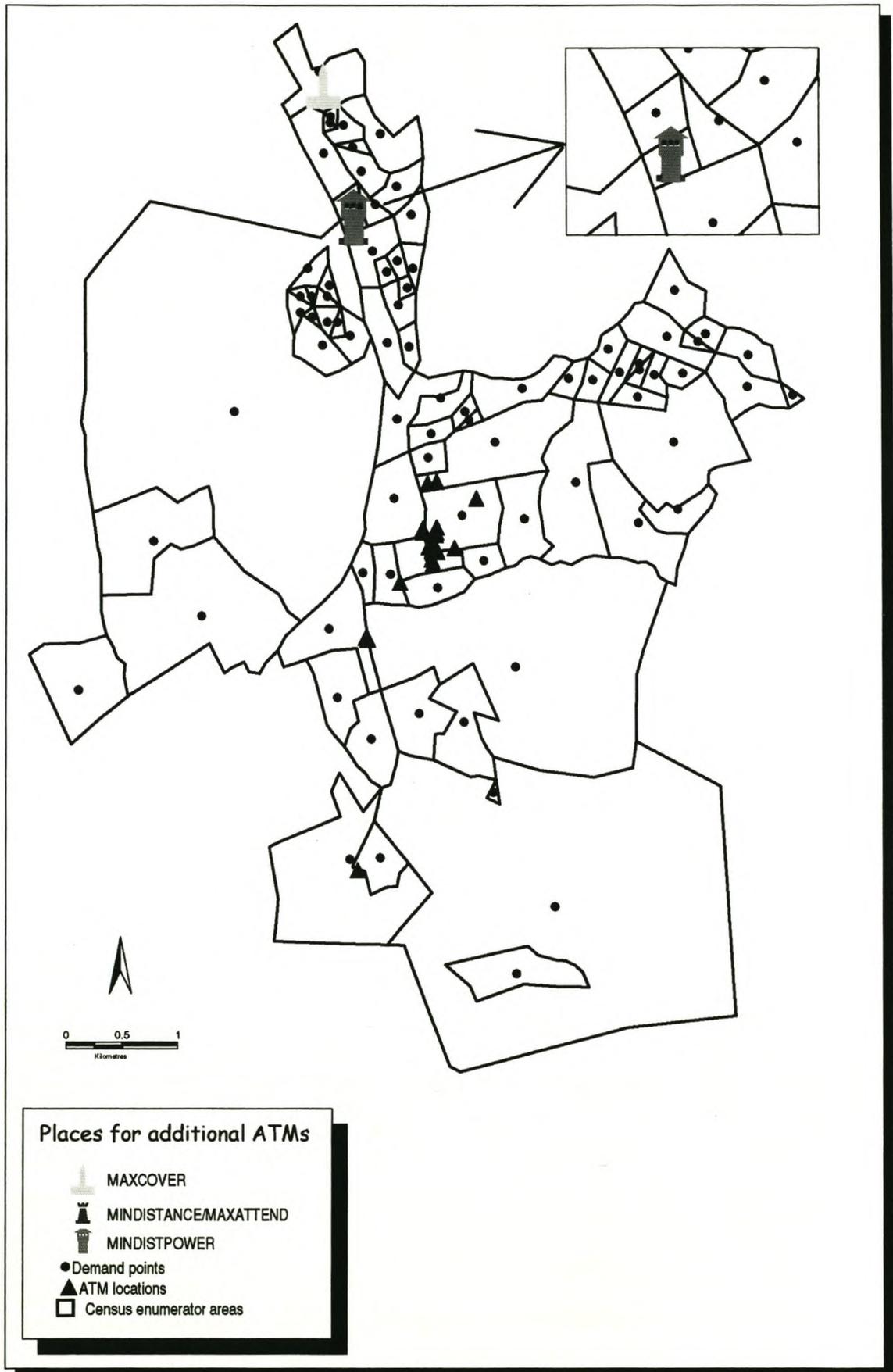


Figure 38: Location of additional Standard Bank ATMs in Stellenbosch according to location-allocation models

4.5 SUITABILITY OF OPTIMAL SITES

In summary, there are four main additional ATM sites identified using GIS. These are: Uniepark, Cloetesville in Carriem Street, Green Oaks near Cloetesville and Banhoek near Helshoogte Road. Significantly, these sites are all located in residential areas. This finding is in line with many of the customers' expressed wish to have ATMs closer to where they live.

Figure 40 shows the places and areas where respondents would like additional ATMs and the number of requests in each case. Figure 41 presents the results spatially. Suburbs where customers pointed out they would like more ATM sites, without specifying the particular location were plotted at the centroid of a suburb. Although several customers want more ATMs added to areas or places that already have ATMs, such as Eikestad Mall and Neelsie Student Centre, most of them would like ATMs located nearer to where they reside. Figure 27 showed that having ATMs located to where the customer lives was one of the major reasons why customers would like more ATMs.

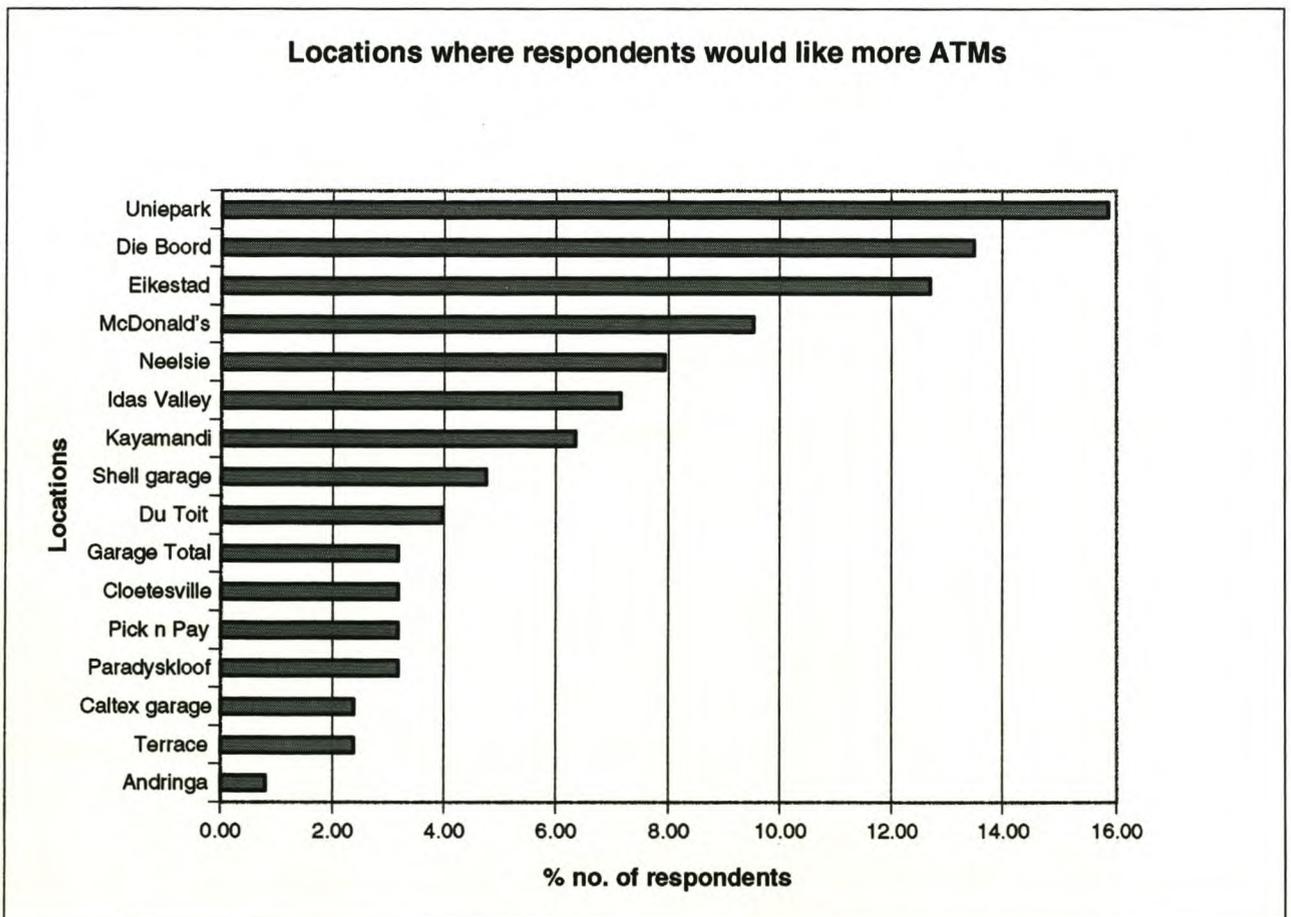


Figure 40: Locations where respondents would like more ATMs in Stellenbosch

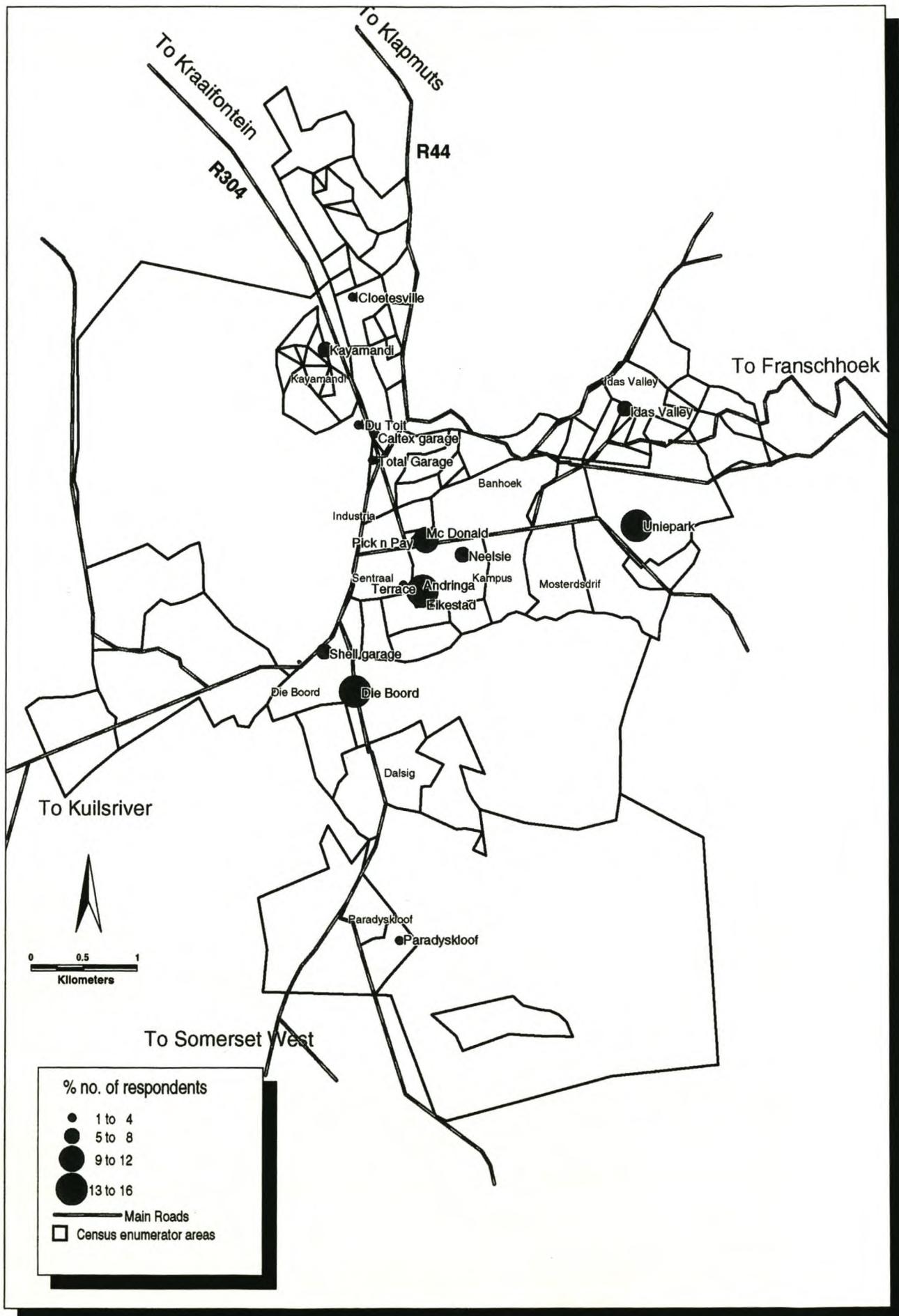


Figure 41: Customers' preferences for additional ATMs in Stellenbosch

This need for ATMs near to where customers live is underscored by the responses that 78% of the customers interviewed in Simonswyk, 86% of those in Uniepark and 88% of those interviewed in Rozendal would like an ATM in Uniepark. Uniepark is an optimal location identified by the GIS. Locating an ATM site there would effectively serve the demand in these residential areas. This area is also a convenient location for an ATM site as a shopping centre near Uniepark already exists there. Many respondents quite likely visit this shopping centre regularly thus fulfilling their expressed wish for ATMs to be located near where they shop. This explains the relatively high number of respondents who want an ATM in the environs of Uniepark.

In Kayamandi 42% of those interviewed would like an ATM anywhere in Kayamandi, 26% at Du Toit railway station and 16% at the Total garage on Bird Street. In Cloeteville 22% of those interviewed would like an ATM anywhere in their suburb. Suitable ATM sites identified using the GIS that would effectively serve these customers are those identified at Carriem Street in Cloeteville and in Green Oaks. To ensure the ATM sites are in line with customers' demands and preferences, and are also located in areas where there is some economic activity such as shops, garages or restaurants, the ATMs may suitably be located at the Total garage on Bird Street. Bird Street is an access road to Stellenbosch from routes R304 and R44 past Kayamandi and Cloeteville (and Green oaks) and is a busy pedestrian and traffic thoroughfare to and from Kayamandi and Cloeteville.

Another suburb where there is a demand for a new ATM site is Idas Valley where 60% of those interviewed there would like an ATM to be located there. 15% of those interviewed in La Colline would like an ATM at the Caltex garage in Bird Street. An optimal site identified by the MINDISTPOWER model is in Banhoek on Helshoogte Road (see Figure 36). This site is relatively near to La Colline and Idas Valley and would therefore serve the demands for ATM services of residents in both suburbs.

GIS has been shown to be an effective tool that can be used to find optimal sites given a set of demands. Optimal locations for additional ATM sites in Stellenbosch have been

identified using the Arc/Info location-allocation models. The demand that would be reached with the addition of these ATM sites has also been compared with the current demand served. The final section summarizes the results and draws some conclusions. It also identifies areas needing further research.

5. SUMMARY AND CONCLUSION

The study aimed at developing a method in which GIS can be used to find optimal locations for ATMs while at the same time addressing the viability of existing ATMs in Stellenbosch. This has successfully been carried out and the results presented. This section therefore summarizes the results achieved and presents areas that need further research.

5.1 INTRODUCTION

The first objective of the study was to investigate the criteria currently used for locating ATMs. This was done through interviews with banks and an extensive search in the existing literature. Though one of the banks, Standard Bank, was unwilling to co-operate, the information obtained from the other banks and from the literature gave sufficient insight into the procedures currently used to locate ATMs.

The second objective aimed at addressing the viability of existing ATM locations in Stellenbosch. The purpose was to investigate the most frequented ATMs, to obtain customers' feelings about present ATM locations and to determine how accessible the ATMs are to customers. A household questionnaire survey was carried out to obtain customers' opinions about ATM provision in Stellenbosch. The questionnaires were prepared in both English and Afrikaans versions and dropped in the post-boxes in selected residential areas according to the sample requirements. The questionnaire requested respondents to identify the ATMs they visit and to indicate their feelings about the current location of ATMs. These were analyzed and provided valuable insights into the current use of ATMs and the customers' attitudes towards existing locations. In addition, the proximity of ATMs to customers was also analyzed. This was done with the help of ArcView GIS. The 1996 population census data was used to determine the total population and demand for ATMs per census Enumerator Areas. The demand was calculated based on the total income per enumerator area. Both the total population and the demand were plotted at the centroid of each enumerator area. The proximity of the existing ATMs to the customers was analyzed by determining the population reached and demand served within specific distance zones. The results were tabled in Excel and presented graphically.

Finally, the last two objectives endeavoured to develop a method for using GIS to determine optimal locations for ATMs and to apply the GIS for locating additional ATM sites in Stellenbosch. The capabilities of a GIS to find optimal locations was discussed. Various options exist within GIS and the Arc/Info location-allocation models are especially designed to find optimal locations given a set of demands. Each of the models is designed to solve different locational problems and each model was discussed in detail. Consequently, the location-allocation models that can be used in the Stellenbosch situation were applied to find additional optimal sites for ATMs. As expected, the results produced different optimal sites depending on the model used. The total demand that would be served with the additional ATM sites using the different models was then compared with the current demand served. The results were tabled in Excel and presented graphically.

SUMMARY OF RESULTS

The Arc/Info location-allocation models MINDISTANCE, MAXATTEND, MAXCOVER and MINDISTPOWER have all been tested and the results presented. The models show that additional ATMs will result in a considerable increase in the total amount of demand reached compared to that presently reached by the five banks. The MAXATTEND model produced identical results to the MINDISTANCE model. This may be attributed to the fact that Stellenbosch is a relatively small area and the demand points are not spaced widely enough to produce sufficiently different solutions. Locating an ATM site to reduce the average distance travelled (as would be the case of the MINDISTANCE model) would also mean that the ATM site would be located where a majority of the demand exists (as is the case with the MAXATTEND model).

At a distance within 500m of existing ATMs, the MAXCOVER and MINDISTPOWER models locate ATMs that would reach a greater demand than the MINDISTANCE model. Banks that want to serve customers within this distance zone could therefore use any of these two models, that is MAXCOVER and MINDISTPOWER. However, to serve customers at distances between 500 and 2000m of existing ATMs, the MINDISTANCE model has shown locations that will serve a greater demand than the other models. The MINDISTANCE model is suitable to use for banks targeting

customers within these distance bands. But at distances greater than 2000m, the MAXCOVER and MINDISTPOWER models are more successful at locating ATM distributions that reach greater demands. This is attributed to the fact that the MAXCOVER model seeks to maximize coverage for the whole population and therefore takes into consideration customers at distant locations. The MINDISTPOWER model is essentially aimed at addressing more widely distributed customers. It tends to equalize distances, thereby pulling facilities to the outlying demands. It is a useful tool if banks observe that the nearby population is well served and would therefore want to place an ATM aimed at addressing those demands located further away.

On the other hand, the MINDISTANCE model is suitable for those banks that want to minimize the average distance travelled by all their customers. In this case the emphasis is on addressing the needs of customers who are situated near the town centre and not those located far away. The assumption is that customers located far from the town centre come to the CBD for multiple purposes and hence have little interest in having ATMs located outside the town centre.

The survey found that 64% of the customers interviewed would like more ATMs to be installed. The general feeling was that customers were satisfied with the present location of ATMs at the time of the survey, but that they would like more of them. However, 43% of the customers interviewed felt that the ATMs should be located closer to where they live. Demand was plotted at the census districts where the population lives and optimal sites identified in terms of these locations. The MINDISTANCE, MAXCOVER and MINDISTPOWER models proved to be most useful at locating sites for ATMs to comply with these demands. In addition, most of the places or areas where customers feel they would like more ATMs to be located are near to residential neighbourhoods. *The optimal sites identified by the modelling exercise should be considered by the banks in order to come up with the best locations for additional ATMs in Stellenbosch.*

5.3 TOPICS FOR FURTHER RESEARCH AND DEVELOPMENT

Using GIS for finding optimal locations for ATMs is a daunting challenge for bank managers. Most bank employees have little knowledge or experience with GIS, yet GIS is

a useful tool for determining optimal locations. To overcome this problem, a suitable solution would be to create a user-friendly GIS, which can be used effectively by banks to find optimal locations. The GIS would have a user interface that will enable bank employees to simply key in their requirements and allow the GIS to find optimal sites. A programme would have to be written which requires banks to input their own data. The type of data to be inputted would vary from bank to bank and would depend on what is deemed as the "demand".

There are two main programming languages available for use in the Arc/Info and ArcView GIS, that is, Arc Macro Language (AML) and AVENUE. The AVENUE programming language is incorporated within the ArcView GIS software package, while AML is an extension of Arc/Info software. However, the current ArcView software does not have the location-allocation capabilities of Arc/Info. Getting optimal sites for ATMs would therefore have to be done using Arc/Info. If road or street distances are to be used, the Network module should be employed. An AML would have to be written which allows users to simply input their data requirements, and consequently find optimal sites. To work with ArcView, AVENUE scripts would have to be written which could implement the location-allocation algorithms or simply call the AML scripts. However, options also exist to use other programming languages such as Visual Basic and C++.

Further research is also required to extend current GIS capabilities by incorporating factors other than geographical location in finding optimal sites for ATMs. The optimal sites should also be optimal in terms of pedestrian traffic, security characteristics and the host of other factors mentioned previously. This means that a complete system should prescribe a particular database design, provide a user-friendly customized menu interface to incorporate user requirements and then identify the optimal location in respect of these specifications. In order to produce such a system, would require considerable research on the underlying rationale to create a knowledge base and an expert system with commercial value.

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APPENDICES

APPENDIX 1: HOUSEHOLD QUESTIONNAIRE (ENGLISH)

QUESTIONNAIRE SURVEY ON DETERMINING THE BEST LOCATIONS FOR ATMs IN STELLENBOSCH

Automated Teller Machines (ATMs) play a very important role in our daily activities. With most banks closing over the Weekends and holidays, ATMs ensure that we still have access to our bank accounts 24 hrs a day! However, ATMs should be located in areas accessible to those whom they are intended for: the customers. Keeping this in mind, **Jacquelyne Wambugu**, a masters student at the **Department of Geography and Environmental Studies** at Stellenbosch University, is doing research together with various banks and customers to determine the best locations for ATMs. This study is therefore aimed at addressing the present location of ATMs in Stellenbosch, how customers feel about them and whether there are certain areas where they would like more ATMs.

Your neighborhood has therefore been selected through a sampling method to represent customers' opinions. It would be greatly appreciated if you, as a member of the local community in Stellenbosch, could assist her by answering the following questions. Be assured that the **information** you provide will be **treated in strict confidence**.

Mr. PJ Eloff (Supervisor)

If you have any questions, please do not hesitate to contact
Jacquelyne Wambugu: 8833973

The questionnaire will only take about **5 minutes** to complete
Thank you for your willingness to participate!

July 1999

Official Use

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INSTRUCTIONS

- i. Please place a cross (x) in the appropriate box or write your answer in the space provided
- ii. The completed questionnaire will be fetched from your home within three days

1. What is your occupation (teacher, housewife, student etc)? _____

2. Where do you work (company name and town e.g. Standard Bank, Stellenbosch)

3. On average, how many times do you visit an ATM?

Per month

Or per week

Any other (please specify) _____

4. Below is a list of all the ATM locations in Stellenbosch. Please indicate which ATMs you visit and how you feel about their current location.

ATM	Visit	Happy	Not Happy
ABSA, Die Boord			
ABSA, Eikestad Mall (upstairs)			
ABSA, Eikestad Mall (downstairs)			
ABSA, McDonald/BP Express			
ABSA, Neelsie Student Centre			
ABSA, Outside Pick 'n Pay			
ABSA, Plein Street			
ABSA, Paradyskloof			
Boland, Andringa Street`			
Boland, Church Street			
FNB, Bird Street (near Die Dros)			
FNB, Neelsie Student Centre			
FNB, Plein street (outside the bank)			
FNB, Plein street (opposite the bank)			
FNB, Dorp Street/BP Express			
NBS, Bird Street (near Die Dros)			
Nedbank, Bird Street			
Nedbank, Die Boord			
Permanent Bank, Plein Street			
Standard Bank, Bird Street			
Standard Bank, Die Boord			
Standard Bank, Neelsie Student Centre			

5. If you're happy with the current location of the ATMs you use, please tick your reason(s)?

- They are close to where I work
- They are close to where I live
- They are close to where I shop
- They are close to eating outlets
- They are situated in a 24-hr shop/garage
- There is plenty of parking space
- There is less crowding at the ATM
- They are situated in a safe area

Any other (please specify) _____

6. If you're not happy with the current location of the ATMs, what is/are your reason(s)?

- They are situated far from where I work
- They are situated far from where I live
- They are situated far from where I shop
- They are situated far from eating outlets
- They are not situated in a 24-hr shop/garage
- There is not enough parking space
- There is normally a long queue at the ATM
- They are not situated in a safe area

Any other (please specify) _____

7. Do you think more ATMs should be added? Yes No

If yes, by which bank? _____

At which place? _____

What is/are your reason(s)?

- It would be close to where I work
- It would be close to where I live
- It would be close to where I shop
- It would be close to eating outlets
- It would be close to a 24-hr shop/garage
- There would be plenty of parking space
- There would be less crowding at the ATM
- It would be in a safe area

Any other (please specify) _____

THANK YOU FOR YOUR TIME AND EFFORT!

APPENDIX 2: HOUSEHOLD QUESTIONNAIRE (AFRIKAANS)

VRAELYS OM DIE GESKIKTE PLEK/LIGGING VAN OTMs IN STELLENBOSCH TE BEPAAL

Outomatiese tellermasjiene (OTMs) speel 'n belangrike rol in ons daaglikse aktiwiteite. Die meeste banke is gesluit gedurende naweke en vakansiedae, maar OTMs maak dit vir ons moontlik om 24-uur toegang tot ons bankrekening te hê. Nietemin moet OTMs geskikte liggings hê, sodat dit toeganklik is vir kliënte. Met laasgenoemde in gedagte, doen Jacquelyne Wambugu, 'n meesterstudent van die Department van Geografie en Omgewingstudie aan die Universiteit van Stellenbosch, tesame met verskillende banke en kliënte navorsing om beter liggings vir OTMs te vind. Die bestaande liggings van OTMs in Stellenbosch en kliëntemenings daarvoor word ondersoek.

Om kliënte se mening te verteenwoordig, is u woonbuurt by wyse van 'n ewekansige steekproef gekies. Dit sal baie waardeer word as u as lid van die Stellenbosch gemeenskap haar kan ondersteun deur die vraelys in te vul.

U kan verseker wees dat die inligting wat u veskaf **vertroulik** hanteer sal word.

Byvoorbaat dankie vir u samewerking.

Mnr. PJ. Eloff (studieleier)

**Indien U enige vrae het, kontak asseblief vir Jacquelyne Wambugu: 8833973
Die vrae sal hoogstens 5 minute van u tyd neem om te voltooi.**

July 1999

Vir kantoor gebruik

--	--

INSTRUKSIES

- i. Maak asseblief 'n kruisie (x) in die geskikte blokkie, of skryf u antwoord in die voorsiene ruimte.
 ii. Die voltooide vraelys sal by u huis afgehaal word binne drie dae.

1. Wat is u beroep (bv. onderwyser, huisvrou, student, ens)? _____

2. Waar werk u (maatskappy se naam en dorp bv. Standard Bank, Stellenbosch)

3. Gemiddeld hoeveel keer besoek u 'n OTM

Per maand

Of per week

Indien ander, spesifiseer asb. _____

4. Hieronder is 'n lys van OTM-liggings in Stellenbosch. Dui asseblief aan watter OTM u besoek en hoe u voel oor die bestaande ligging.

OTM	Besoek	Gelukkig	Nie Gelukkig
ABSA, Die Boord			
ABSA, Eikestad Mall (tweede verdieping)			
ABSA, Eikestad Mall (grondvloer)			
ABSA, McDonald/BP Express			
ABSA, Neelsie Studente Sentrum			
ABSA, Buite Pick-n-Pay			
ABSA, Pleinstraat			
ABSA, Paradyskloof			
Boland, Andringa straat			
Boland, Kerkstraat			
FNB, Birdstraat (naby Die Dros)			
FNB, Neelsie studente sentrum			
FNB, Pleinstraat (buitekant die bank)			
FNB, Pleinstraat (oorkant die bank)			
FNB, Dorpstraat/BP Express			
NBS, Birdstraat (naby Die Dros)			
Nedbank, Birdstraat			
Nedbank, Die Boord			
Nedbank, Eikestad Mall			
Permanent Bank, Pleinstraat			
Standard Bank, Birdstraat			
Standard Bank, Die Boord			
Standard Bank, Neelsie Studente Sentrum			

5. Indien u gelukkig is met die bestaande posisie of ligging van OTMs wat u tans gebruik, merk asseblief u redes?

- Dit is naby my werk
- Dit is naby waar ek woon
- Dit is naby waar ek inkopies doen
- Dit is naby wegneem eetplekke of restaurante
- Dit is geleë by 'n 24-uur winkel of vulstasie
- Daar is genoeg parkeerplek
- Daar is minder samedromming by die OTM
- Dit is geleë in 'n veilige area

Indien ander, spesifiseer asb. _____

6. Indien u nie gelukkig met die bestaande liggings van OTMs is nie, wat is u rede(s)?

- Dit is geleë ver van waar ek werk
- Dit is geleë ver van waar ek woon
- Dit is geleë ver van waar ek inkopies doen
- Dit is geleë ver van eetplekke/restaurante
- Dit is nie by 'n 24-uur winkel/vulstasie geleë nie
- Daar is nie genoeg parkeerplek nie
- Daar is normaalweg lang rye by OTMs
- Dit is nie in 'n veilige area geleë nie

Indien ander, spesifiseer asb. _____

7. Dink u dat daar meer OTMs moet wees? Ja Nee

Indien Ja, by watter bank? _____

By watter plek? _____

Wat is u rede(s)?

- Dit sal naby my werk geleë wees
- Dit sal naby my woning wees
- Dit sal naby wees waar ek inkopies doen
- Dit sal naby eetplekke wees
- Dit sal naby 'n 24-uur winkel of vulstasie geleë wees
- Daar is genoeg parkeerplekke
- Daar sal minder samedromming van mense en lang rye wees
- Dit sal binne 'n veilige area wees

Indien ander, spesifiseer asb. _____

BAIE DANKIE VIR U TYD EN MOEITE!

SUMMARY OF QUESTIONNAIRE RESULTS

Neighborhood	Code	Total received
Kayamandi	1	19
Cloetesville	2	18
Idasvallei	3	15
La colline	4	13
Dennesig	5	11
Simonsvyk	6	9
UniePark	7	7
Rozendal	8	8
Town Centre	9	6
Dalsig	10	10
Die Boord	11	11
Paradyskloof	12	13
Onder Pappegaalberg	13	11
Total		151

(Question 1)

Occupation	Neighborhood													Total	%
	1	2	3	4	5	6	7	8	9	10	11	12	13		
Student	5	5	5	9	8	3	4	3	6	3	2	1	1	55	36
Housewives			3	1	1	1	1	1		3	3	2	2	18	12
Pensioners			1	1	1	1	1							5	3.3
Businessmen					1					2	3	2		8	5.3
Professionals	14	13	6	2		4	2	3		4	4	7	6	65	43
Total	19	18	15	13	11	9	7	8	6	10	11	13	11	151	100

(Question 2)

Stellenbosch	Neighborhood													Total	%
	1	2	3	4	5	6	7	8	9	10	11	12	13		
Stellenbosch	17	18	15	13	11	8	7	7	6	8	10	12	10	142	94
Outside Stellenbosch	2				1		1		2	1	1	1		9	6
Total	19	18	15	13	11	9	7	8	6	10	11	13	11	151	100

(Question 3)

No. of visits to ATMs	Neighborhood													Total	%
	1	2	3	4	5	6	7	8	9	10	11	12	13		
1 -2	2	2	4		2	3	2	2		2	2	3	3	27	18
3 -4	7	5	5	6	4	3	2	3	3	4	6	5	5	56	38
5 -8	6	4	5	2	2	1	2	1	2	3	4	3	2	37	25
9 -12	2	4	1	5	1	2	1	2	1	2	1	1	1	24	16
More	2	1			2									5	3.4
Total	19	16	15	13	11	9	7	8	6	10	11	13	11	149	100

Category					
Students	Working	Housewives	Priv. Businessm	Pensioners	Total
10	12	3		2	27
25	21	6		1	53
11	17	5		4	37
7	12	4		1	24
1	2			2	5
54	64	18		8	144

% Category				
Student	Working	Housewife	Priv. Busin	Pensioners
18	18	17	0	40
45	32	33	13	60
20	26	28	50	0
13	18	22	13	0
2	3	0	25	0
100	100	100	100	100

(Question 5)

Reasons why customers are happy with the current location of ATMs

Reasons	Neighborhood													Total	%
	1	2	3	4	5	6	7	8	9	10	11	12	13		
Close to working areas	7	10	9	3	2	1	3	2	4	3	5	3	4	56	37.086
Close to where they live		3		3	5	2	1	3		4	6	5		32	21.192
Close to where they shop	10	9	11	9	5	5	4	5	4	7	8	9	8	94	62.252
Close to eating outlets		6	8	7	3	3	4	3	3	4	2	2		45	29.801
They are situated in a 24hr shop/garage	4	8	8	7	5	3	3	2	1	2	5	4		52	34.437
There is plenty of parking space		3	2	3	1	5	3	4	2	3	3	4	6	39	25.828
There is less crowding at the ATM	7	4	9	2	2	3	2	2		2	4	6	6	49	32.45
They are situated in a safe area	6	10	9	5	4	3	2	2	2	3	2	4	6	58	38.411

% of responses
13.2
7.5
22.1
10.6
12.2
9.2
11.5
13.6
100

Coding Visit = V Happy = H Not Happy = N

	Neighborhood																							
	1			2			3			4			5			6			7			8		
	V	H	N	V	H	N	V	H	N	V	H	N	V	H	N	V	H	N	V	H	N	V	H	N
ABSA, Die Boord	1									7	7		2	2		5	5		3	3		2	2	
ABSA, Eikestad Mall	9	7	2	7	6	1	5	5	0	7	7	0	5	4	1	3	2	1	3	3	0	4	3	
ABSA, McDonald/BP Express				6	5	1	4	3	1	10	8	2	6	6	1	4	4		4	4		4	3	
ABSA, Neelsie student center				4	4		3	3		7	7		5	5		3	3		3	3		3	3	
ABSA, Outside Pick-n-Pay	7		5	2	1	1				7	4	3	5	4	1	3	1	2	2	1	1	2	1	
ABSA, Plein street				5	4	1	3	3		4	4					1	1		1	1		1	1	
ABSA, Paradyskloof																								
Boland, Andringa street				1	1		3	3		3	1	2	1	1		1	1		1			1		
Boland, Church street				1	1		3	2	1	3	1	2	1	1		1	1		1			1		
FNB, Bird street (near Die Dros)	4	4								1	1													
FNB, Neelsie student center	3	3		1	1					4	3	1				1	1		1			1		
FNB, Plein street (outside the bank)	7	5	2	1	1		3	1	2	1	1					1		1	1		1	1		
FNB, Plein street (opposite the bank)	4	4		1	1		3	1	2	1	1					1		1	1		1	1		
FNB, Dorp street/BP Express	3	3																						
NBS, Bird street (near Die Dros)										3	3													
Nedbank, Bird street	5	3	2	2	1	1	3	3		5	3	2	1		1	1	1		1	1		1	1	
Nedbank, Die Boord													1		1	1	1		1	1		1	1	
Permanent Bank, Plein street				2	2					2	1	1												
Standard Bank, Bird street	5	2	3				3	3		5	4	1	2	1	1							2	2	
Standard Bank, Die Boord	1	1								2	2					2	1	1						
Standard Bank, Neelsie							2	2		7	7		3	3					2	2		2	2	

(cont)

	9			10			11			12			13			Total			%		
	V	H	N	V	H	N	V	H	N	V	H	N	V	H	N	V	H	N	V	H	N
ABSA, Die Boord	2			4	4		5	5		7	7		9	9		47	47	0	31.1	31.1	0.0
ABSA, Eikestad Mall	3	3	0	3	2	1	4	4	0	3	2	1	5	4	1	61	52	9	37.7	33.8	4.3
ABSA, McDonald/BP Express	3	2	1	2	2		2	1	1	2	2		2	1	1	49	41	9	32.5	27.2	6.0
ABSA, Neelsie student center	4	4		2	2		3	3		1	1		3	3		41	41	0	27.2	27.2	0.0
ABSA, Outside Pick-n-Pay	2	1	1	1	1		2	1	1				2	1	1	34	21	13	22.5	13.9	8.6
ABSA, Plein street	2		2				1	1		2	2		4	4		24	23	1	15.9	15.2	0.7
ABSA, Paradyskloof				1	1					5	5					6	6	0	4.0	4.0	0.0
Boland, Andringa street				1		1	2	1	1	1			1	1		15	8	7	9.9	5.3	4.6
Boland, Church street				1		1	2	1	1	1			1	1		15	7	8	9.9	4.6	5.3
FNB, Bird street (near Die Dros)										1	1	1	1			7	6	1	4.6	4.0	0.7
FNB, Neelsie student center																10	9	1	6.6	6.0	0.7
FNB, Plein street (outside the bank)				1		1	1	1		2	1	1	2		2	21	12	9	13.9	7.9	6.0
FNB, Plein street (opposite the bank)				1		1	1	1		2	1	1	2		2	18	11	7	11.9	7.3	4.6
FNB, Dorp street/BP Express				1		1	1	1		2	1	1	2	1	1	9	6	3	6.0	4.0	2.0
NBS, Bird street (near Die Dros)																3	3	0	2.0	2.0	0.0
Nedbank, Bird street				2	2		2	2		2		2	3	2	1	28	18	10	18.5	11.9	6.6
Nedbank, Die Boord				2	2		2	2		2	1	1	3	3		13	10	3	8.6	6.6	2.0
Permanent Bank, Plein street													1			5	3	1	3.3	2.0	0.7
Standard Bank, Bird street	2			2	2		2	2		3	3		2	2		28	21	5	18.5	13.9	3.3
Standard Bank, Die Boord				2	2		2	2		3	3		2	2		14	13	1	9.3	8.6	0.7
Standard Bank, Neelsie	2			1	1					1	1					20	19	0	13.2	11.9	0.0

% OF RESPONSES			
V	H	N	%H
10.04	12.47	0.00	100
13.03	13.79	10.23	85
10.47	10.88	10.23	84
8.76	10.88	0.00	100
7.26	5.57	14.77	62
5.13	6.10	1.14	96
1.28	1.59	0.00	100
3.21	2.12	7.95	53
3.21	1.86	9.09	47
1.50	1.59	1.14	86
2.14	2.39	1.14	90
4.49	3.18	10.23	57
3.85	2.92	7.95	61
1.92	1.59	3.41	67
0.64	0.80	0.00	100
5.98	4.77	11.36	64
2.78	2.65	3.41	77
1.07	0.80	1.14	60
5.98	5.57	5.68	75
2.99	3.45	1.14	93
4.27	5.04	0.00	95

Reasons why customers are not happy with the current location of ATMs

- Not close to working areas
- Not close to where they live
- Not close to where they shop
- Not close to eating outlets
- Not situated in a 24hr shop/garage
- No parking space
- High crowding at the ATM
- Not situated in a safe area

	Neighborhood													Total	%
	1	2	3	4	5	6	7	8	9	10	11	12	13		
Not close to working areas	6	1		4	2	1	1	2		2		3	2	24	15.894
Not close to where they live	8	1	11	8	2	3	5	4		1		3		46	30.464
Not close to where they shop				1	1									2	1.3245
Not close to eating outlets				2										2	1.3245
Not situated in a 24hr shop/garage	2		2		1	1	1	2		4	5	4	2	24	15.894
No parking space	1	1		7	3	3	4	3		3		3	4	32	21.192
High crowding at the ATM	1	1	4	3	1	5	4	4		3	4		2	32	21.192
Not situated in a safe area	1	1		5	2	2	1	2	3				6	23	15.232
	185														

% of responses
13.0
24.9
1.1
1.1
13.0
17.3
17.3
12.4
100

(Question 7a)

Those who would like more ATMs

	Neighborhood													Total	%
	1	2	3	4	5	6	7	8	9	10	11	12	13		
Yes	19	8	11	10	8	6	5	6	2	4	4	7	7	97	64.238
No		10	4	3	3	3	2	2	4	6	7	6	4	54	35.762
Total	19	18	15	13	11	9	7	8	6	10	11	13	11	151	100

(Question 7b)

Need more ATMs by which bank

	Each banks responses	Responses for more ATMs	% of responder	% of responses	% of tot responses
ABSA	262	38	25.2	31.93	14.50
BOLAND	30	14	9.3	11.76	46.67
FNB	65	17	11.3	14.29	26.15
NEDBANK	46	25	16.6	21.01	54.35
STANDAR	62	25	16.6	21.01	40.32
	465	119	79	100	

(Question 7c)

Reasons

- Close to working areas
- Close to where they live
- Close to where they shop
- Close to eating outlets
- They would be in a 24hr shop/garage
- There would be plenty of parking space
- There would be less crowding at the ATM
- They would be situated in a safe area

	Neighborhood													Total	%
	1	2	3	4	5	6	7	8	9	10	11	12	13		
Close to working areas	4	1	4	2	2	3	1	2		2	1		3	25	16.556
Close to where they live	9	2	8	5	2	7	6	7		4	5	6	4	65	43.046
Close to where they shop	4	2	2	6	4	8	7	7		4	4	6	4	58	38.411
Close to eating outlets	2			4	2		1					1		10	6.6225
They would be in a 24hr shop/garage	3		4	2	1	1	1	2	1			4	5	24	15.894
There would be plenty of parking space	1	1	2	3	4	4	4	4		2	1	1	2	29	19.205
There would be less crowding at the ATM	3	1	1	3	3	2	4	3	2	1	1	2	3	29	19.205
They would be situated in a safe area	2	2		5	4	4	2	2		2	1		4	28	18.543
	268														

% of responses
9.3
24.3
21.6
3.7
9.0
10.8
10.8
10.4
100

(Question 7b)

Areas where customers would like more ATMs and by which bank

Neig	ABSA		STANDARD		NEDBANK		FNB		BOLAND		%
	Total	Area	Total	Area	Total	Area	Total	Area	Total	Area	
1	3	Du Toit	2	Du Toit							26.32
	2	Kayamandi	2	Kayamandi	2	Kayamandi	2	Kayamandi			42.11
	2	Garage Total	1	Garage Total							15.79
					1	Andringa					5.26
							1	Eikestad			5.26
2	3	Cloetesville	1	Cloetesville			1	Eikestad	1	Eikestad	22.22
3	5	Idas Valley	2	Idas Valley			2	Idas Valley			60.00
			1	Eikestad	1	Eikestad	1	Eikestad			20.00
4	1	Eikestad	3	Eikestad	1	Eikestad					38.46
	1	McDonald/ Bp Express	3	McDonald/ Bp Express	1	Mc Donald/ Bp Express			1	Mc Donald Bp Express	46.15
					1	Neelsie			1	Neelsie	0.00
					1	Pick n Pay			1	Pick n Pay	15.38
	2	Caltex garage									15.38
5	2	Eikestad			1	Neelsie			1	Neelsie	18.18
	1	Die Boord									18.18
			1	Terrace	1	Terrace			1	Terrace	9.09
					1	24 hr garages			1	Pick n Pay	27.27
6	3	UniePark			1	Neelsie			1	Neelsie	9.09
	1	Van der Stel			1	UniePark	3	Unie Park			22.22
	1	Mc Donald									77.78
7	3	UniePark	2	UniePark	1	UniePark					11.11
			1	Mc Donald/ Bp Express	1	Pick n Pay					11.11
											85.71
											14.29
8	4	UniePark			2	UniePark	1	UniePark			14.29
	1	Mc Donald					1	Mc Donald/ Bp Express			0.00
			1	Eikestad							87.50
					1	Neelsie			1	Neelsie	25.00
9	1	Neelsie									0.00
			1	Mc Donald							16.67
10					2	Die Boord	1	Die boord	1	Die Boord	16.67
11					2	Die Boord	1	Die boord	2	Die Boord	40.00
											45.45
12					2	Die Boord	2	Die boord	1	Die Boord	38.46
			3	Paradyskloof	1	Paradyskloof					30.77
13	2	Shell garage	1	Shell garage			2	Shell garage			45.45
					1	Die Boord			1	Die Boord	18.18
					1	Eikestad	1	Eikestad			18.18
Tota	38		25		25		17		14		
%	25.2		16.6		16.6		11.3		9.3		

APPENDIX 4

LIST OF BANK OFFICIALS INTERVIEWED

- 1. AMANDA KNOETZE - ABSA BANK, TEL (021) 8092311**
- 2. BRENDA NICOLE – BOLAND BANK, TEL (021) 8872940**
- 3. ALPHONZA PIENAAR – NEDBANK, TEL (021) 8871008**
- 4. JACKIE ROUX – FIRST NATIONAL BANK, FNB, TEL (021) 8871326**