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KWAZULU-NATAL**

**INYUVESI
YAKWAZULU-NATALI**

**School of Management, Information Technology and Governance
College of Law and Management Studies**

**TRANSPORTATION NETWORKS AND STUDENTS TRAVEL PATTERNS: THE
CASE OF THE UNIVERSITY OF KWAZULU-NATAL**

By

RENALDIN PONNAN

210504501

**A dissertation submitted in fulfilment of the requirements for the degree of
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Supervisor: Dr Thokozani P. Mbhele

2015

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Acknowledgment

My work is dedicated to,

Otisha Ponnann

I wish to thank God for blessing me with the knowledge, wisdom and perseverance to complete this research study.

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Abstract

An increase in students' accessibility to tertiary education and the decline in higher education funding have resulted in a greater number of students that reside off-campus. This trend has also given rise to off-campus students spending a significant amount of time commuting to and from campuses at University of KwaZulu Natal. The research objectives for this study aim: firstly, to explore the transportation challenges and capacity constraints impeding the travel of off-campus students at the University of KwaZulu-Natal; secondly, to establish the correlation between the constraints of public and private transportation scheduling systems on students' academic activities; thirdly, to establish students travel patterns in an attempt to effectively balance the scheduled demand for and capacitated supply of transportation; and finally, to determine the extent to which the different geographical locations in which students reside correlate with their academic performance.

The total population of students residing off-campus for selected campuses totals to 20764 while sample size decision constitutes 377 respondents. This study used questionnaires to collect data from the off-campus students. Quantitative data analysis is used to respond to research questions through univariate and bivariate methods.

The findings of this study reveal that most students travel five days a week to campus. The location of the campuses seems to have an influence on the mode of transportation used to that particular campus. The managerial implications on this study indicates that all the stakeholders should negotiate with each other as well as with the students when planning and putting forward proposals that involve student transportation.

Key concepts: Off-campus, commuting, capacity constraints, scheduled demand and capacitated supply

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Abbreviations

ANOVA	Analysis of variance
CBD	Central business district
DP	Duly performance
KZN	KwaZulu-Natal
M	Mean
PRASA	Passenger Rail Agency of South Africa
SANRAL	South African National Roads Agency Ltd
SAPS	South African Police Service
SCM	Supply Chain Management
SD	Standard Deviation
SPSS	Statistical Package of Social Science
UKZN	University of KwaZulu-Natal
VTT	Value of Travel Time

Chapter One

Introduction to the study

1.1 Introduction

Transportation has evolved over the years from its very primitive origins to play a pivotal role in promoting the liveability of societies (Miller, Witlox and Tribby, 2013:51-64). Transportation, while essentially movement from one point to another, can be defined and interpreted in a number of ways. Wessel (2012) sees it as a basic need. While road transport is the primary mode of transport, transportation can be broken down into six different modes such as pipeline, air, cable, road, water, and rail. Transportation for campus students is the focus of this study and falls under the category of passenger transportation where Kaplan (2015) divides this mode into two subcategories: private and public. Private transportation can be described as transportation arranged by the individual, and public transportation can be described as that in which operatives provide scheduled transportation services (Kaplan, 2015:173-186).

The population of universities has increased drastically over the years at the same time as there have been reductions in government tertiary education funding. This development has resulted in the rationalisation of infrastructure development (Mbara and Celliers, 2013: 1-8). There are currently more students staying off-campus than students residing on campus, and the off-campus students are deprived in terms not only of finance, but also of being able to participate fully in academic programmes and extra-curricular activities due to time spent on travel. Students have been experiencing transportation problems to and from campus for years, and now that more and more students are going to universities, they have to travel greater distances (Junaidi, 2012). Students require sustainable modes of transportation for their daily travelling. The term “sustainable” is used to describe a function that is viable over a long period of time (Kutzmark, 2016).

1.2 Background and Motivation of the Study

The human foot is said to have been the first form of transportation. Other forms of transportation originated probably between the years 4000 and 3000 BC (Lambert, 2014). Animals were believed to have been domesticated between those years, and people would have started using animals for transportation. Durban has a rich history when it comes to its early transportation, because the nature of its transportation was clearly a by-product of its economic prosperity (Rossenbourg, 2011). Over time various socio-political forces moulded Durban's public transport into what it is today (Khan, 2015). Horse and cart have slowly made way for motor cars (Motavalli, 2015). Globally, the need for transportation is increasing rapidly, with more and more people moving from place to place daily (Dawood, 2015). Students, along with other daily commuters, require viable modes of transportation to travel from home to campus and back, either by public or private transportation. This research study attempts to determine if campus students embrace public transportation, to what extent public transportation is used, and the challenges associated with this. There are several campuses in Durban, including both public and private campuses, and thousands of students attend on these campuses and require sustainable modes of transportation which depend on the nature and extent of students' travel patterns (Mbara and Celliers, 2013:1-8). These ultimately dictate the modes of transportation used by students residing in different geographical locations. The focus of this study is the three UKZN campuses, Westville, Howard and the Medical School. The study investigates the daily hurdles students at these campuses face in terms of getting to and from campus. One of these hurdles is the lack of accessible, sustainable, and cost-effective student-orientated transportation. These challenges are the result of a lack of vision and varying degrees of mismanagement by various stakeholders and a lack of tertiary education funding (Mbara and Celliers, 2013:1-8).

1.3 Research Problem

Transportation plays an integral part in commuting students in safely manner and reliable scheduled times to and from respective campuses. Student commuting can have an impact on the student's academic performance and productive wellbeing. The capacity of both the public and private transportation systems requires sustainable transportation mode to ameliorate commuting students' challenges between the campuses and places of residence. The extent to which the university is actively involved with assisting students has to be established within the context commuting needs of off-campus students. The main aim of this study is to

determine the transportation capacity for both public and private systems that university students use and the effects travel patterns to gain insight into the challenges confronting students on their daily basis.

1.4 Research Objectives and Questions

The research objectives of the study aim:

- To explore the transportation challenges and capacity constraints impeding the travel of off-campus students at the University of KwaZulu-Natal.
- To establish the correlation between the constraints of public and private transportation scheduling systems on students' academic activities.
- To establish students travel patterns in an attempt to effectively balance the scheduled demand for and capacitated supply of transportation.
- To determine the extent to which the different geographical locations in which students reside correlate with their academic performance.

Research questions

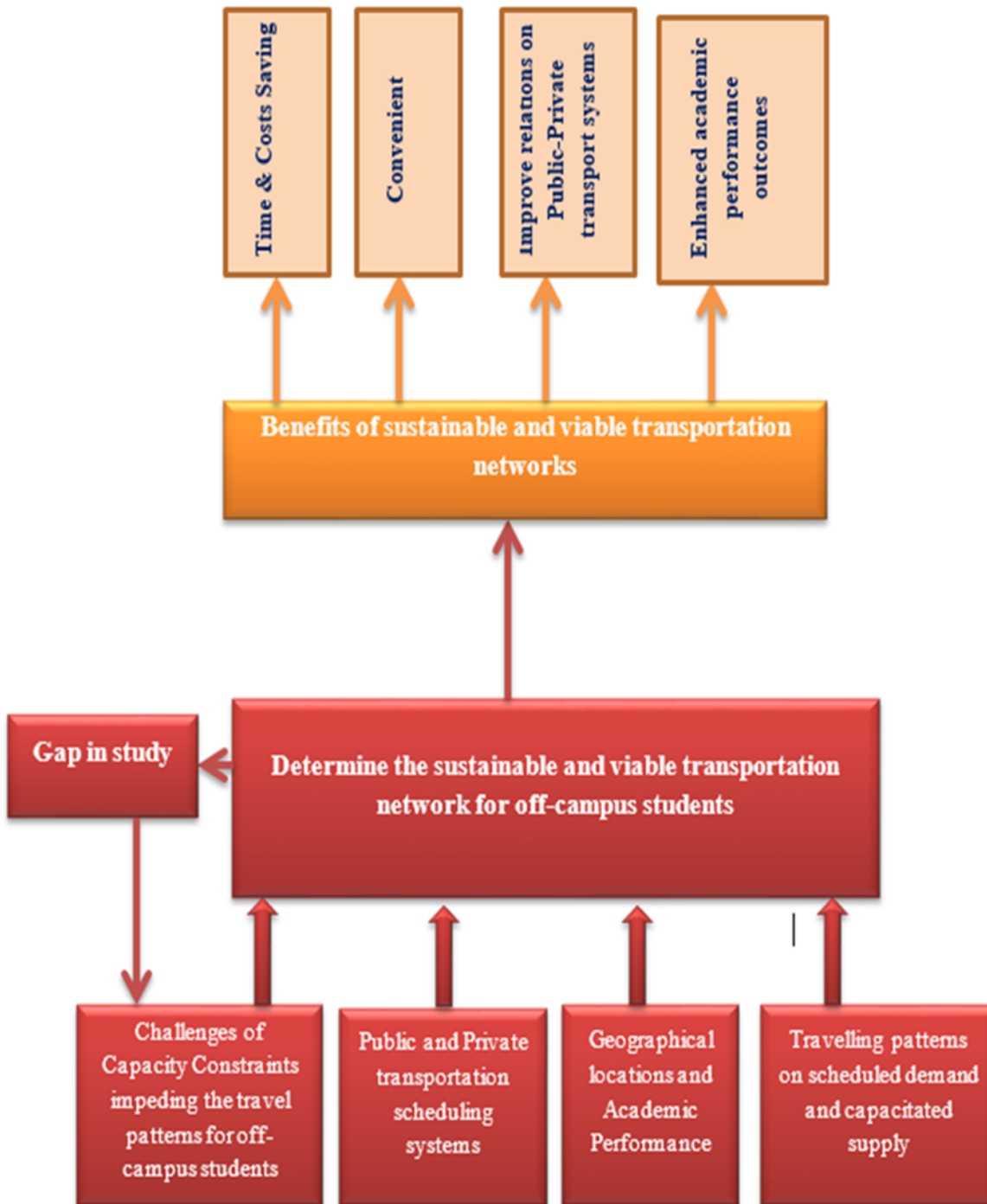
- What are the transportation challenges and capacity constraints that disrupt the travel patterns of selected off-campus students at the University of KwaZulu-Natal?
- What is the influence of public and private transportation scheduling systems on students' academic activities?
- To what extent do the students travel patterns depend on proper planning to effectively balance the scheduled demand and capacitated supply of transportation networks?
- To what extent does the effect of geographical location influence the students' academic performance?

1.5 Theoretical framework

The theory of constraints suggests ways of controlling and overcoming constraints (that are sometimes called bottlenecks in the system) that restrict the system from reaching its goal (Goldratt, 1990). The resources that are around a constraint are extended or expanded till such time that a limitation is relieved. There are three focus areas of the framework, namely logical thinking, performance measurement, and logistics (Hamilton, 2015). The performance measures are used to evaluate whether or not the system is attaining the desired goals. The

performance-related element assists in this study with the gauging of public and private transportation systems as the logistical provision to support the academic activities. The possible bottlenecks in the systems are aligned with the logistics activities to determine the extent to which the distance at which a student lives from campus is related to academic performance. The theory of constraints underpinning this study creates a platform to establish the students' travel patterns in planning the effective balance of scheduled demand and capacitated supply of transport. The theory of constraints can be applied in a supply chain context to be adapted for use in terms of transportation systems.

Figure 1.1 Conceptual structure of this study



Source: Designed by the researcher.

1.6 Literature Review

1.6.1 Definition of Transport

There are various definitions of transport, one of the most basic of which is the action of moving from one distinct point to another (Latinopoulou, Basbas and Gavanas, 2013:310-323). Transport moves people, animals and goods from one place to another (Robinson, 2013). Transport can be undertaken via various modes, and is heavily relied upon to get across great distances. Students rely on transportation to get from their places of residence to their various universities, and some students use multimodal means of transportation to get to and from university.

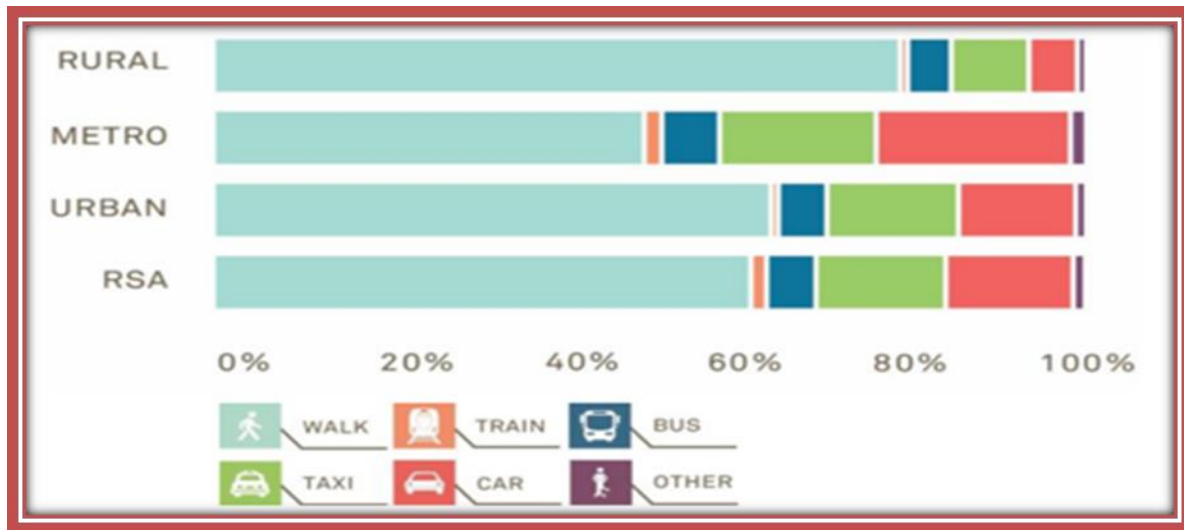
1.6.2 Definition of Sustainable

“Sustainable” can be defined as being able to maintain something or to keep up an action or task (Atherton and Guirco, 2011). Sustainable in the context of this research can be explained as being able to maintain transportation at a balanced and consistent level. Transportation is being sustainable in terms of reliability as a means of consistent transportation for students to travel to and from campus.

1.6.3 Transportation Networks

Transportation networks are basically a web of different modes of transportation infrastructure that are all linked. There are two types of networks, namely highway and transit networks (Gijsbert, 2014). University students that reside off-campus have to travel via the transportation networks to get to and from campus. The availability of transportation that utilises these networks differs for the different geographical locations. Students travel from their places of residence via different networks, all of which lead to the campuses. Some take rail networks leading to the campus from the different stations, others take taxis that lead to a predetermined destination, and some even take buses with appropriate routes (Allsop, 2015). Some travel directly to the campus via private transport, and others have to get to a central location like the city centres, and then from the city centres get to the university or close to the university, where walking would be the next phase. The figure below shows that there has been an increase in students using their own cars to get to their place of study, and this could mean that the passenger transport strategy has not been as effective as it should be.

Figure 1.2 Travel Modal Split to Educational Centres (%)



Source: Passenger Transport, (2013).

1.6.4 Subsidised transport and Lift Clubs

Transport that is partially funded by the government to benefit individuals or groups of people is known as subsidised transport (Dawood, 2015). These subsidies help lower the travel fares for passengers especially students. Public transport is often subsidised for scholars. There are designated buses for students that are subsidised and students often purchase a ticket for buses that lasts a month. Lift clubs are often organised private transport where a number of people travel together to a particular location (Dhoda, 2007). Students often travel in lift clubs to get to and from campus. Students that travel in a lift club either pay weekly or monthly. Cars or even small private taxis are utilised to transport students in lift clubs to campus. Each student in a lift club may start and end at different times therefore a lift club often leaves early so that everyone is on time. Lift clubs leave the campus in the evening when all the students that are a part of the lift club are complete with their activities. The maximum capacity of a vehicle is often used up in the case of lift clubs.

1.6.5 Challenges of student travel patterns

The more a city grows the more expensive it is to operate public transport. In many large cities investments made into public transportation do not always mean that more commuters are going to make use of the investment (Rodrigue, 2015a). According to Rodrigue (2015a), the main challenges of urban transit include getting finance, competition among operators, connectivity between terminals, the decentralisation of activities, increasing petrol prices,

demand for lower travel fares, and competition from private vehicles. Almost all of the systems have discarded the distance rate charging system and now work with the flat rate system. Competition amongst operators is always present in this crowded segment. There is sometimes competition between public and private transportation. Public systems are in most cases independent of the other modes of transportation. Public transportation has been designed to cater for large numbers of commuters with a large density, instead of a scattered density (Rodrigue, 2015b).

The ever-increasing fuel prices also pose a challenge to urban transit. Travel becomes expensive when the fuel price goes up. There is also the increasing demand from scholars to drop the rate of the fare. Scholars are always demanding lower travel fares from operators and this can sometimes pose a challenge. The increase in the number of private vehicles results in traffic congestion and also contributes to increased air pollution (Latinopoulou *et al.*, 2013:310-323). Most private vehicles carry only the driver. The vehicle is travelling empty when it could carry passengers. Many students have private vehicles.

The travel time and waiting time is another challenge that many students face. Students sometimes spend a lot of time when they could be studying either waiting for transportation or travelling to campus (Mbara and Celliers, 2013:1-8). Students travelling via public transport have to get to the various stations, then take either a bus or a taxi to the CBD, then walk to another rank where there are taxis that will take them near their destination. Buses that are contracted to the university and some others come onto campus, and they have particular schedules, so students have to be on time. As a result, students have limited time to do research or use the computer labs.

1.6.6 Public and private transportation scheduling systems

There are various pros and cons of both public and private transportation. Public transportation is provided by the government or by the taxi industry. The vehicles involved are buses, trains and taxis. Trains and buses will have fixed schedules along the planned routes. Private transportation includes the private vehicles of students and also organised transportation by a group of students, and these schedules are more flexible. Public transport is definitely cost effective. The fare is often regulated so it is kept at a minimum. There are many hidden costs in operating a car over and above the fuel. Public transport can also get you from one place to another quickly due to the routes that the operators tend to cover. Every driver of a private

vehicle needs to find parking, and unfortunately finding parking anywhere is usually very difficult. Using public transportation eliminates this hassle.

According to Barton (2016), the disadvantages of public transportation include the long waits, the usual delays, the rush-hour delays, poor consumer satisfaction, and increasing travel fares.

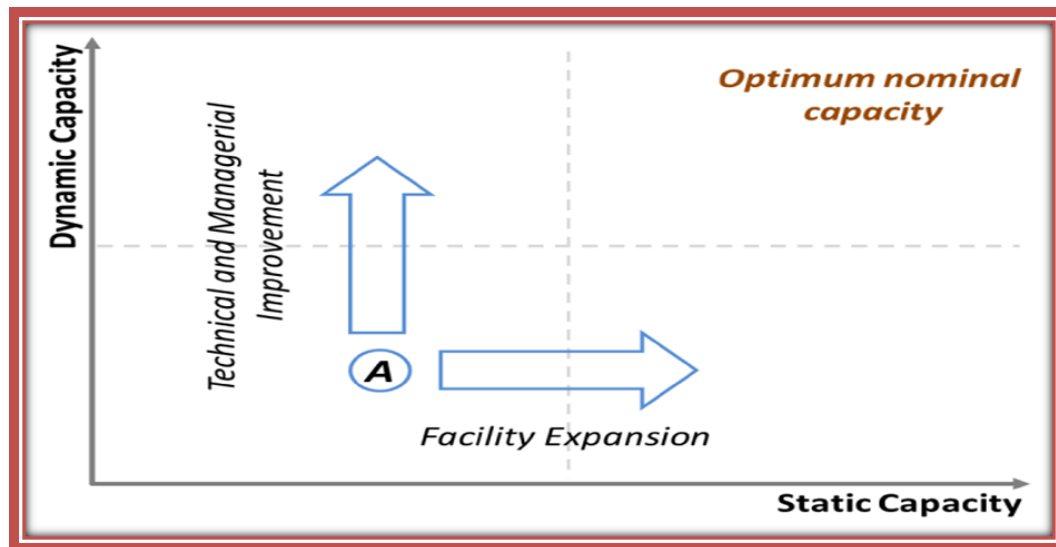
1.6.7 Scheduled and general academic activities

Students have lectures and a whole host of other academic activities such as tests, exams and tutorials. All academic activities are scheduled to specific time periods daily. Students' formal academic activities are governed by time-frames. It is important that students have reliable transportation in order to get to campus on time for their lectures and tests (Navyatha, 2011). Tests on campus are sometimes written during normal class time, which is not really an issue, because students are required to be in class anyway. Tests are also written in the evening, and this poses a challenge for many students because of the need for transportation. This poses a challenge for students residing off campus. Students that use public transportation find it difficult to get home after they have written a test scheduled for the evening. Tutorials are also scheduled in some cases during class times and in some cases during afternoon lectures. Students that use buses sometimes have to leave during a tutorial in order to catch their bus. The same happens with afternoon lectures. Many students have to leave during the lecture or completely miss the lecture in order to be on time for their transportation (Bertolino, 2015).

1.6.8 Effective and efficient transport planning and the dynamics of the supply and demand of transport

Efficient and effective planning of a transport system is the fundamental key to being able to provide a capable transport network (Galilee, 2016). Sound planning requires good forecasting. Travel forecasting works in terms of supply and demand. The people involved in transport are the suppliers of transportation and those who demand transport - the users of the transportation. The different modes of transport are in existence in order to satisfy a transport demand. According to Notteboom (2016), transportation is a component of the service sector that has to be used immediately. Thus the transportation service cannot be stored away. There must be movement through the transportation infrastructure, which has a fixed capacity, by providing a transport supply. Transport needs can be fulfilled when the transport supply meets the transport demand. Dynamic capacity has to do with technology and infrastructure that can often be improved, which improvement can result in improving the productivity of the transportation resources.

Figure 1.3 Dynamic Capacity vs Static Capacity



Source: Notteboom, (2016a).

- **Transportation supply:** Supply is conveyed in terms of capacity. This is the capacity of the modes of transport and the transportation infrastructure. Capacity is often evaluated as static capacity, which is the volume or amount of space available in the transport system. Capacity can also be assessed in other terms, such as dynamic capacity, which is the number of passengers or volume that can be transported per unit of time (Notteboom, 2016b).
- **Transportation demand:** Transportation demand can be assessed in terms of the number of passengers or the volume. The number of passengers can be used as an indicator to gauge the demand of transportation. A high number of passengers will indicate a strong demand for transportation.

1.6.9 Geographical locations vs distanced travelled vs academic performance outcomes

Students come from many different geographical locations. The distances that students travel will depend on their geographical locations. Students that reside further away from campus will travel a greater distance to and from campus and spend more time travelling. Some students use multimodal means of transportation to get to and from the university (Manaadiar, 2013). A student could get onto a train then take a taxi. The distance travelled by off-campus students will differ from one to another depending on their place of residence from the campus. Students travel from urban areas, townships and rural areas. Some students even reside in communes

that are off campus (Radebe, 2013). The figure below shows that there a substantial growth in students using minibuses as well as taxis. There is also significant growth in private car usage.

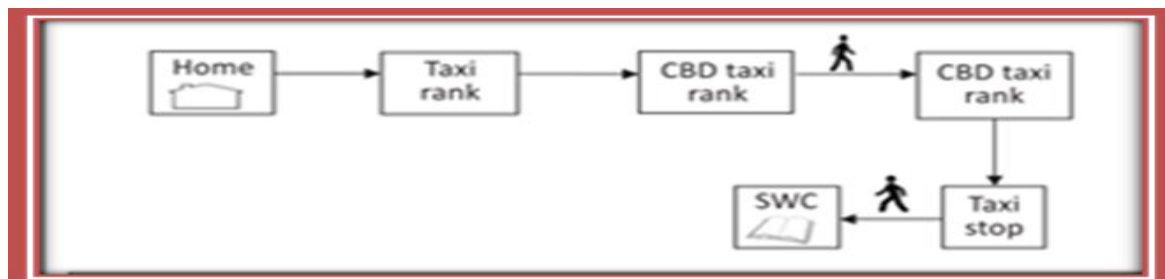
The amount of time a student studies is often used as an indicator of projected academic performance. Students perform better when they increase the amount of time that they study. Travel time shortens study time, and study time has been recognised as being able to positively contribute to academic performance (George, 2013). The greater the distance that a student has to travel from the place of residence to campus the greater is the time lost to study. Travel behaviour that manifests as a result of the greater distance is students frequently coming late to class, which results in diminished study time (Qianying, 2014). The unreliability of the students’ travel time is another factor of travel behaviour that disrupts the learning time. Students may even have to leave afternoon lectures early because some buses leave early, and valuable lecture time is therefore lost. The figure below shows that there has been an increase over a period of time in the usage of private cars and taxis.

Figure 1.4 Travelling to Education



Source: Passenger Transport, (2013).

Figure 1.5 Travel pattern of a student



Source: Mbara and Celliers, (2013).

1.6.10 The process of balancing- capacitated supply and scheduled demand

The capacitated supply should meet the needs of the scheduled demand. There should be a balance between the supply and the scheduled demand of the transportation system. When planning transportation, it is important to consider the demand and supply to be able to balance the desire for commuting with the ability of the system to meet the demand (Manso, 2015). Scheduled transportation systems are basically transportation systems that have fixed routes and schedules that are controlled by a third party. Utilization is very important and to ensure that resources are not being wasted (Terwiesch, 2016). The utilization of resources should be optimised. The capacity of a transit mode is extremely important and it is basically the number of passengers that can be expected to be carried from one point to another (MacKechnie, 2015). Capacity should always be described using the maximum number of commuters who can be moved per hour at the regular speed of the vehicle. The travel patterns of students will be useful in determining how much capacity is required from the different geographical areas. There will be different numbers of students coming from different locations, and some locations may require excess capacity.

1.6.10.1 The number of passengers per vehicle

The number of passengers that can fit into each vehicle is called the load factor (MacKechnie, 2015). Motor cars can accommodate five passengers and do not have a high load factor. The maximum load factor of a bus is normally 1.5 times the number of seats because it is taken that when the bus is fully occupied an additional half of the number of the seated passengers will be standing. There are other modes of transportation such as rail which can reach a load factor of 2.

1.7 Justification for the study

1.7.1 Significance of the study

Many students face difficulties in getting to and from campus due to the nature of their transport. This research is necessary in order to assess the effectiveness of viable transportation and the capacity of the transportation systems. An analysis needs to be undertaken to explore the various modes of transportation and the capacity levels of the systems currently operating. This study could uncover many challenges as well suggest solution for these challenges which could prove beneficial to students. The results of the research will assist in finding a way

forward for challenges that student's face and will assist the various stakeholders in understanding what is required to satisfy the students' needs.

1.7.2 Justification of the study

If this research is not conducted, many students will continue facing difficulties during their years at university. Moreover, they will not gain knowledge of the benefits of viable transportation and would therefore continue to have to face this problem for years to come, until something is done about solving the problem. The number of students entering tertiary institutions is increasing and therefore there is a need for an increased capacity of the transportation for campus students. There are limited studies on transportation networks on students' travel patterns conducted and those studies that are conducted are mainly conducted in other provinces. There are studies of this nature conducted elsewhere and conducting this study in the province of KwaZulu-Natal will assist in understand the challenges present and the dynamics of a different location.

Three campuses chosen are the Westville, Medical School and the Howard campus. These three campuses were chosen because of their locations and it is important to get data that is valid and reliable therefore having one campus located near the town area which is Howard campus and one campus situated away from the town will give the research a more accurate sense of the challenges that exist. The three campuses are chosen to show the differentiation in the travel patterns. The campuses are in different locations such as one closer to the town and this may or may not have sufficient transportation capacity than another campus that is away from the town and will ensure that the research is covering three different type of locations for a dispersed set of data.

1.8 Research methodology

1.8.1 The research onion

The research onion has six different categories that research can be classified into the layers. The layers include; philosophy, the approach, methodological choice, strategy, time horizon and techniques (Saunders, Lewis and Thornhill, 2012a:128). The first layer consists of the different philosophy's that can be used in research and the philosophies include; positivism, realism, interpretivism and pragmatism (Saunders *et al.*, 2012a:128). This research will follow the positivism philosophy which is the researcher adopts the stance of a natural scientist. The second layer of the onion consists of the different approaches which includes the deduction

approach, the abduction approach and the induction approach (Saunders *et al.*, 2012a:128). This research will follow the induction approach. The induction approach draws its conclusions from either one or more facts or evidence (Cooper and Schindler, 2008:74).

The third layer of the research onion consists of the methodological choices. The methodological choices consist of mono method quantitative, mono method qualitative, multimethod quantitative, multimethod qualitative, mixed method simple and mixed method complex (Saunders *et al.*, 2012a:128). This research will follow the quantitative approach and questionnaires will be used. The fourth layer of the research onion comprises of the different strategies. These include; Experiment, survey, archival research, case study, ethnography, action research, grounded and narrative (Saunders *et al.*, 2012a:128). This research will follow the case study strategy. A case study explores the research topic that is within a real-life perspective and is often used in exploratory research (Cooper and Schindler, 2008:144). The research uses a case study strategy because this strategy gives a rich understanding of the context of the study.

The fifth layer of the research onion comprises of the time horizons and there two time horizons which are the cross-sectional and longitudinal. A cross-sectional time horizon is a research that is conducted under a constrained time and a longitudinal study is completed over a longer period of time. This research will be completed using the cross-sectional time horizon due to time constraints. The sixth layer consists of data collection and data analysis. This step in the research process requires the researcher to collect data and to finally analyse the data.

1.8.2 Research design

The research design involves a series of rational decision making choices (Sekaran, 2003:117). These decision making choices are crucial because they affect the outcomes of the study. Cooper and Schindler (2008:141) defines the research design as guide for selecting types of information and that is a time based plan. A research design is an outline of how the research will be performed. This research will be based on an exploratory design, to ensure that the research is completed efficiently and effectively. Exploratory research design is often described as the initial research into a theoretical idea in order to determine if the various factors that are being observed can be explained by existing theories (Kowalczyk, 2016). An exploratory research design is undertaken in instances where there is little or no previous research that has been conducted on a problem and it is flexible in terms of answering different questions such

as why or what (Eugene, 2016). The research will be conducted in different phases, as there will be a flow in the investigation. Firstly, the research will explore the capacity constraints of the transportation for off-campus students, and this exploration will discover the challenges that students are facing in this regard. Finally, the patterns of scheduled demand and capacitated supply will be explored.

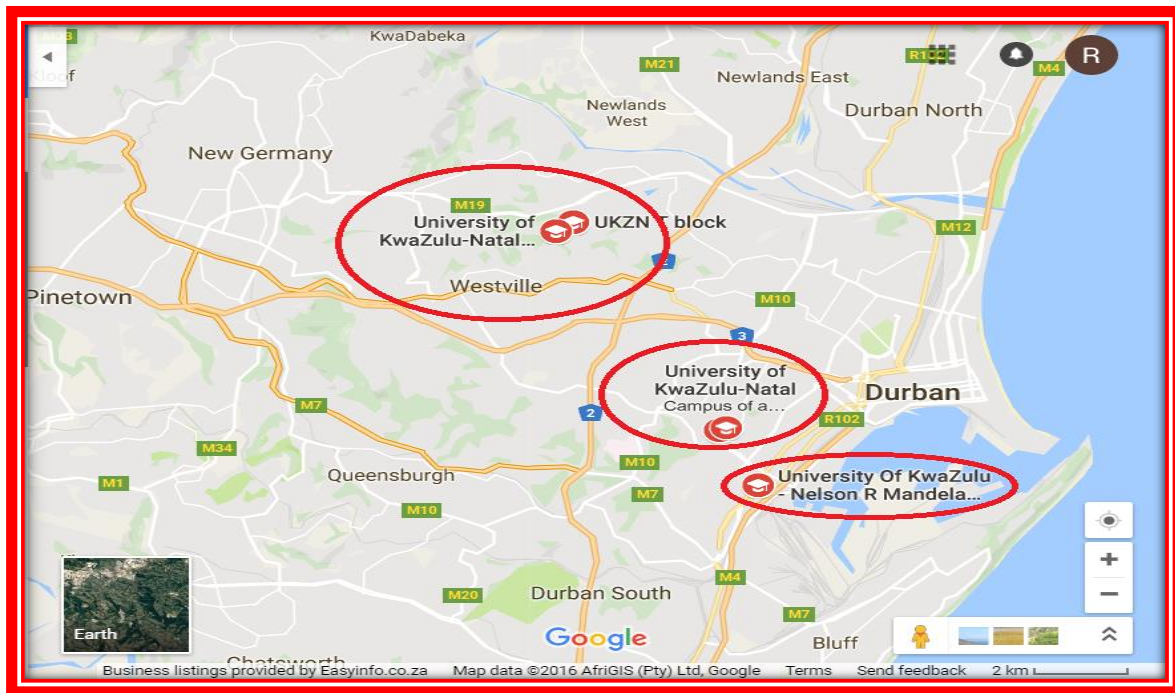
1.8.3 Research approach

There are three different types of research approaches such as quantitative, qualitative and the mixed method. The research approach for this study will follow the quantitative method of research. The quantitative method will be utilised in order to obtain data from students. Qualitative method of research comprises different techniques which tries to decode and translate information (Cooper and Schindler, 2008:162). The difference between qualitative and quantitative research is that qualitative data in word form from observations and documents and quantitative data are in the form of numbers (Cavana, Delahaye and Sekaran, 2001:35). The data will be collected by utilising questionnaires. The scheduling for both public and private transportation will then be explored to obtain a better understanding of how the schedules work for these two systems. The basic approach of this research will be undertaken in four stages related to the objectives of the study. The first step will be to research the challenges of capacity constraints impeding travel patterns for off-campus students. The next step will be to research the public and private transport scheduling systems. The third step will be to research the geographical locations and academic performance, and finally the last step will be to research the travel patterns on scheduled demand and capacitated supply.

1.8.4 Study site

The study site refers to the location where the study will be conducted. Three of the University of KwaZulu-Natal's (UKZN) campuses will be covered. The Westville campus, the Howard campus and the Medical School. This would result in a dispersed set of data, which should increase the reliability of the data. Westville campus is on University Road in Westville, the Medical School is situated on Umbilo Road and the Howard campus is situated on Mazisi Kunene Road, which is in the Glenwood area of Durban (UKZN, 2016a). Figure 1.6 below depicts the geographical location of the three UKZN campus on a map.

Figure: 1.6 Geographic locations of the campuses



Source: Google Maps, (2016a).

1.8.5 Target population

Sekaran (2003:265) defines a target population as all the elements in a population that the researcher will use in the research. The target population of the study will consist of the off-campus students from the Westville and Howard campuses and the Medical School. According to the campus intelligence, the total student population of The Howard campus is 14647. The figure comprises of 3998 students that reside on the campus, the population of off-campus students for the Howard campus will be 10649 students. The total student population of the Westville campus is 12000 students. The figure of 3532 students that reside on the campus, the population of the off-campus students for the Westville campus will be 8468 students. The total student population of the Medical School is 2447 students. This figure comprises of 800 students that reside at a residence. The number of off-campus students therefore is 1647 students. The total population of the off-campus students for both the campuses will be 20764 students.

1.8.6 Sample

A sample is defined as a subset of the entire population (Sekaran, 2003:266). A sample is a representative portion of a research population (Creswell, 2009). Samples are chosen to represent entire populations. Samples of students from the Westville, Medical School and

Howard campuses will be chosen to participate in the study. Studying the sample will enable the researcher to come to conclusions that can be generalise about the population of interest (Cavana, *et al.*, 2001:253). The sample of this study consist of students from the three campuses.

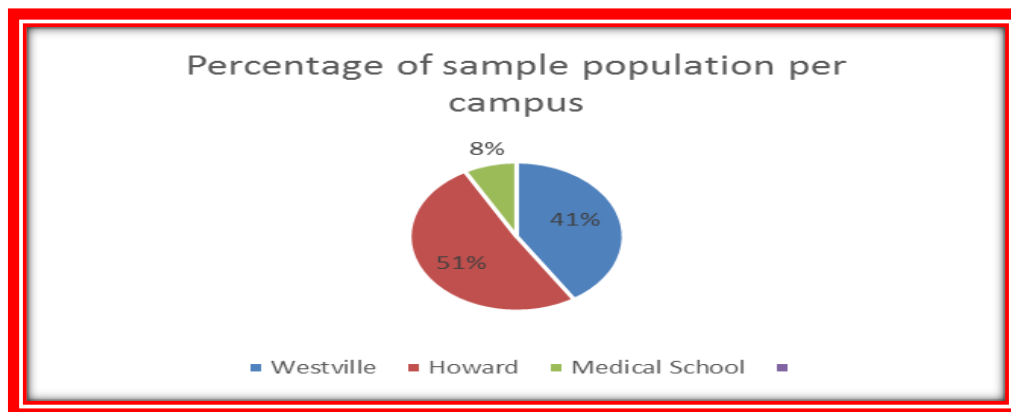
1.8.7 Sampling method

There are two types of sampling which are probability and non-probability. The probability sampling method enables the researcher to make confidence estimates that are probability based and with a non-probability sampling method is subjective and does not have a known chance of being selected (Cooper and Schindler, 2008:379-385). This research will use the probability sampling method. There are different types of sampling that the probability sampling consists of such as double sampling, cluster sampling, stratified sampling, systematic sampling and simple random sampling. This research will use the stratified sampling technique. The stratified sampling is separating populations into many different subpopulations and will be used because it increases the statistical efficiency and it provides enough data that is required for analysing the different strata (Cooper and Schindler, 2008:390).

1.8.8 Sampling and sample size

The total population of students residing off-campus for both campuses is 20764. The sample size decision table will be used to determine the sample size (Sekaran, 2003:294). The sample size according table will be 377 respondents. Westville will consist of 41% of the sample population therefore 155 respondents will be sampled. Howard campus will consist of 51% of the sample population and therefore 192 respondents will be sampled. The Medical School will consist of 8% of the sample population therefore 30 respondents will be sampled. Figure 1.7 below depicts the percentage of the sample population.

Figure 1.7 Percentage of sample population



Source: Designed by the researcher

1.8.9 Data collection methods

Data collection is the collecting or gathering of data and is extremely important in any research because data that is not correct can have a negative impact on the results, thus leading to invalid results (McCombs, 2016). The data that is required for this research will be obtained using questionnaires. Questionnaires will also be used in order to get mass data from students travelling in the buses to and from campus. The questionnaires will be short and will include only important questions (Cooper and Schindler, 2008:215).

1.8.10 Data quality control

The quality of the data in a research project is extremely important, as it affects both the reliability and the validity of the study. The validity and reliability of the study will be discussed in detail to ensure that the data that is reflected in the study is absolutely reliable. (Bala, 2016). Different types of validity that can be used to check the results are criteria-related validity, content validity and construct validity. Face validity makes sure that questions that are on the questionnaire are understandable to respondents (Cavana *et al.*, 2001:212). Content validity makes sure that there is adequate coverage of investigative questions such as research questions that are guiding the study (Cooper and Schindler, 2008:290). Construct validity considers works with both the measuring instrument and theory that is being used in the research. This research will use content validity. Reliability is also important, and the data and findings must be reliable. The reliability of a study is a measure of testing both the stability and consistency (Sekaran, 2003:307). The reliability of a study can be measured using the split-half reliability, parallel-form reliability and the test-retest reliability methods (Cavana *et al.*, 2001:211). Reliability can also be measured by internal consistency such as the using the coefficient alpha also known as Cronbach's alpha (Hair, Babin, Money and Samouel, 2003:172). The test-retest reliability and Cronbach's alpha will be used in this study.

1.8.11 Data analysis

Data analysis is extremely important because it can assist in exploring the relationship between variables as well as to convert data into knowledge and information (Bala, 2016). The data gathered from the study can be analysed by using different techniques. Quantitative data can be analysed using various analysis methods such as the descriptive statistics and inferential statistics. Inferential statistics enable the researcher to make findings about the sample and can be used in this research. Data can be analysed using three methods which are; univariate,

Bivariate and multivariate (Hair *et al.*, 2003:260). The bivariate method will be used in this research. The cross-tabulation using the chi-square analysis will be used because it uses frequency distribution from one or more groups and compares them on a table.

1.9 Ethical Considerations

It is extremely important that all ethical issues are taken into consideration when conducting research. It is important to get the proper consent from respondents before acquiring data from them. The respondents must be well informed about what they are getting into before they become a part of the study. The privacy and confidentiality of each respondent is extremely important and the respondents will be given the option to either divulge information or keep it private. The research must be carried out with respect for human dignity.

1.10 Limitations of the study

All studies incur some sort of limitations. Time constraints are a major limitation. This research is limited in other terms in that it is impossible to include every student on a Durban campus in this study. Only three of UKZN's campuses were included in the study. This was entirely due to the location that the researcher resides in but due to the different geographic locations of the chosen campuses the research will yield valid results. It may also be difficult to get many students to volunteer as participants, as students are generally very busy or always on the move.

1.11 Chapter Outline

Chapter one: Introduction

Chapter one presents an introduction to the study. It discusses the operational, conceptual and theoretical framework to the study by contextualising the topic in terms of the need for the study. This chapter further outlines the problem statement and limitations of the research and what the researcher seeks to achieve from the study.

Chapter two: Literature Review

Chapter two provides the theoretical framework for the study by examining the previous and current literature on transportation. It presents an analysis of arguments and viewpoints that captures the concept of transportation networks and student travel patterns.

Chapter three: Research Methodology

This chapter discusses the various research methods used in this study and the analysis tools utilised on the data collected. The next chapter the sample size, the type of study, the sampling design and methods of data collection and the measuring instruments utilised.

Chapter four: Data Analysis

Chapter four presents the results of the study using the software SPSS as a tool for statistical analysis. Statistics, diagrams, tables and charts are used to present the data.

Chapter five: Discussion on the Empirical Results

The chapter discusses the results presented in the previous chapter. These are analysed together with the study's theoretical framework and the objectives.

Chapter six: Conclusion and Recommendations

The chapter concludes the study by determining if the research questions have been answered and what future research needs to be conducted. Recommendations based on the findings of the study are also discussed.

1.12 Conclusion

This chapter provides the basic structure and outline of the study in terms of the following; the problem statement, objectives of the study and the research questions. Chapter one has also highlighted the background of the study and introduced the theoretical framework to be used in this study. The research methodology aspect has been introduced in this introductory chapter and will be detailed in chapter three of this study. The results of the study will be further analysed with literary factors. The forthcoming chapters will provide information on the knowledge of transportation networks and students travel patterns.

Chapter Two

Literature Review

2.1 Introduction

As was described in chapter 1, the current research study aims to explore the transportation networks of eThekweni municipality in relation to the travel patterns of students at three of the University of KwaZulu Natal's campuses, and the ways in which these impact on students' attendance and academic performance. The steady increase in the need for student transportation in line with the increasing number of students entering tertiary institutions, together with decreased government funding of tertiary institutions, was described in chapter 1 (1.1), as well as the pressure this is exerting on the existing transport systems as well as on students. The various challenges faced on a daily basis by commuting students face regarding the capacity and constraints of the student transportation upon which they are forced to rely were also enumerated.

The theory of constraints (Goldratt and Cox, 1984) forms the theoretical basis of this study, suggesting as it does, ways of overcoming those constraints that restrict a system from performing its function. This theory, and subsequent refinements and consolidations of it by more recent transport systems theorists, are explored and discussed in this chapter. This literature review looks at various theories and research studies related to transportation in general, including transport sustainability, capacity, and capacity constraints, and how these assist and/or constrain scheduled university teaching programmes and students' academic performance. A background to the area of study, sourced from relevant literature, is also presented. In the theoretical framework discussion, the three focus areas of the framework are explained.

Based on a range of sources consulted, areas relating to transportation networks include descriptions and discussions of transportation infrastructure, including the two main types of transport networks: road networks and rail networks, all as they relate to, and affect, student transportation, and how these in turn affect student attendance/completion of academic programmes, and their academic performance. In addition to public transportation networks, literature on the nature and degrees of the availability to students of private transport and lift clubs, subsidised transport, and contracted buses, is reviewed and discussed. In the area of challenges faced by commuting students in terms of their modes of transportation and their

travel patterns, factors such as the affordability of transportation, competition among private transport operators, connectivity between terminals, increasing fuel prices, competition from private vehicles, and travel time/waiting time are reviewed and discussed. These include public and private transportation scheduling systems and the pros and cons of both public and private transportation scheduling systems in terms of students' daily commuting.

Scheduled and general academic activities as they relate to student transport, and accessibility to these by students, are explored including students' academic activities and extracurricular activities. Literature which describes and discusses possible models of effective and efficient transport planning are discussed, including effective and efficient transport planning, adequate supply of transportation, demand for efficient and sufficient transportation, and dynamic capacity. Geographical location in terms of distance travelled, and the ways in which travel affects students' academic performance, as mentioned in chapter 1 (1.2), is further explained and discussed. In this context, the process of balancing capacitated supply and scheduled demand is described and discussed, including scheduled transportation for tertiary students, and the specifics of the transportation demands from tertiary students.

2.2 Background of the study

As was described in chapter one, students' daily travel time to campus is to a large extent dictated by the academic programme timetable, which in turn affects their academic performance. Municipal buses and those owned by private companies and/or individuals, with their capacity to accommodate a large number of students, play a major role in the transportation of students. The Ethekewini Bus Services is an example of a bus company that secured a contract with the University of KwaZulu-Natal to transport students to and from the Westville and Edgewood campuses (Gabisa, 2016). A number of buses travel from different geographical areas directly or close to the campus and such an example is the Myna bus services (Muvo, 2016). There are buses or shuttles contracted by the University for transporting students. Many students travel by taxis, which, although privately owned, also form part of public transportation, and in private vehicles, or form a lift club in order to utilise the excess capacity of a vehicle.

The increasing number of students attending tertiary institutions and exerting pressure on the transportation system resulting in turn in pressure to increase the capacity of the existing system has been mentioned. The increase in students attending universities brings good business for the transport sector. For a balance to exist between the transport needs of all off-campus

students and the existing supply of transportation, ways need to be found to match this demand for transportation with the capacity of the system. The supply needs to meet the demand for transportation. Given this context, the researcher would argue that students require student-orientated transportation that is sustainable, safe, and reliable, including transport after hours and at night. Some students want to utilise the library, and some tests and exams that are scheduled during the evenings.

2.3 Theoretical Framework

2.3.1 Theory of Constraints

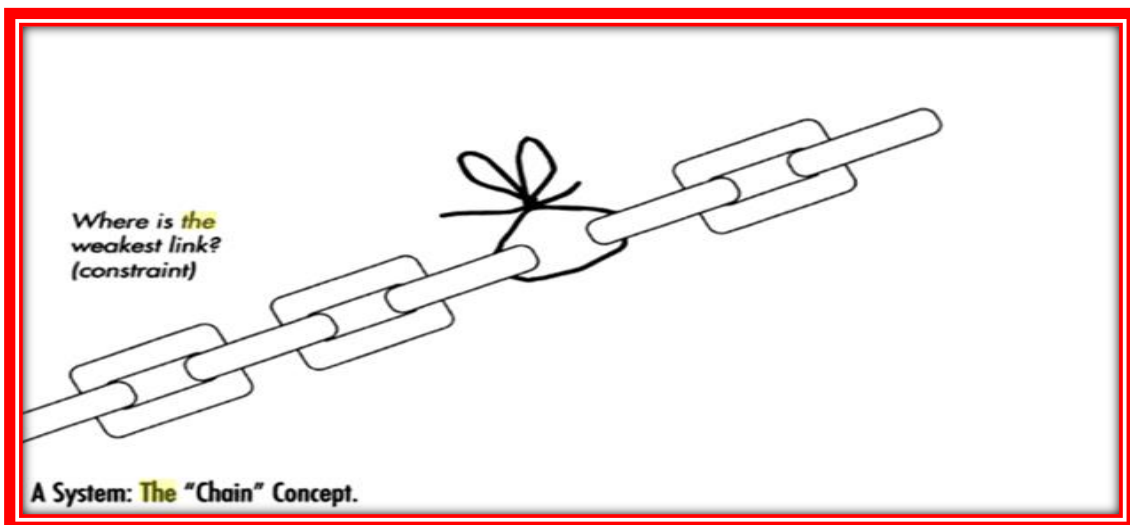
The literature yielded several theories and theoretical frameworks for transportation systems, including the theories of constraints, and prescriptive theories. The classic theory of constraints developed by Goldratt in 1984 identified the weakest link, or the ‘limiting factor’, as forming the constraint in a system (Goldratt and Cox, 1984). Prescriptive theories outline the rules and guidelines to be followed in a design of a system (Knudtzon, 2002). Knudtzon’s (2002) theory is adapted for the current research for use in identifying the constraints in the existing transportation system for students in terms of their needs as students.

Dettmer (1993), expanding on Goldratt’s original 1984 theory of constraints, describes a systems approach to continuous and sustained improvement of a system. Specific systems are developed to attain specific goals, and the stakeholders often decide on the goals and how to achieve these. In this context, the stakeholders could be the government, private or public corporations. The stakeholders in the case of the current study could include the university, the public transport sector, and the private sector. The theory of constraints is based on the assumption that the organisation and its stakeholders know what the purpose and goal of a project are and what goal is being achieved (Dettmer, 1993:5). According to the systems of constraints theory, organisations and stakeholders have to decide on the goals of the system (Goldratt, 1990); in the case of the current study, the system refers to the transportation system for students. Once the goals are established the various requirements for attaining these goals must be identified. Goldratt (1990) uses the well-known chain metaphor to describe the working of systems: a chain is only as strong as its weakest link.

Just as chains often fail at the weakest link, according to Dettmer (1993), a system’s weakest link is the systems constraint. The weakest link in a system can be identified as the constraint that prevents the system (the whole chain) from achieving its goal (Dettmer, 1993:8). Goldratt (1984) argued that, at any given time, there is only one constraint that exists in and affects the

entire system, and this constraint can be compared to the narrowing of an hourglass neck. This one constraint can limit the output or performance of the entire chain or system. Thus the system can only be improved by focusing on the weakest link, which is the constraint. Thus, the researcher would argue, the transportation system that students use must be evaluated in such a way that any bottlenecks in the system can be identified and addressed. This I attempt to explore and identify in the current study, using the theory of constraints as a theoretical framework and a guide.

Figure 2.1: The ‘Chain’ Concept



Source: Dettmer, W. (1993).

As has been mentioned, Goldratt’s (1984) theory of constraints was fundamentally about change in transportation systems, and posed three questions which are essential to bringing about change in a system:

- What needs to change? This relates to the constraint or bottleneck, and this constraint must be addressed and changed.
- In what specific ways does this bottleneck need to change? This questions deals with a plan of action dealing with the constraint/bottleneck.
- How can the change be realised or implemented?

Goldratt’s (1984) theory of constraints outlined five focusing and interlinking steps to enable a system to yield positive effects:

- Identify the systems constraint
- Decide how to exploit the constraint

- Subordinate everything else to this
- Elevate the constraint

2.4 Transportation Infrastructure

In order to explore the quality, suitability, and sustainability of student transport in one geographical area of South Africa, the quality of the transportation infrastructure of South Africa as a whole needs to be described and discussed. The country's infrastructure is described as contemporary and well-built. South Africa boasts the largest rail, road, and air networks on the African continent (Oxford, 2016). The transportation system and infrastructure enable the country to compete economically in a range of local and global markets.

A transportation infrastructure includes the support structures that make up the infrastructure, such as airports, railway systems, ports, and road networks, and together constitute the framework that supports the transportation system. Government is responsible for the development and maintenance of the country's infrastructure, at both provincial and national levels. Thus substantial investment in infrastructure allows the country's transportation to develop and advance in line with global systems (OECD, 2016; Doke, 2011).

Investing in transportation infrastructure is extremely important because it ensures that funds are spent on the upgrading of existing transport infrastructure as well as on the construction in new transportation infrastructure (OECD, 2016). On-going development of transportation infrastructure benefits the entire country and the economy. Businesses require logistics and without transportation businesses cannot operate. Commuters are not able to travel to their work places, schools, and universities.

As has been mentioned above, the increasing numbers of students entering tertiary education as a result of the expansion of universities and the building of new tertiary institutions, require universities to develop support structures to accommodate this influx of students. The transportation infrastructure is one of those support structures that universities should have in place to ensure that students are able to travel safely and timeously to and from the university.

2.4.1 Road networks

The road network system in South Africa is described in order to assess how this affects student commuter transportation. The total road network system of South Africa is 747000km (Doke,

2015). The roads of the country are maintained by the South African National Road Agency. SANRAL (2016) looks after the national roads of the country which amounts to 16200 km of road, as well as the 18500km that make up provincial roads and finally 6600km of municipality roads (SANRAL, 2016). These road networks are well developed in most areas of the country, and about 19% of the country's roads are toll roads (SANRAL, 2016). Building and maintaining road networks costs the government billions of Rands each year. Toll fees assist with the building and maintenance of roads more directly and immediately than do tax revenues (SANRAL, 2016). The majority of students use road networks to get to and from campus as they use taxis, buses and cars for this journey. Road networks are therefore important and should be maintained. Development of new road infrastructures benefits all road users, not only to students. Why? A good example of this kind of road infrastructure is the development of the interchange constructed over the N2 that links Newlands, Reservoir Hills and Umgeni road (Pillay, 2016). This construction was commissioned to ease traffic bottlenecks, one of the constraints mentioned by Goldratt (1984) and Dettmer (1993).

2.4.2 Rail networks

According to SouthAfrica.info (2012), the fourteenth longest railway in the world belongs to South Africa and spans 20247 km. The railway system of South Africa is managed via the government through the public enterprise Transnet. Approximately 2.2 million people travel by train daily. Trains remain a very popular form of transportation for commuters. Students living far from campus tend to utilise trains. How do you know? The students walk to the railway station then proceed to take a train to a railway station that is closest to the university, then either walk to the university or take a taxi to the university. For students train travel is the most cost effective and affordable. The Passenger Rail Agency of South Africa (PRASA) provides rail services for commuters in the metropolitan areas of the country (PRASA, 2016).

2.5 Subsidised transport and student transportation

The idea of a subsidy is to ultimately reduce the market price of a good or service below the cost of production or a particular reason or group. Prices can also be kept low or a special grant can be instituted dedicated to keeping the price low. In certain cases government subsidises student transportation at both school and university level. The fare structures of the different modes of transportation is most likely to have an influence on the mode of transportation that is used (Iseki, Taylor and Miller, 2006:7).

2.6 Lift clubs and student transportation

Lift clubs or carpooling can cut transport costs. A lift club is formed by people who agree to travel together by sharing a vehicle and the driver either charges a fee or the passengers share the cost of petrol. Generally the people in the lift club reside in the same geographical area. A lift club is not only a good way of saving money, but is a way of using up unused vehicle capacity. Numbers of students form lift clubs for these reasons, and in areas where there is limited access to public transportation, or if they are searching for direct transportation (du Toit, 2011:348). All members of a student lift club would leave for university at the time of the earliest lecture of a member of the club, and the lift club leaves campus when the last person is finished with lectures. Students often have trouble finding lift clubs and are more likely to form lift clubs if assistance is received in finding lift club partners (Dhoda and Allopi, 2007:145).

2.7 Affordability of Transportation

Venter (2005) defines transportation affordability as the financial capacity of a commuter to embark on a 'necessary movement from point A to point B. Necessary journeys would include travel to work, school, and to health services, for example (Carruthers, Dick and Saurkar, 2005:2). In recent years the financial cost of daily travelling has been attracting a lot of attention due to the instability of energy prices, making transport affordability an important issue in most developing countries. Inevitably poorer households, which in many urban areas of South Africa, due to Apartheid urban planning, live at greater distance from the urban centres, spend more on public transportation, and a greater proportion of their household income, than do more wealthy households (Venter, 2011:4). The reason for this in a developing country such as South Africa is the location of the poorer households relative to the urban areas. Thus the low demand for transportation from areas away from urban areas, and the distance travelled are the main reasons for higher travel fees (Venter, 2011:5).

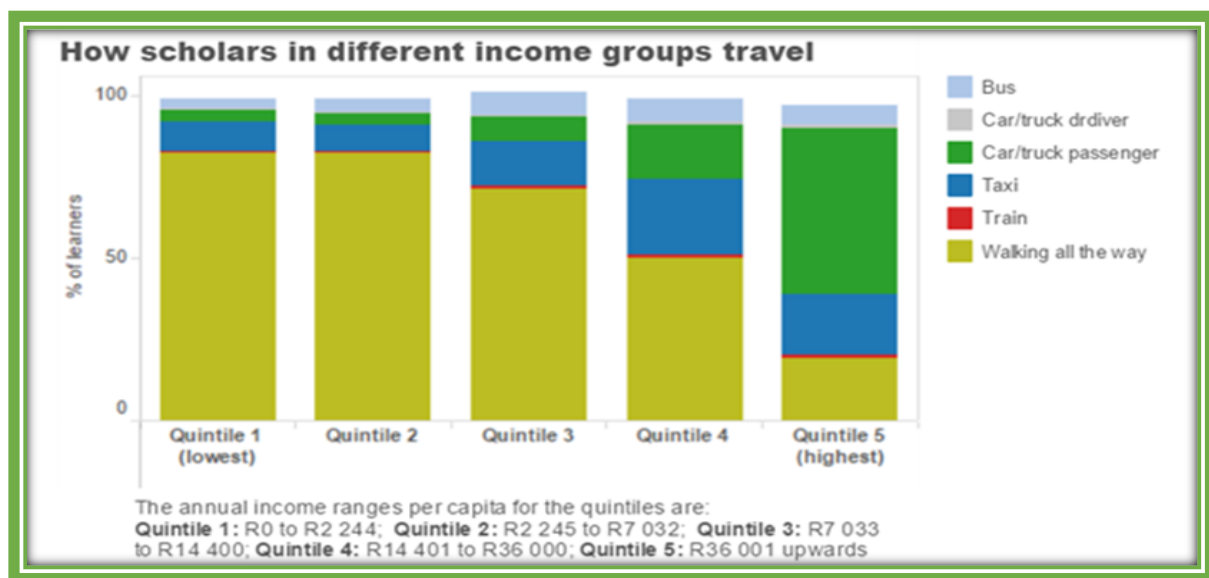
The geographical location of the student along the urban-rural range greatly affects the student's expenditure on transport. The further away the student resides from the campus the more the student would have to spend on transportation. The cost of transportation will depend on the mode of transportation used as well as on the distance travelled by the passenger.

Students' travel patterns differ from one another depending on the location of their place of residence as well as the annual income of their households. Their expenditure on transportation

also differs based on how many modes of transportation that students will have to use to get to and from campus. For commuters, including students, differentials exist in the cost of transportation varies between public and private transportation; private transportation can cost significantly more than public transportation which is regulated to ensure fair competition. In South Africa, where possible, the poorest citizens walk to their place of employment because of the non- affordability of transportation for them (Venter and Behrens, 2005: 673).

The figure below depicts how scholars travel based on their annual income ranges.

Figure 2.2: How scholars in different income groups travel



Source: Grant, L. (2014).

2.8 Increasing fuel prices

Taxi fares increase as the fuel price increases but the fares do not go down when the fuel price goes down. According to Ralph Jones, secretary general of the South African National Taxi Council, the reason the taxi fares do not go down when the fuel price goes down is because a large profit has been made during the fuel price increase. While taxi fares may be too expensive for some students, they nevertheless have to find the fare because there is no other alternative transport if these students reside in areas not served by public transport. The schedules of some students in terms of their academic programme and extracurricular activities may not be aligned with the schedules of student buses, forcing these students to resort to taking taxis. In a study conducted in the US by Folger (2011) on the effects of fuel prices on the economy and thus on student attendance at universities, found that some colleges adopted a four day week in order to create a limit on the monetary burden on students for travelling. Many universities around

the world have followed suit and are adopting a four day week to relieve students of the financial burden of travelling (Folger, 2011). In South Africa rising fuel prices affect all commuting students, using both private and public transportation. Students that use private transportation are also affected, private transportation being the student’s private vehicle or the vehicle of the lift club to which the student belongs to a life club for example.

Table 2.1: Fuel Prices (Unleaded) 2016

Petrol	Reef			Coast		
	Unleaded		LRP	Unleaded		LRP
	93	95	93	93	95	95
02 November 2016	1279	1305	1279	1241	1257	1257
05 October 2016	1234	1260	1234	1196	1212	1212
07 September 2016	1190	1217	1190	1152	1169	1169
03 August 2016	1208	1235	1208	1170	1187	1187
06 July 2016	1307	1334	1307	1269	1286	1286
01 June 2016	1296	1326	1296	1258	1278	1278
04 May 2016	1244	1274	1244	1206	1226	1226
06 April 2016	1232	1262	1232	1194	1214	1214
02 March 2016	1146	1174	1146	1120	1131	1131
03 February 2016	1215	1243	1215	1189	1200	1200
06 January 2016	1209	1237	1209	1183	1194	1194

Source: Automobile Association, (2016).

2.9 Travel time and time waiting

The value of travel time (VTT) is the cost of time invested by a commuter in transport and involves both waiting time and the actual travel time (Hassen and Sandberg, 2012:113-1145). Travel time saving represents the benefits accrued from the reduction in travel time costs. In the context of commuting students, travel times differ among students; the greater the distance a student has to travel, the greater the travel time of that student. Waiting time for a commuting student would include the time a student has to wait in order for transportation such as a taxi to depart and/or arrive. The waiting time would also include the time a student has to wait in order to get a place in a bus or taxi when there is a limited amount of space and often a queue of waiting commuters which works on a first come serve basis (Engelson and Fosgerau, 2016:13). A taxi will only leave the taxi rank when it is full, in other words when it has reached its maximum capacity. Transport can also be scheduled and students will have to wait for the times on the schedule for transportation to arrive. The actual time of travel is the time that it takes for a commuter to get to her or his destination (Iseki, Taylor and Miller, 2006:9). The actual time of travel can differ depending on the vehicle’s speed and also the conditions of the

road if it is road transportation. Traffic density, accidents, and road maintenance are some factors that can cause delays in road travel. Obviously the travel time of students travelling great distances to campus would be far greater than those living within the metropolitan area. The table below shows the many different perspectives for valuing travel time and the travel time saving.

Table 2.2: Time Perceptions

Name	Description	Implications
Travel Time	Any time devoted to travel.	This is the least specific definition.
Clock Time	Travel time measured objectively.	This is how time is usually quantified.
Perceived Time	Travel time as experienced by users, which can vary greatly from clock time	This reflects traveler comfort.
Paid (also called <i>On-the-Clock</i> or <i>commercial</i>)	When workers are paid for their travel time (for deliveries, traveling to worksites etc.).	This type of travel tends to have a relatively high value per hour.
Personal Travel Time	Time devoted to personal travel (commuting, errands, etc.).	This is the largest category of time value in most economic studies.
Generalized Costs	Combined travel time and financial costs.	This is how travel time is incorporated into traffic models.
Effective Speed	Total time devoted to travel, including time spent earning money to pay transport costs.	Higher costs for more expensive modes.

Source: Victoria Transport Policy Institute (2013).

2.10 Public and private transportation scheduling systems

Public transportation, such as buses, taxis and trains, can be scheduled. These forms of transportation work using schedules. The scheduling system of public transportation works on a timetabling system where the transportation leaves a certain place at regular time intervals every day. The Durban transportation buses run on a schedule, for example, showing the different places at which the buses pick up commuters from different areas, below is a picture showing the different areas in Durban that the Durban Bus Services service operate from to the various areas (eThekweni Municipality, 2016). Public taxis work in a similar way to the buses in terms of the scheduling. Taxis are used by majority of the population to get from place to place (Barrett, 2003:11). Commuters that utilise taxis are familiar with the taxi schedules. In some cases the taxi scheduling does not work because of the waiting time, waiting for the taxis to fill up with passengers. Taxis are used by majority of the population to get from place to place

For students private transportation encompasses private vehicles individually owned, or lift clubs. A relatively small number of students travel to campus using private transportation such

as private cars (Danaf, Abou and Kaysi, 2016:5). These students would be from middle class socio-economic areas, and able to be more flexible with time than the majority of off-campus students. Students who are car owners would obviously not need to follow a fixed schedule. They are not bound by a rigidly fixed schedule in comparison to those students having to use public transportation. Lift clubs are a little different; the times that the students leave home to get to campus and then leave campus to get home would ultimately depend both on the academic timetables of those students and on the schedules of other members of the club. The students in the lift club would leave campus after the student with the last lecture is complete.

Figure 2.3 Bus Timetable

Bus timetables	
Central Area	South Area
Chesterville	Gijima-Lamontville
Durban North – Umhlanga Rocks	Umlazi BB Route 4
Fynnland – Brighton Beach	Umlazi C&J-Route 3-7
Mt Vernon – Malvern	Umlazi F&G-Route 1
Marine Garage – Merewent	Umlazi U-Route 5
Pinetown – Mariannridge via Westville	Umlazi Z-AA-Route 6
<u>Shallcross – Hillview</u>	Umlazi-M&R-Route 2
Umbilo	
Woodlands – Woodhaven	Mynah
	Botanic Gardens
North Area	Kensington-St Mathias
Gwala's House Saturday – Sunday	Morningside
Gwala's house Monday – Friday	Musgrave Road – Mitchell Park
Kwa Mashu K via D	Tollgate
Kwa Mashu J via E-F-G	
Newlands East – New Dawn Park	People Mover
Ntuzuma G	People Mover
Ntuzuma – Central Areas	
Ntuzuma North Coast Rd	
Ntuzuma – Southern Areas	
Ntuzuma – Western Areas	

Source: Muvo (2016).

2.11 Students' academic activities

Students' on-campus activities can include both academic and extracurricular activities, some of which may be scheduled in the late afternoon and evening (Wilson, 2009:10). Academic activities would include lectures and tutorials and scheduled tests and exams, some of which may be written during the evening. Extracurricular activities include a variety of sports. The Westville and Howard campuses are well resourced in terms of sports facilities, which means that large numbers of students are able, and would want, to take full advantage of these and

that involvement in sports activities would have a bearing on students' travel times (UKZN, 2016b).

2.12 The influence of effective and efficient transport planning on student travel patterns

Transportation networks that are well planned and efficient not only influence the economy but also have a significant impact on people, and the mobility of people and the growth of the economy are closely interrelated. Transport systems that are efficient and effective ensure that mobility is maximised (Rivasolata, Iseki and Smith, 2012:57-73). The ultimate effect of this on student commuters is to ensure their full participation in academic programmes and their graduation into the job market. The efficiency of transportation needs to be considered in relation to the effects of high transport expenditure incurred on the income of a household (NPC, 2011), which in turn impacts students' entrance to and attendance at university. Transportation planning for students should also be given prime consideration when in the process of developing routes in terms of adequate accessibility to universities and the various challenges faced by students.

2.13 Dynamic Capacity

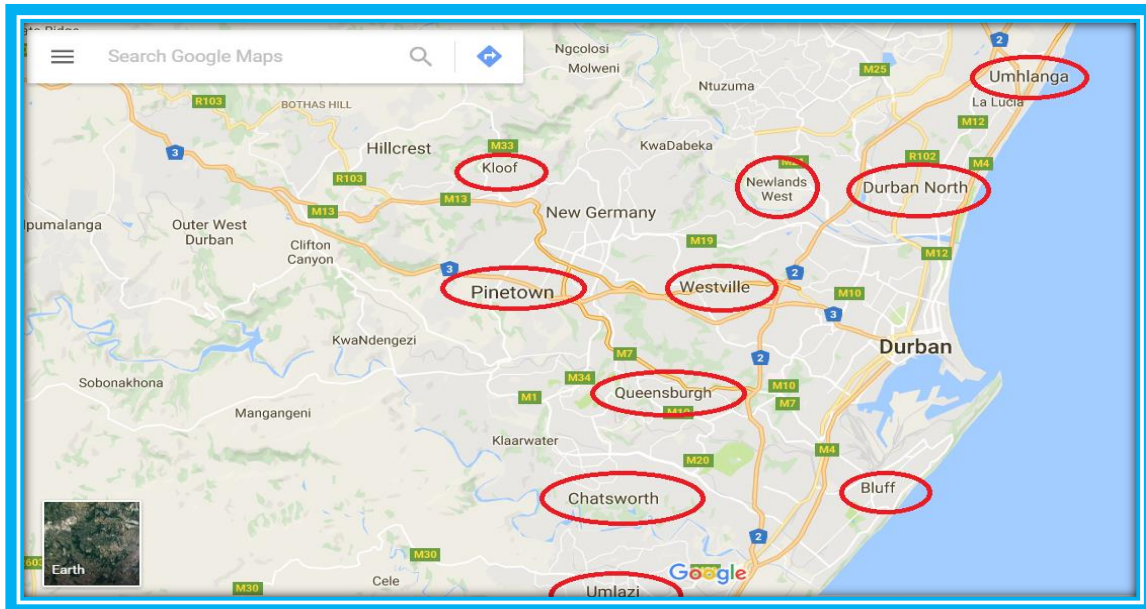
Dynamic capacity in the context of transportation often relates to three factors that can be utilised and developed: technology, infrastructure and labour (Rodrigue, 2016). The efficiency and productivity of transport can be improved by employing a dynamic capacity strategy. A dynamic capacity strategy can be used to improve a road system by simply installing traffic lights, with better management: a relatively straight forward strategy used to improve the effectiveness and efficiency of the transport systems of the country. Dynamic capacity refers to developments that can be undertaken by better management and better technology.

2.14 Geographical locations of students' places of residence

As has been mentioned, the variety of different geographical locations from which students come or indicates varying distances travelled to and from, campus. These areas can be classified into different demographic regions: the city, rural areas, townships, and urban/suburban areas (Garcia, 2013:1-5). Students who reside in rural areas often attempt to move closer to the city in order to be able to travel to universities on a daily basis (Kathleen, 2016). When investigating student transportation patterns and the challenges faced by students,

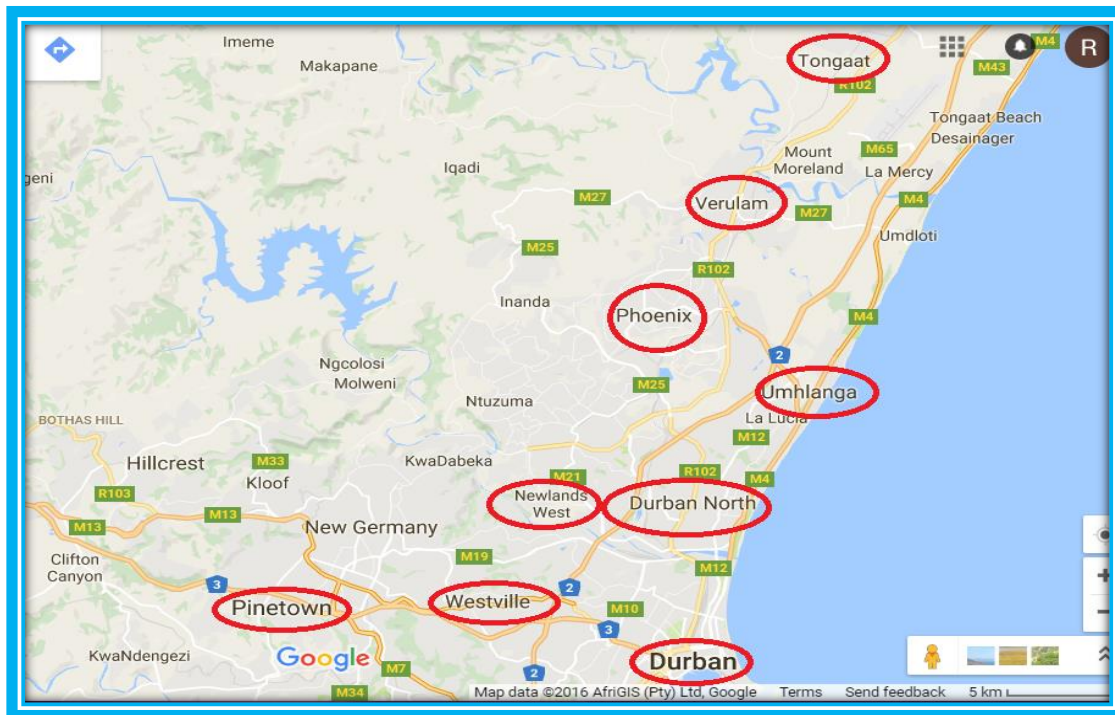
it is important to know where students reside in order to understand the travelling patterns and distance travelled and the effects of these on students' wellbeing and academic performance. Figures 2.6 and 2.7 below depicts the different areas that students reside in on a map of KZN.

Figure 2.4: Map of KZN illustrating the different geographic locations



Source: Google Maps, (2016b).

Figure 2.5: Map of KZN illustrating the different geographic locations



Source: Google Maps, (2016c).

2.15 Reliable transport as a factor affecting academic performance

Academic performance can be assessed according to a range of factors, not only by a student's overall average mark. Test scores, the students duly performance (DP), and examination marks can all be used in this assessment. There are both positive and negative factors, related to students' commuting, that can affect the academic performance of a student. Students who attend lectures on a regular basis tend to perform well in tests and exams. Regular attendance increases the potential for students to acquire comprehensive knowledge of the entire curriculum. Students can only attend lectures on a regular basis if they have reliable daily transportation (Odumbe, Simatwa and Ayodo, 2015:78-85). Early syllabus completion improves academic performance, allowing as it does more time for revision and study. One of the negative factors affecting academic performance could be the distance from the student's home to the university. A long distance means a longer journey to the university and loss of lecture attendance and study time. Inefficient or unreliable means of transportation to university may have a similar effect on a student's academic performance.

2.16 Demand of transportation by tertiary students

The increasing burden on the current transportation infrastructure occasioned by the increase in tertiary students has been mentioned, together with tertiary institution funding cuts. These factors, together with growth in the number of tertiary institutions within the last decade, point to a higher demand for student transportation (Mbara and Celliers, 2013:2). This in turn indicates the need for universities to develop and increase the capacities of their own transport infrastructure to ensure that the university is able to provide for excess transportation capacity. When a university is situated near or within a city, students' high demand for transportation contributes a significant share to the city's volume of traffic. Thus the location of the university would be a major consideration in determining the type of transportation that students use, or could use, to get to campus (Mbara and Celliers, 2013:7). Students' demands for a variety of different modes of transportation may differ from one student to another depending on the place of residence of these students and their preferred mode of travelling. Thus, it is hoped that the findings of the current study will indicate an urgent need for universities both to be knowledgeable about public and private transportation, and to develop and create their own transportation systems that are sustainable and that meet both current and future demands.

2.17 Chapter Summary

This chapter has explored the theoretical framework that is going to be employed in this research study which is Goldratt's Theory of Constraints. The South African current transportation infrastructure has been explored which included both the road and rail modes and this assists with understanding the transportation networks and travel patterns of commuters. This chapter has discussed important factors that affect the students' travel patterns and the transportation network. Based on literature it is imperative that the various stakeholders get involved with ensuring that the demand for transportation for students are met. Students have both academic activities and extracurricular activities such as sport thus transportation has to be available for the students should the student play sport. Efficient transportation planning is therefore imperative to achieve efficient management and better management of existing resources. The different geographic locations that students reside in has also been discussed in this chapter and it will assist the researcher to track the travel patterns of the students.

Chapter Three

Research Methodology

3.1 Introduction

The research onion was adopted in this research study, the onion can be further classified into six different layers. One of these layers is the methodical choice and this research study follows the quantitative methods. It is crucial that the research methodology aspect of the study is well planned, this will ensure that the results and findings are both valid and reliable for further use on the topic. This chapter outlines the manner in which the research for this study is conducted. It specifies the type of research design, the nature of the study and the methodology that is selected to analyse the data.

3.2 Research design

A research design is an outline of the research project, a blue print for collecting and analysing the data. It includes the structural framework for the process the researcher intends using in order to answer the problems the study is attempting to address (Cooper and Schindler, 2008:140). In the case of the current study, the research design provides the structure the researcher needs in order to attain the answers to the research questions on University of KwaZulu-Natal students' travel patterns in terms of transportation networks. In addition the research design serves as a framework for stipulating the relations amid the variables of the study (Cooper and Schindler, 2003:146).

For reasons which will be described and explained, the researcher selected an exploratory research design for the current study. Exploratory research designs are used when information on a research project is not immediately or easily available, and when a researcher wishes to gain or develop an improved understanding of a problem (Hair, 2015:147). Since the researcher found very little information from documentary and/or secondary sources about the transportation networks and travel patterns of students from the University of KwaZulu-Natal, he chose this particular type of research design. An exploratory study has the potential to facilitate the gathering of new and hitherto unexplored insights, besides- assisting in clarifying the research problem (Saunders, Lewis and Thornhill, 2007: 133). This design has the potential for providing new and deeper knowledge in terms of transportation networks and students' travel patterns in general, and specifically those of students at UKZN (Saunders *et al.*, 2007:133).

3.3 Hypotheses of the study

Table 3.1 Hypotheses explained

H ₀₁ : There is no association between the bus transportation mode and the campus locations.
H _{A1} : There is association between the bus transportation mode and the campus locations.
H ₀₂ : There is no association between the private vehicle transport mode and the campus locations.
H _{A2} : There is an association between the private vehicle mode of transportation and the campus locations.
H ₀₃ : There is no association between the private vehicle mode of transportation and the campus locations.
H _{A3} : There is an association between the private vehicle mode of transportation and the campus locations

Source: Designed by the researcher

3.4 Research approach

The research approach selected and adopted for a particular kind of research involves a comprehensive detailing of the processes and plans involved in the collection of data, an in-depth analysis of the data, and drawing useful conclusions from the analysis (Creswell, 2014:1). The research approach involves numerous decisions that must be made by the researcher in an order to ensure the coherence and systematic nature of the research process. Thus the selection of a particular research approach is based on the form and nature of the research problem. The various possible research approaches include quantitative, qualitative, and mixed methods research. Qualitative research is generally described using words as opposed to using numbers or statistics (quantitative research). Qualitative processes encompass utilising questions to collect data from questionnaires, interviews and focus groups, as well as from the setting of the researcher and participants. From these the researcher interprets or draws meaning for the findings of, and conclusions from, his research (Creswell, 2014:2). Quantitative methods of research are used in order to test objective theories and to make

comparisons between the relationships that exist between variables (Creswell, 2014:2). The variables are then measured on instruments of the researcher's choice; data such as numbered data are then captured and analysed by the researcher. This research is using the quantitative approach. A mixed methods research model encompasses both qualitative and quantitative data and involves integrating both these methods in the process of gaining a better, more in-depth, comprehensive understanding of the research problem than would be gained using either approach on its own.

3.5 Study site

The study site, or setting, includes three of the University of KwaZulu-Natal's campuses: the Westville campus, the Howard campus and the Medical School. The campuses are located in KwaZulu-Natal, Durban. The Westville campus was established in the 1960's, the Howard Campus was opened in 1931, and the Medical school in 1947 (UKZN, 2016c). The University of KwaZulu-Natal, a composite of these three campuses, was formed in 2004 as a result of a merger between the Westville University formerly known as the University of Durban Westville and the University of Natal. Geographically speaking, the Westville campus is located on University Road, Westville, the Howard campus on King George V Avenue, Berea, and the Medical School on Umbilo Road, Congella. These three campuses were selected for the current study based on their strategic locations. The Westville campus is located away from the CBD area, while the Howard campus and the Medical school are situated closer to the CBD than the Westville campus. The Howard and Westville campuses are located in different regions of Durban and conducting the study in these campuses would result in a dispersed set of data. Travel patterns can be conveniently and systematically studied, affording the study greater reliability and validity. Potential respondents were recruited at the campuses, their universities forming the study sites for the research.

3.6 Target population

The target population refers to the whole group of elements or people that a researcher aims to study (Sekaran, 2003:265). The target population can be defined and selected by studying/taking into account the research objectives as well as the scope of the study (Hair, Babin, Money and Samouel, 2003:209). The researcher identifies the target population which he/she intends to study so that the research questions and findings can be evaluated from the perspective of the respondents (Hair *et al.*, 2003:188). A single member of an entire population is an element of that population (Sekaran, 2003:265). An off-campus student is therefore an

element. The target population is therefore the complete group of elements that are most applicable to the research. The target population is important because from it the researcher is able to obtain the information relevant for the study: information about the travel patterns and the transportation networks that students utilise.

The target population for this research study includes off-campus students from all three university campuses. Off-campus students are those students who do not reside on campus at a campus residence. These students are the target population because the information these potential respondents possess in terms of commuting to and from the campuses is crucial in terms of answering the research questions and objectives. The total number of students on the Howard campus is 14647. This number can be broken down into on-campus and off-campus students. The number of students that reside on campus is 3998, and there are 10649 off-campus students. The total number of students at the Westville campus is 12000, a figure which, when broken down into on and off campus students 3532 residing on campus and 8468 off-campus students. There are 2447 students at the Medical School, 800 residing at a residence, and 1647 off-campus students. The total target population is 20764 students from the three campuses.

3.7 Sample

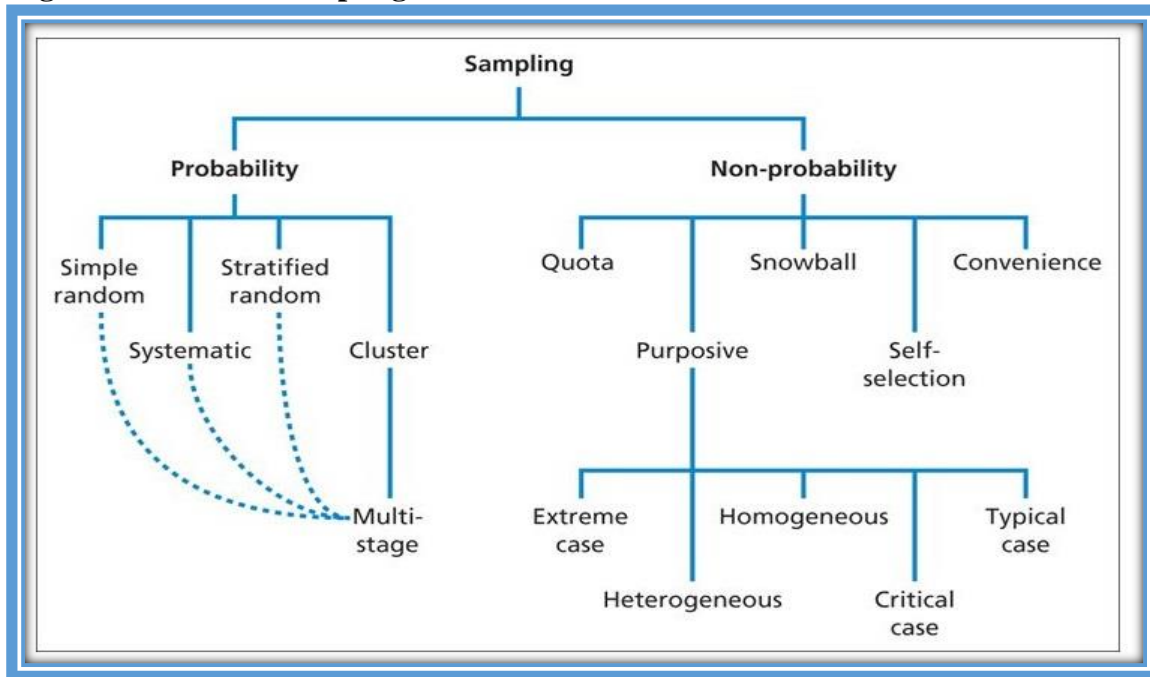
A sample is a segment of the population that is selected by the researcher for investigation (Bryman and Bell, 2011:176). The sample for the current study consists of a number of participants selected from the target population, the smaller group of the population making it possible for me to draw conclusions about the population as a whole (Sekaran, 2003:266). Samples of students selected from the three campuses are as follows: 155 students from the Westville campus, 192 from the Howard campus, and 30 students from the Medical School.

3.8 Sampling method

Sampling can be of two different types: probability and non-probability sampling. With the probability sampling method the probability of each subject being selected from the population is known, and for non-probability sampling, the probability of each subject being selected is not known (Saunders *et al.*, 2007:207). There are different types of probability sampling, such as simple random sampling, systematic sampling, stratified random sampling, and cluster sampling (Bryman and Bell, 2011:179-181). The use of the simple random sampling method would mean that each subject or unit of the population has a probability that is equal in terms

of being included in the sample. The systematic sampling method is different from simple random sampling because the researcher selects the units directly from the sampling frame. Cluster sampling is made up of groups which are called clusters; the target population can be grouped into clusters.

Figure 3.1: Cluster Sampling



Saunders, Lewis and Thornhill, (2012b).

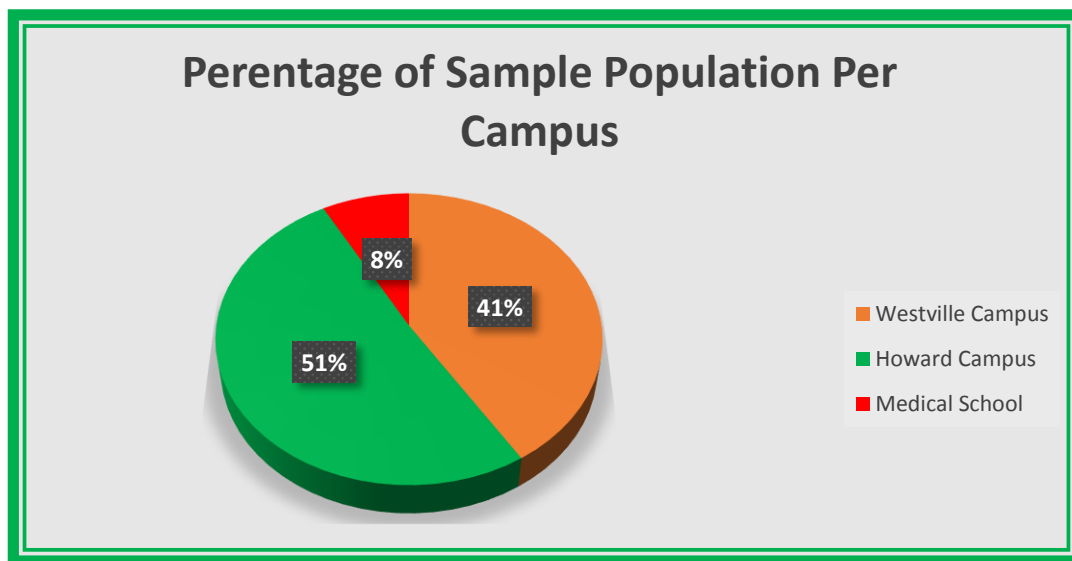
The research uses stratified random sampling, a sampling method which splits the population into relevant strata founded on either one or more attributes (Saunders *et al.*, 2007:221). The sampling frame of the research is divided into numerous subsets. Stratified random sampling encompasses the process of stratification also known as segregation (Sekaran, 2003:272). In this sampling process the population is often divided into segments or groups that are considered the most appropriate and most important in terms of relevance to the study. Stratification can be seen as an efficient and effective method of sampling because it offers useful information with a given sample size. Stratified random sampling can be extremely practicable if the relevant information required is available from the respondents included in the sample. Different criteria can be used to stratify the population using this method of sampling.

3.9 Sampling and sample size

In order to maximise the quality and reliability of the research, the researcher needs to evaluate the different characteristics from the population, and it is crucial that an estimation of the sample size is determined before any data are collected. Many factors have to be taken into account when determining the sample size, such as the budget for the research, the time available, type of sample that is required, and the variability of the target population (Hair *et al.*, 2003:218).

As was detailed in Section 4 above, the total number of off-campus students from the three campuses is 20764. The number of students from Howard campus who qualify as off-campus students is 10649 students, at Westville 8468 students, and 1647 at the Medical School. The sample size of the research is therefore, in terms of the percentage of the populations of the respective campuses, 377 students.

Figure 3.2: Sample size decision



Source: Designed by the researcher

3.10 Data collection methods

Data can be defined as constituting the facts gathered from the study's environment that is chosen and presented to the researcher for investigation (Cooper and Schindler, 2003: 87). There are two ways in which data can be obtained: the first is through primary sources and the second is through secondary sources. According to Sekaran (2003) the data that is gathered by the researcher based on the variable that is needed for the study is called primary data and secondary data are the data obtained from existing sources. Data can be collected through

numerous means: questionnaires, interviews, and observation. The collection of data is very important and once the data are collected they must be critically analysed so that the researcher can then make important decisions (Hair *et al.*, 2007:192). The amount of data that is to be collected is dependent on both the objectives of the research and the nature of the study.

This study utilises primary data, the purpose being to obtain the data first-hand from the students. The method used to obtain the data is the utilisation of personally administered questionnaires. A questionnaire consists of a set of questions formulated by the researcher in order to have the answers of the respondents in the sample recorded. A questionnaire can be an effective means of data collection because the researcher is able to elicit the information required (Sekaran, 2003:236). There are different methods used for administering and distributing a questionnaire: electronically, personally, and via e-mail. The current research utilised the personally administered method. One of the main advantages of this method is the opportunity it provides for the researcher to explain misunderstandings that might be encountered by respondents in the course of their completing the questionnaire, and the researcher being able to help clarify these as well as any doubts respondents may still have in terms of the purposes of the research. The questionnaire was administered to students on the Westville campus, Howard campus and the Medical School. This study required 377 respondents and thus 377 questionnaires were administered proportionately between the three campuses. At the Westville campus 155 questionnaires were administered, 192 at the Howard campus, and 30 at the Medical School.

3.11 Assessment of data collection and analysis

3.11.1 Reliability

Reliability is the extent of consistency that the researcher's data collection techniques yield (Saunders, 2003:149). As consistency being associated with reliability in research, there are different criteria that can be used to measure the consistency and accuracy of scales: test-retest reliability, alternative forms reliability, and internal consistency reliability. Reliability can be measured by using the test-retest reliability measure and this is obtained by the measurement being repeated. Alternative forms of reliability are two forms of the construct which are equivalent which are created by the researcher. Each respondent is evaluated or measured twice at different times. The reliability is measured by the correlation that is in the middle of the two different responses (Hair *et al.*, 2003:171). The next reliability measurement criterion is the interval consistency measure; there are two different types of interval consistency measures:

the split-half reliability and the coefficient alpha (Cronbach's alpha) (Cooper and Schindler, 2003:239). Split half reliability is the correlation that exists between the two halves of an instrument.

3.11.2 Validity

Validity can be defined as the degree of a construct measure (Hair *et al.*, 2007:246). The validity of a study is judged by whether or not the indicator that is devised for the research actually measures that particular concept. There are different types of validity: measurement validity, internal validity and external validity (Bryman and Bell, 2011:42). Measurement validity applies to quantitative research and is also known as construct validity. Construct validity measures the degree to which the devised concept reflects the concept that it is required. Internal validity is the validity of causal relationship and deals with identifying whether these casual relationships between two or more variables hold any significance. External validity deals with the generalizable nature of collected and analysed data. Content validity ensures that there is adequate coverage of investigative questions such as those research questions that are guiding the study (Cooper and Schindler, 2008:290).

3.12 Data Analysis

Data analysis assists in exploring the relationship between variables as well as converting data into knowledge and information, ideally new knowledge and information (Bala, 2016). Data gathered from a study can be analysed by using different techniques. Quantitative data can be analysed using either of two methods of analysis: descriptive and inferential statistics. Inferential statistics enable the researcher to make findings about the sample and are suitable for this research. Data can be analysed using three methods: univariate, bivariate and multivariate (Hair *et al.*, 2003:260). The bivariate method is used in this research. The cross-tabulation using the Chi-square analysis is used because it uses frequency distribution from one or more groups and compares them on a table. Nominal and ordinal scales are used. The following tests are used to analyse the data collected from the current study:

- Descriptive statistics (Means and standard deviations)

Descriptive statistics will be depicted by means and standard deviations, where applicable. Frequencies will be represented in both tables and graphs.

- Chi-square goodness-of-fit-test: a univariate test, used on a categorical variable to test whether any of the responses' options are selected significantly more/less often than the others.

- Chi-square test of independence: Used on cross-tabulations to see whether a significant relationship exists between the two variables represented in the cross tabulation.
- ANOVA: a test for several independent samples that compares two or more groups of cases in one variable.
- Binomial test: tests whether a significant proportion of respondents select one of a possible two responses. This can be extended when data with more than 2 response options are split into two distinct groups.
- One sample t-test: tests whether a mean score is significantly different from the scalar value

3.13 Chapter summary

The scope for the methods to be used in order to collect data in this research study has been set in this chapter. The data collected for the research study and the results that are gained can only be valid and accurate if a proper research methodology design is employed. The quantitative approach was adopted, the data will therefore be analysed from the statistics collected. For this exploratory research, the stratified sampling technique will ensure that more information is provided on transportation networks and students travel patterns at the University of KwaZulu-Natal. The off-campus students from three of the University of KwaZulu-Natal campuses were selected to be a part of this study. The questionnaires of 377 students will be completed and obtained. The obtained results will be interpreted using the analysis techniques and will assist in providing greater insight into the transportation networks and students travel patterns of the students. Research methodology is a crucial aspect in this research study because it ensures greater understanding of the research topic.

Chapter Four

Data Analysis and Presentation of Results

4.1 Introduction

Data analysis is conducted in order to discover the transportation networks and students travel patterns. The research methodology chapter advises that the (Univariate, bivariate and multivariate) methods are the most suitable for this research by using a questionnaire as a survey instrument to collect data that is required for analysis. The SPSS (Statistical Package of social Science) has been used to interpret data that falls under univariate data. Univariate analysis will include the usage of the following; bar graphs, pie charts, frequency distribution and descriptive statistics.

4.2 Univariate Analysis

The analysis of one variable at a time is known as univariate analysis. Descriptive analysis stresses the use of diagrams in the research in order to understand the data that is presented (Saunders, 2007:433). The variables are described numerically in this type of analysis. Descriptive analysis is used for the following reason:

- 1) Provide summaries which are representative of the sample;
- 2) Present the data in a form that is manageable and brings about simplification when large amounts of data are presented; and
- 3) To present data by utilising graphs and tables.

4.2.1 Frequency distribution: Pie and Bar charts

Graphics and charts can aid in assisting the research by making it easy to understand the data captured. Frequency distribution scrutinises the data at one variable at a time and also makes available counts which are for the numerous responses that are received for the numerous values of the variable (Hair *et al.*, 2003:232). The core objective of a frequency distribution is to exhibit the amount of responses that is related with each value of the variable.

Figure 4.1: Year of Study

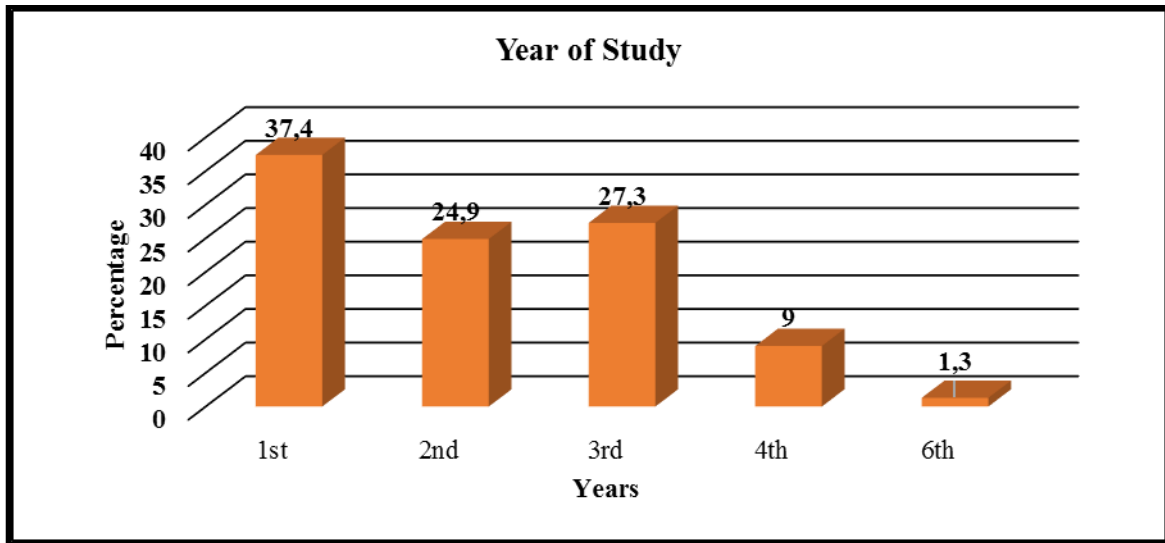
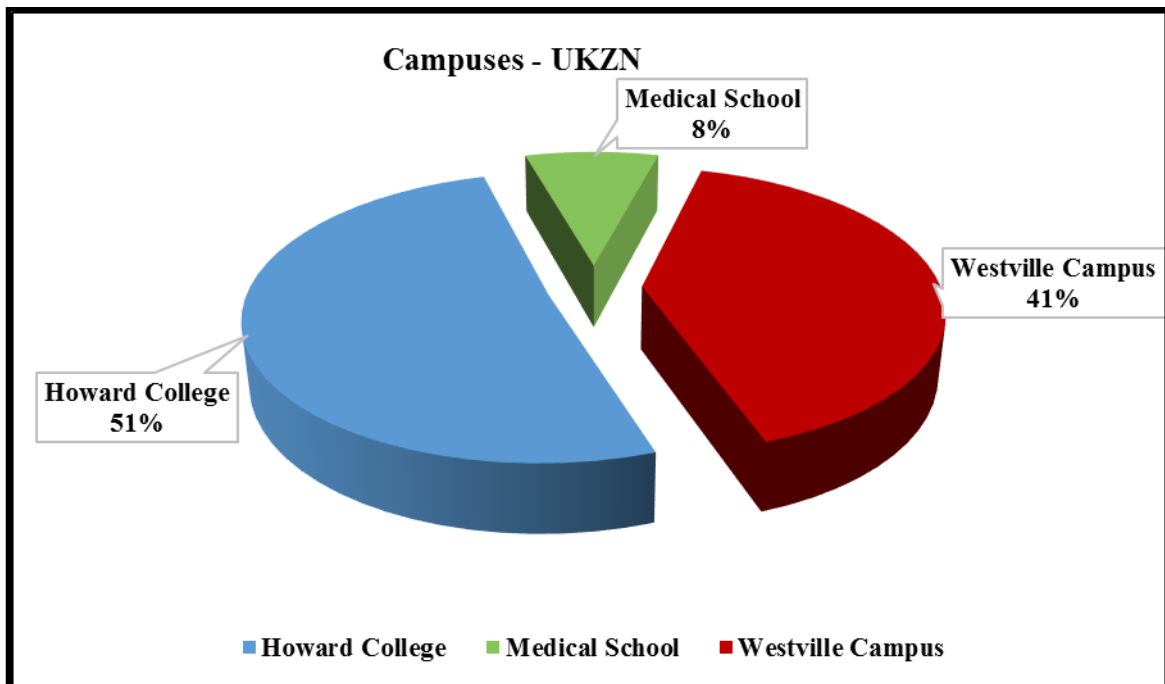


Figure 4.1 shows the percentage of the years of study of the students that have been sampled. It shows that 37,4% of the students are first year students, 24,9% second year students, 27.3 third year students, 9% fourth year and 1,3% sixth year students. Majority of students that attend lectures on a daily basis are the first year students, the second year students and finally, the third year students. There are students who have lectures almost daily, that is five days a week. The year of study of students can be a valuable indicator in assisting with determining travel patterns of different groups and evaluating if there are significant differences among the different groups.

Figure 4.2: Campuses - UKZN



The percentage of students that were recruited from each campus (figure 4.2) indicates that 192 respondents from the Howard campus and this constitutes to 50.9%. The Medical School constituted 8.5% of the sample population thus 32 respondents were recruited and finally the Westville campus constitutes 40.6% of the sample students recruited.

Figure 4.3: Type of Study

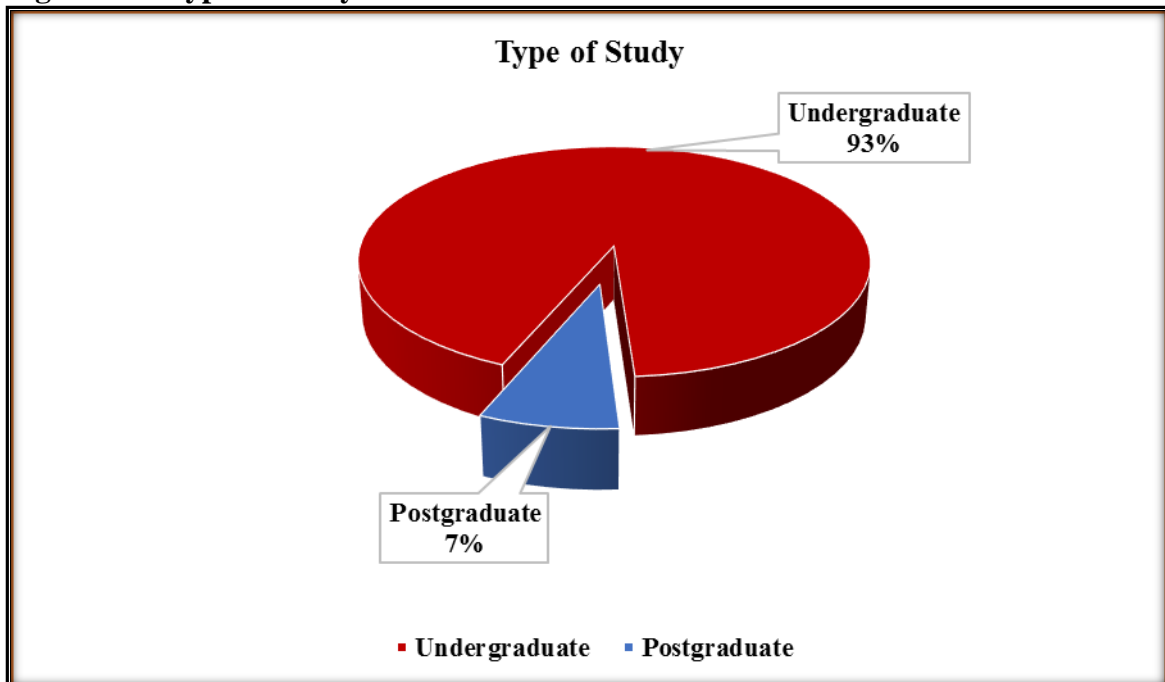


Figure 4.3 displays the type of study that the students are currently completing. Students were divided into two groups, that being undergraduate and postgraduate. Classifying students into these two groups assists the researcher in understanding the travel patterns of these two subgroups. These two groups differ in terms of lecture scheduling and number of days travelled per week. It is important for a comparison to be made so that the transportation needs for each group can be established. The graph above illustrates the split between undergraduate and post-graduate students. The data reveals that 93% of the respondents are undergraduate students and 7% of the respondents are post-graduate students.

Figure 4.4: Place of Residence

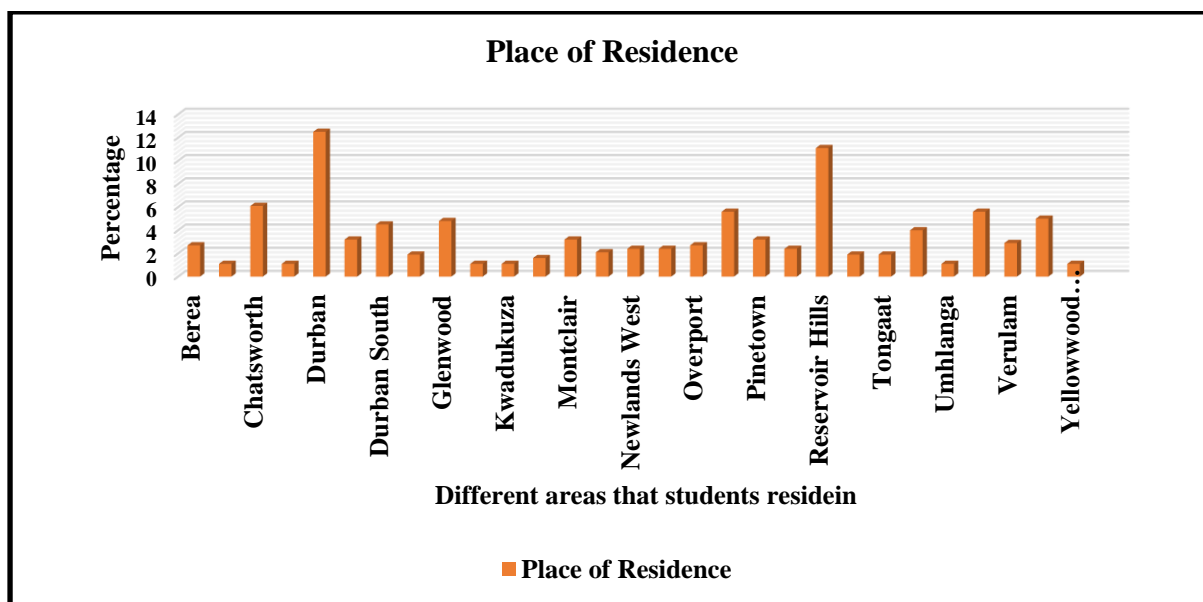


Figure 4.4 depicts the different locations that the sample population of students reside in from the three campuses. The data shows that there is a significant amount of students which is 12.5% of the respondents sampled that reside in the Durban area. The Durban area includes the locations that are in Durban central such as the following: Durban CDB, South Beach and the town area. The data also shows a significant amount of students who reside in the Reservoir Hills area, 11.1% of the respondents which amounts to 42 respondents. A lot of the students who reside in Reservoir Hills are students on the Westville campus renting or in private accommodations.

Students commute great distances to and from the campuses. Students travel from areas that are located in the southern parts of KwaZulu-Natal such as Umkomass and also from the northern parts of the province such as Tongaat. The Durban South Basin includes the following areas: Amanzintoti, Isipingo, Merebank, Umgababa, Umkomass and Umzinto.

Figure 4.5: Type of Transportation

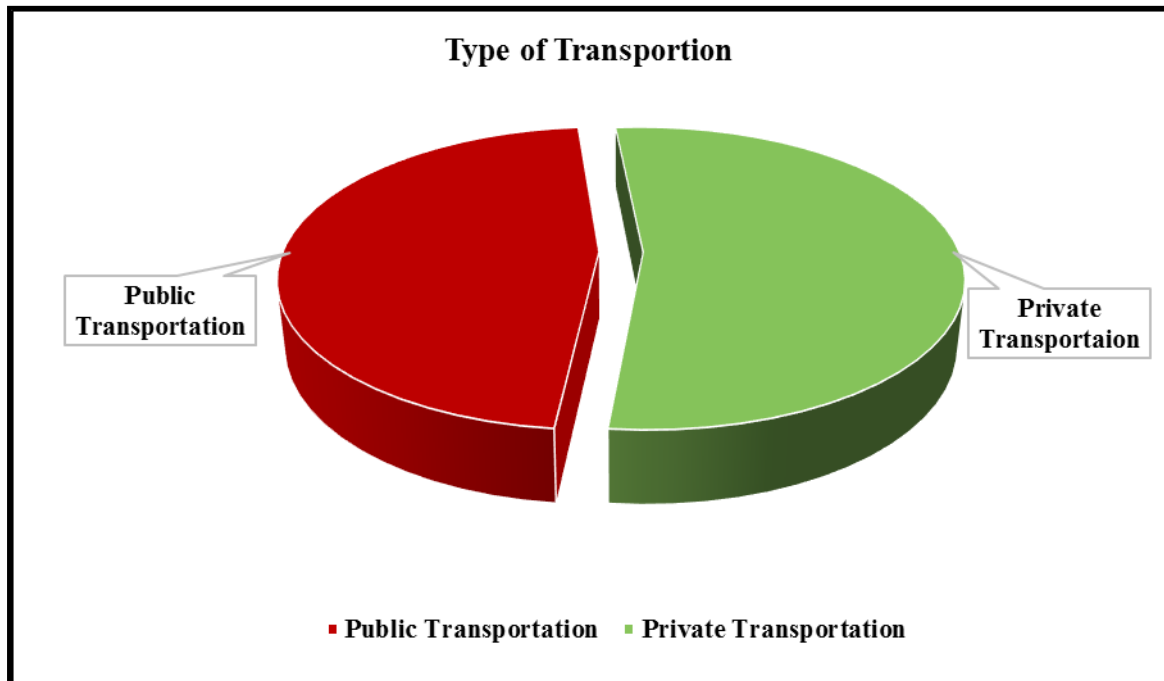


Figure 4.5 depicts the statistical revelation of the types of transportation that students utilise to travel from their place of residence to the respective campuses. There are two types of transportation that can be used namely public or private transportation. The data reveals that 47% of the respondents use public transportation whilst 53% of the students utilise private transportation. The private transportation includes student's private vehicles, lift clubs and private buses from the different areas. The use of either type of transportation will depend on the needs of each individual student individually.

Binomial Test

This test is conducted to determine whether a significant proportion of participants select one of possible two responses.

Table 4.1: Public and Private Transportation

Binomial Test					
	Category	N	Observed Prop.	Test Prop.	Asymp. Sig. (2-tailed)
Transportation	Group 1	Public	177	.47	.257 ^a
	Group 2	Private	200	.53	
	Total		377	1.00	

a. Based on Z Approximation.

A binomial test was conducted to test if there is a significant number of respondents who have indicated either way meaning if the respondents selects one response over another. One can observe from the binomial test that both public and private transportation are used fairly equally. The proportions are not significantly different even though it seems that more students use private transportation.

Figure 4.6: Transportation Systems

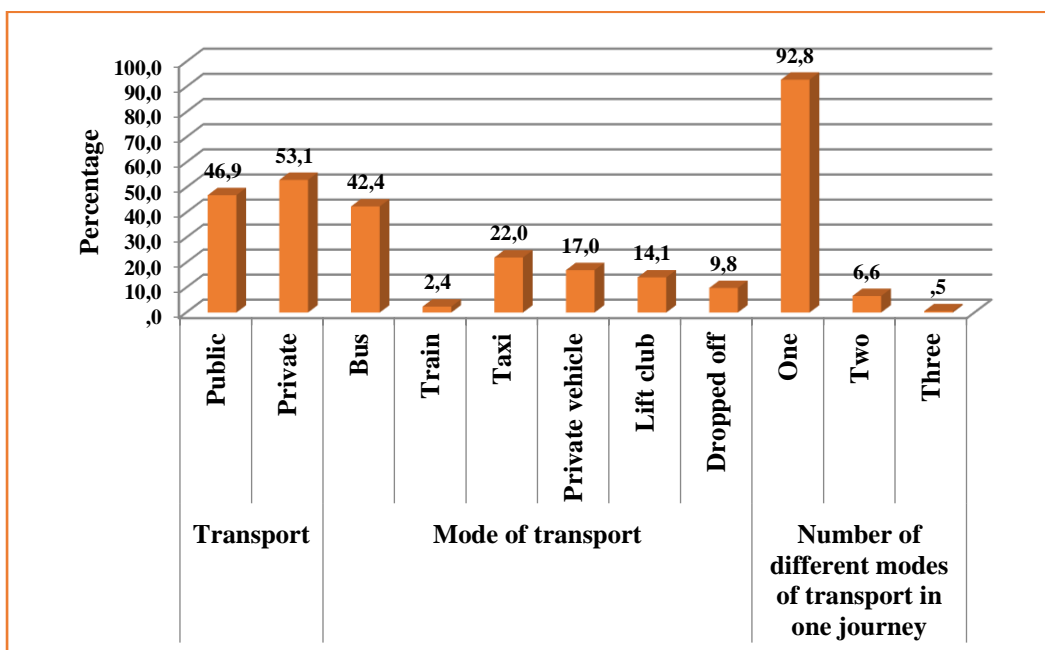


Figure 4.6 provides a summary of the type of transport, the mode of transport used and the number of different modes of transport used in one journey. The different modes of transportation used as depicted show the following: bus, train, taxi, private vehicle, lift club and being dropped off. The data reveals that there is a significant percentage (42.4%) of the respondents who utilise the bus to travel, this amounts to 160 students of the total sample. Taxis are used by 22% of the respondents while 17% of the respondents utilise private vehicles. The mode that is least used of the different modes is the train and 2.4% of the respondents use the train (9 students). Lift clubs are also a popular means of travel for students. The data reveals that 14.1% travel with lift clubs and this amounts to 53 respondents of the 377. Many students also get dropped off at the respective campuses and the data reveals that 37 students (9.8%) travel by this means. The data that appears on the chart above is extremely important and can be used by the researcher to evaluate the use of particular modes of transportation and make evaluations thereof.

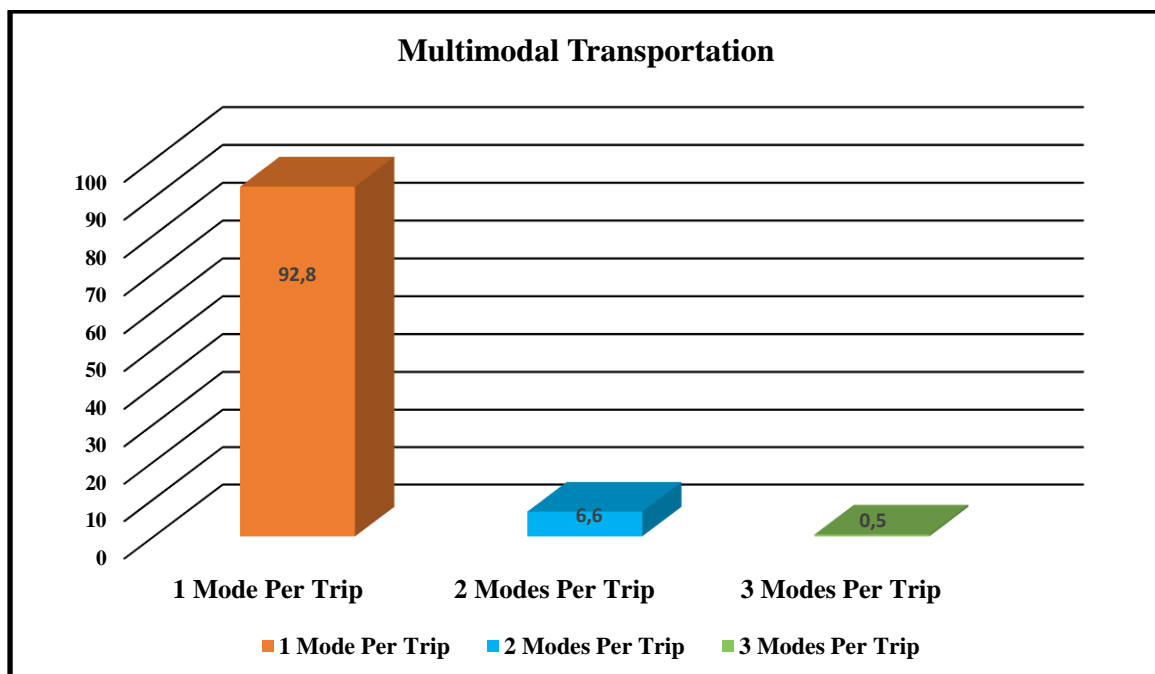
Table 4.2: Modes of Transport

		Binomial Test				
		Category	N	Observed Prop.	Test Prop.	Asymp. Sig. (2-tailed)
Bus	Group 1	No	217	.58	.50	.004 ^a
	Group 2	Yes	160	.42		
	Total		377	1.00		
Train	Group 1	No	368	.98	.50	.000 ^a
	Group 2	Yes	9	.02		
	Total		377	1.00		
Taxi	Group 1	Yes	83	.22	.50	.000 ^a
	Group 2	No	294	.78		
	Total		377	1.00		
Private vehicle	Group 1	No	313	.83	.50	.000 ^a
	Group 2	Yes	64	.17		
	Total		377	1.00		
Lift club	Group 1	No	324	.86	.50	.000 ^a
	Group 2	Yes	53	.14		
	Total		377	1.00		
Dropped off	Group 1	No	340	.90	.50	.000 ^a
	Group 2	Yes	37	.10		
	Total		377	1.00		

a. Based on Z Approximation.

Table 4.2 (binomial test) conducted to evaluate if there is a significant number of respondents who have indicated either mode in particular. According to the results obtained, it is evident that the modes of transportation are spread across all these types. A significant 58% indicated that they do not use the bus to get to campus ($p=.004$). The table shows that 160 students utilise the bus to travel which amounts to 42% of the sample population. A significant 98% of the students indicated that they do not use the train to get to campus ($p<.0005$). The results reveal that a significant 78% does not use a taxi to travel to campus ($p<.0005$). The use of the different modes is spread across the different campuses. The results for the use of private vehicles reveal that a significant 83% of the students does not use this mode to travel to campus ($p<.0005$). The cost of private vehicles is very expensive and students that can afford private vehicles are fortunate to travel with their own cars. The data of results indicates that a significant 86% indicated that they do not use lift clubs to travel to campus ($p<.0005$). Lift clubs can only be formed if there are students from particular locations that have a similar need and there are vehicles from these areas that are travelling with excess capacity. Finally a significant 90% of the students have indicated that they do not get dropped off at campus ($p<.0005$). Parents that work close by the campuses often drop and pick up their children.

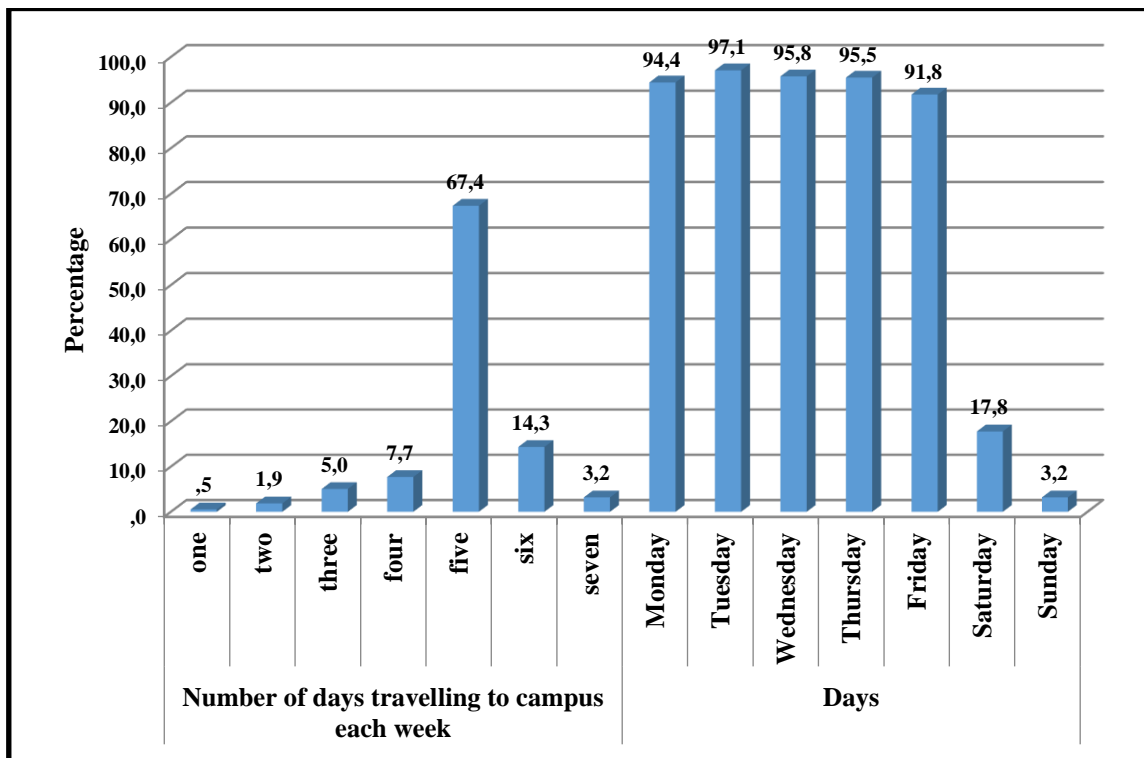
Figure 4.7: Multimodal Transportation



The graph above depicts students travelling, using multimodal transportation that is students who are using more than one mode of transportation to get either to or from campus. The data

reveals that significant 92.8% (350) of the respondents use just one mode of transportation to travel per journey while 6.6% (25) use two modes of transportation in one journey and 0.5% (2) of the respondents uses three modes of transportation to travel per journey. It can be therefore deduced that 7.1% of the respondents utilise multimodal means of travelling to campus. Students in some cases have to utilise more than one of transportation to get to or from campus and there could be several factors which result in students using multimodal transportation.

Figure 4.8 Number of days travelled a week and days travelled

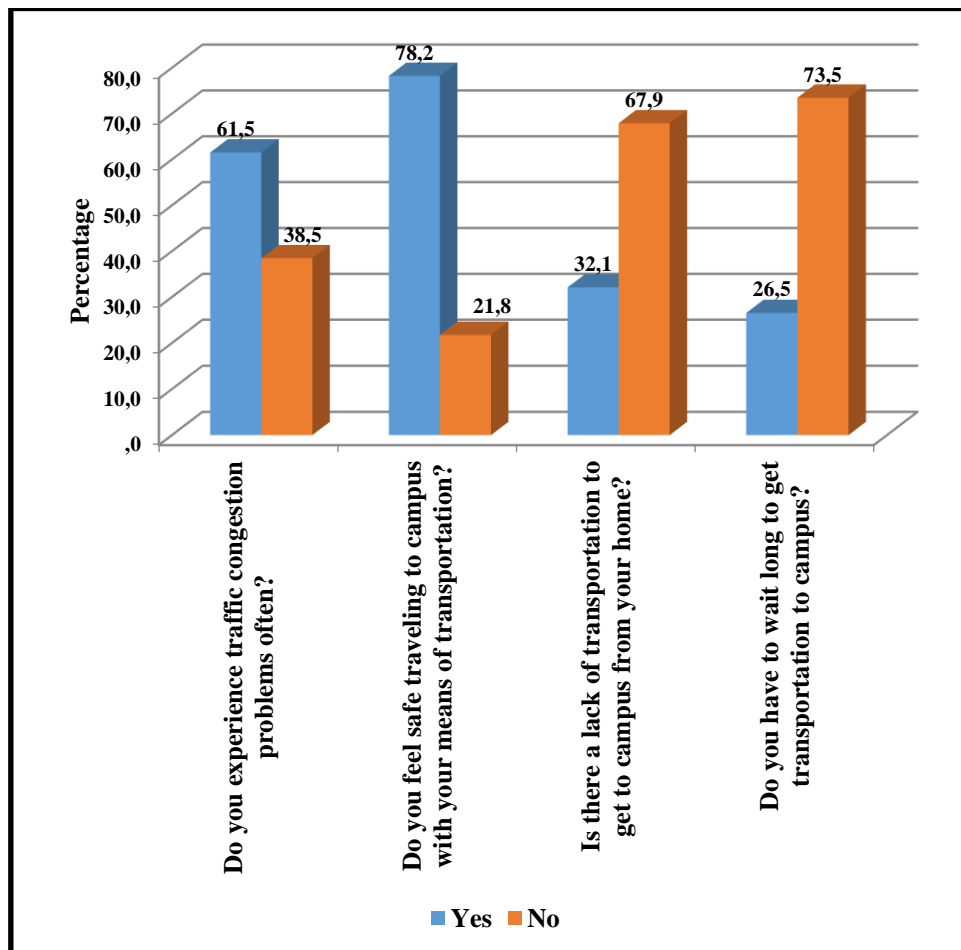


The above figure shows the number of days a week a student travels to campus and on which days. Majority of the students sampled travel five days a week which amounts to 67.4%. Most students have lectures just five days a week therefore the data reveals a 67.4% of the respondents travel five days a week. Students also travel six days a week and the data shows that 14.3% of the respondents travel six days a week. These students may have lectures or tutorials during weekends. The graph reveals that students also travel just one day a week to campus which is 0.5% and these students could be postgraduate students who just come to campus on one day during the week to conduct research. Respondents may also be repeating modules therefore some students attend just two or three days a week. The graph illustrates that 3.2% of the respondents travel seven days a week to campus and these students probably come

to campus to utilise resources such as the library and computer labs to complete work. The number of days that students travel per week will depend on each student's individual needs. Each campus and each degree course will have lectures on different days and other academic activities that differ from one degree to another.

The graph also depicts the days in particular that student's travel to campus. The graph reveals that most of the students travel Monday to Friday which is five days and can be linked to the number of days that most students travel per week which is also five days. The graph reveals that most students travel to campus on a Tuesday (97.1%) while just 3.2% of the student travels on a Sunday to campus. This data can be used to determine which day's students require transportation. In other words, the needs for transportation are high from Monday to Friday.

Figure 4.9: Challenges



The figure 4.9 above is based on the challenges that students may encounter while travelling to campus and been presented in a dichotomous form (yes/no). The data reveals that a

significant 62% of the respondents does often experience traffic congestion problems. The various transportation networks are often congested during the morning and afternoon peak hours.

A significant 78% of the respondents have indicated that they do feel safe while travelling to campus. There could be various factors for the significant 78% of the students indicated that they do feel safe while the remaining 22% do not feel safe and there could also be many factors which may contribute to this. The area that they reside in and the transportation networks that is used can play a crucial part in the safety of the students travel. The data indicates that a significant 68% of the respondents have indicated that there is no lack of transportation from the place of residence to campus. Students have to acquire transportation from the place of residence to campus and therefore the student will seek any means of transportation for travel.

A significant 73% of the respondents have indicated that they do not have to wait long to get transportation to get to campus. Students who utilise private transportation have the flexibility to travel whenever they want to and the same holds true for students that utilise lift clubs. Students who travel by public transportation often rely on taxis and buses, while some buses have scheduled schedules there are still buses and taxis that operate on a first come first serve basis.

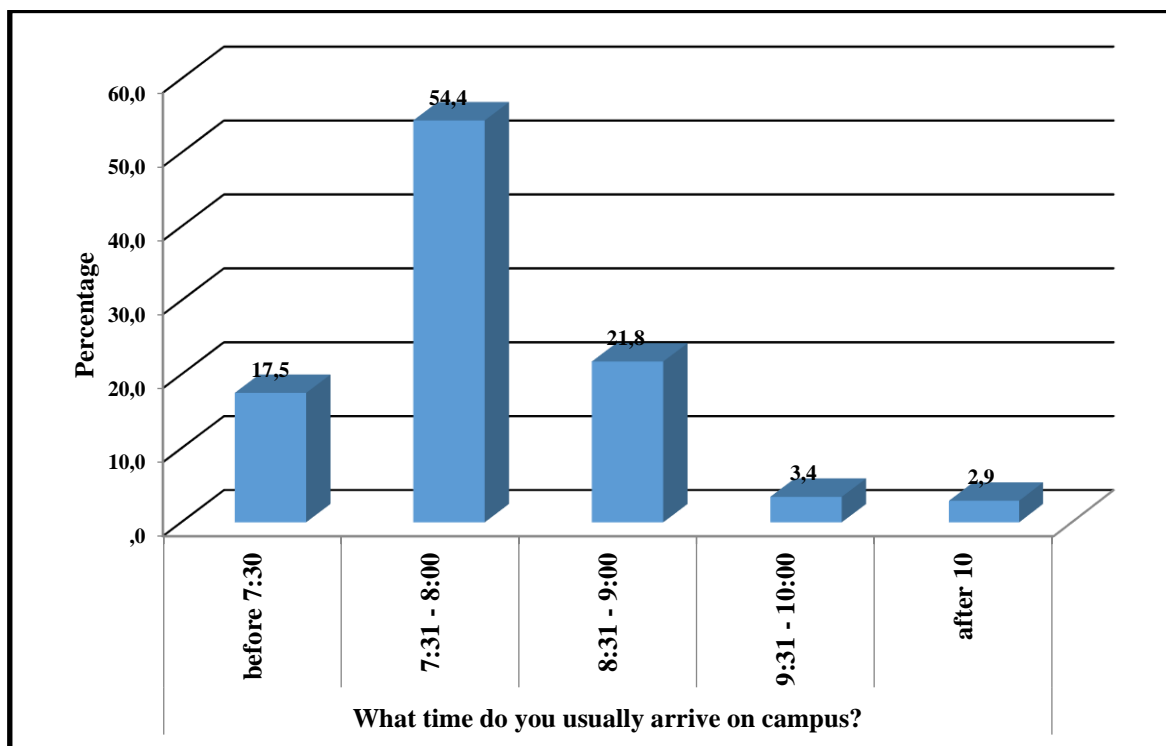
Table 4.3 Factors influencing academic activities

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Timetable	Count	30	31	159	68	89
	% of Total	7.9%	8.2%	42.2%	18%	23.6%
Reliability	Count	32	35	131	74	105
	% of Total	8.5%	9.3%	34.7%	19.6%	27.9%
Hours of Operation	Count	35	48	132	79	83
	% of Total	9.3%	12.73	35.01	20.95	22.01%
Route	Count	21	33	141	80	102
	% of Total	5.57%	8.75%	37.4%	21.22%	27.05%
Journey Time	Count	33	42	121	79	102
	% of Total	8.75%	11.14%	32.1%	20.95%	27.05%

The table 4.3 shows the various factors that were used to evaluate how a student rates the above factors based on the transportation that the students use. The first factor is the timetable of the

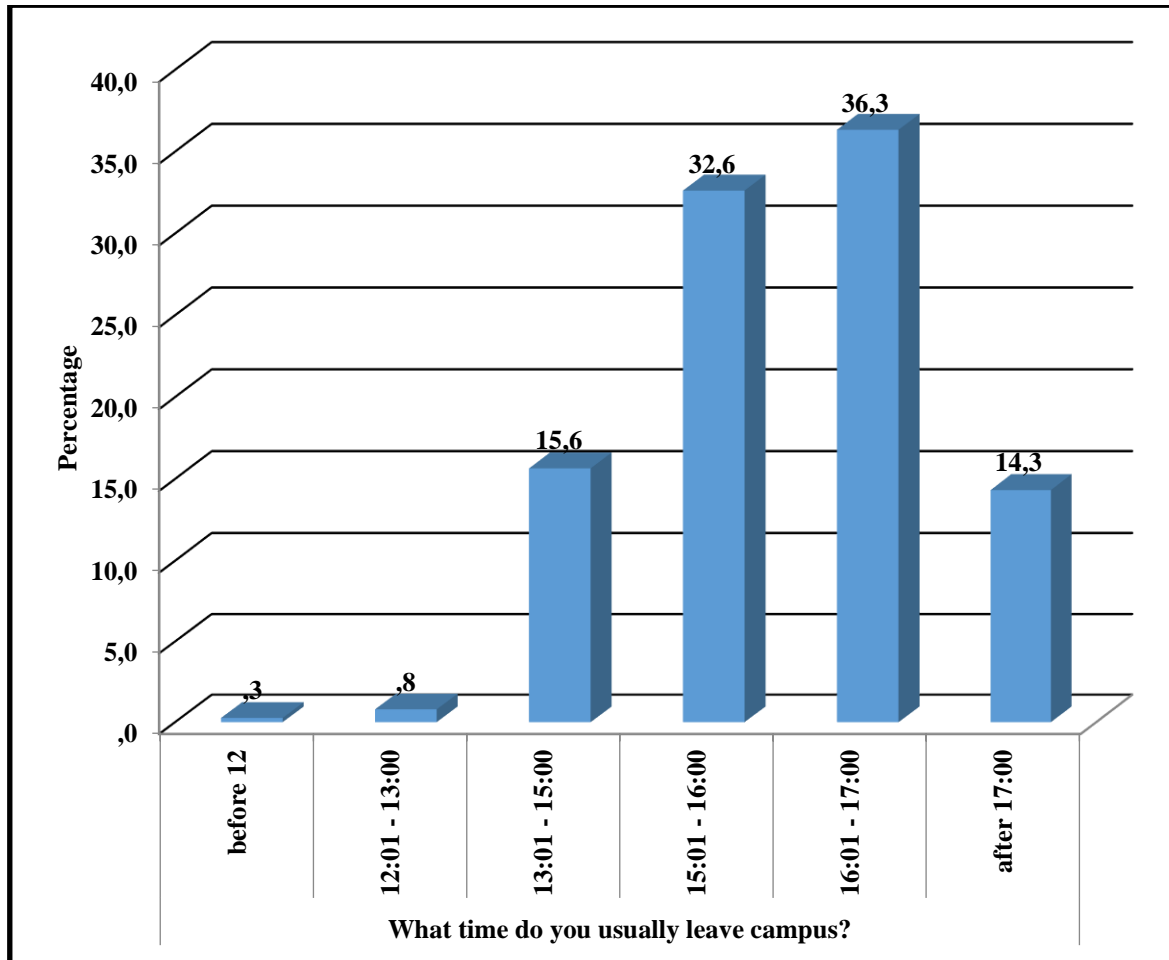
students and the students had to rate their response based on the use of the transportation. Students were basically asked if the mode of transportation that they used suited their timetable and if they made it on time to all their lectures. Students gave a dominantly neutral response to this aspect because their day to day needs varied. Most of the students indicated that the mode of transportation that they use is reliable. Students also indicated that the hours of operation were acceptable by giving a positive response. The route and journey time again showed no significant preference.

Figure 4.10: Time students arrive at campus



The figure above depicts the times that students usually arrive at campus in the mornings. The data reveals that 54.4% of the students arrive at campus between 7:30 and 08:00am. Most lectures begin at 08:30 therefore 54.4% of the respondents indicated that they arrive between 07:30 and 08:00am. The graphs also illustrates that 17.5% of the students arrive at campus before 07:30. These respondents most probably attend morning lectures which usually begin at 07:45am. A significant number (205, 54.38%) have indicated that they arrive on campus between 07:30 and 08:00 in the morning ($\chi^2 (4) = 331,156$).

Figure 4.11: Time students leave campus



The figure above illustrates the times that students usually leave campus. The data reveals that a significant number of students leave campus anytime from 17:00. A significant number (264.459, 36.3%) indicated that usually leave campus anytime between 15:00 and 17:00 in the afternoon ($\chi^2 (5) = 264.45$).

Table 4.4 One-Sample Test

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
21.1 Speed/Time	11.661	376	.000	.629	.52	.73
21.2 Cost	3.491	376	.001	.223	.10	.35
21.3 Convenience	9.584	376	.000	.565	.45	.68
21.4 Reliability	11.690	376	.000	.674	.56	.79
21.5 Impact on studies	5.163	376	.000	.329	.20	.45
One-Sample Statistics						
	N	Mean	Std. Deviation	Std. Error Mean		
21.1 Speed/Time	377	3.63	1.047	.054		
21.2 Cost	377	3.22	1.239	.064		
21.3 Convenience	377	3.56	1.145	.059		
21.4 Reliability	377	3.67	1.119	.058		
21.5 Impact on studies	377	3.33	1.237	.064		

Table 4.4 above depicts the satisfaction aspects of the means of transportation. The data reveals that there is significant satisfaction with: the speed and time related to travelling ($M=3.63$, $SD=1.047$, $t(376) = 11.661$). The speed and time aspects have the second highest mean ($M=3.63$) and this can be associated with acceptable levels of satisfaction from the students. The speed at which a mode of transportation gets the student from their place of residence to campus is not really an issue. Students usually do not have control over the speed aspect of the transportation except in cases where the student is using a private vehicle. It is safer for the student if the transportation mode is moving at an average speed due to road safety. The cost of travelling ($M = 3.22$, $SD = 1.239$) $t(376) = 3.491$, $p=.001$). The mean value of ($M=3.22$) shows that there is satisfaction with the cost of travelling and whilst it may not be the highest level of satisfaction it is a satisfaction level which is just above equilibrium. The cost aspect of travelling shows the least level of satisfaction by students. The convenience aspect of travelling reveals ($M= 3.56$, $SD= 1.145$) $t(376) = 9.584$). The value is greater than 3 and this reveals a sense of satisfaction with this aspect of travelling. Many students experience convenience with acquiring transportation to get to and from campus. Reliability ($M= 3.67$, $SD=1.119$) $t(376) = 11.690$, $p<.0005$. Reliability has the mean value ($M=3.67$). The data therefore reveals that students are

most satisfied by the reliability aspect of the transportation that is used. Reliability is an important factor to students, reliable transportation has to exist in order for students to get to campus daily and on time in order to progress with the academic activities. The impact that transportation has on a student's studies is the next aspect that students rated. The data reveals that ($M= 3.33, SD=1.237$) $t(376) = 5.163, p<.0005$). Students are therefore satisfied that is very little impact on their studies because the data reveals a mean value of $M=3.33$. Many students have found transportation which suits them together with their needs therefore the data illustrates that there is satisfaction with this aspect of transportation.

Figure 4.12: Satisfaction aspects

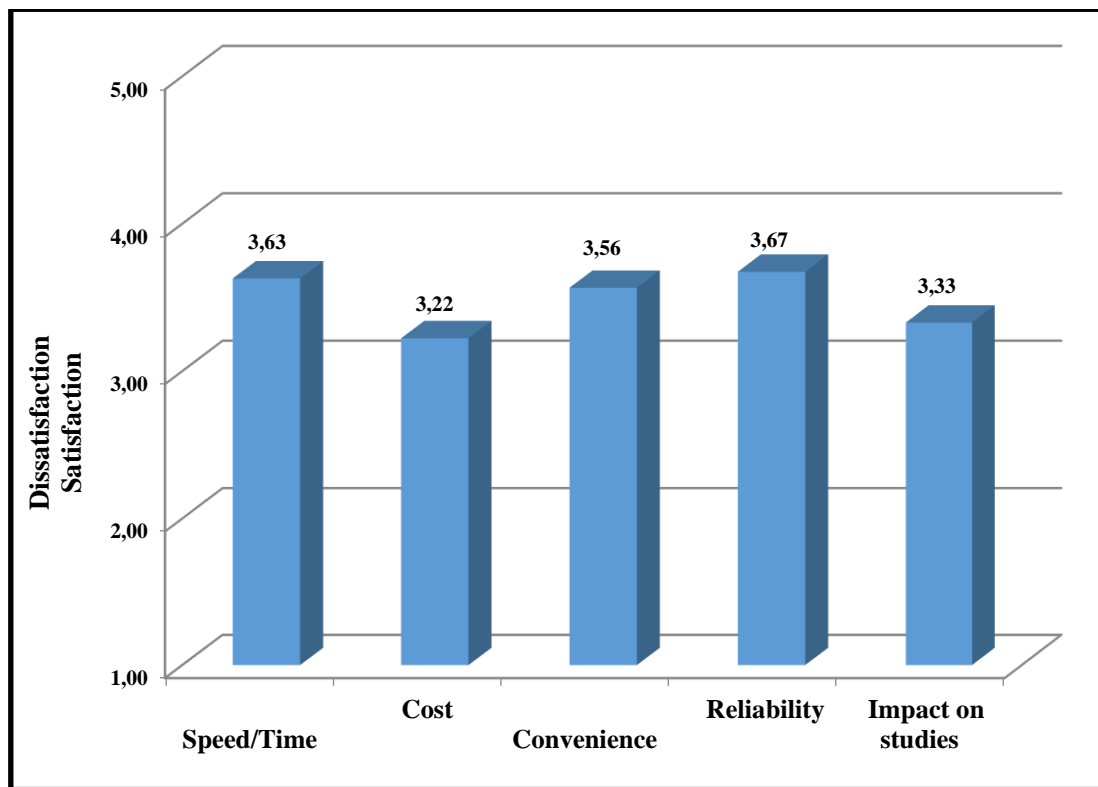
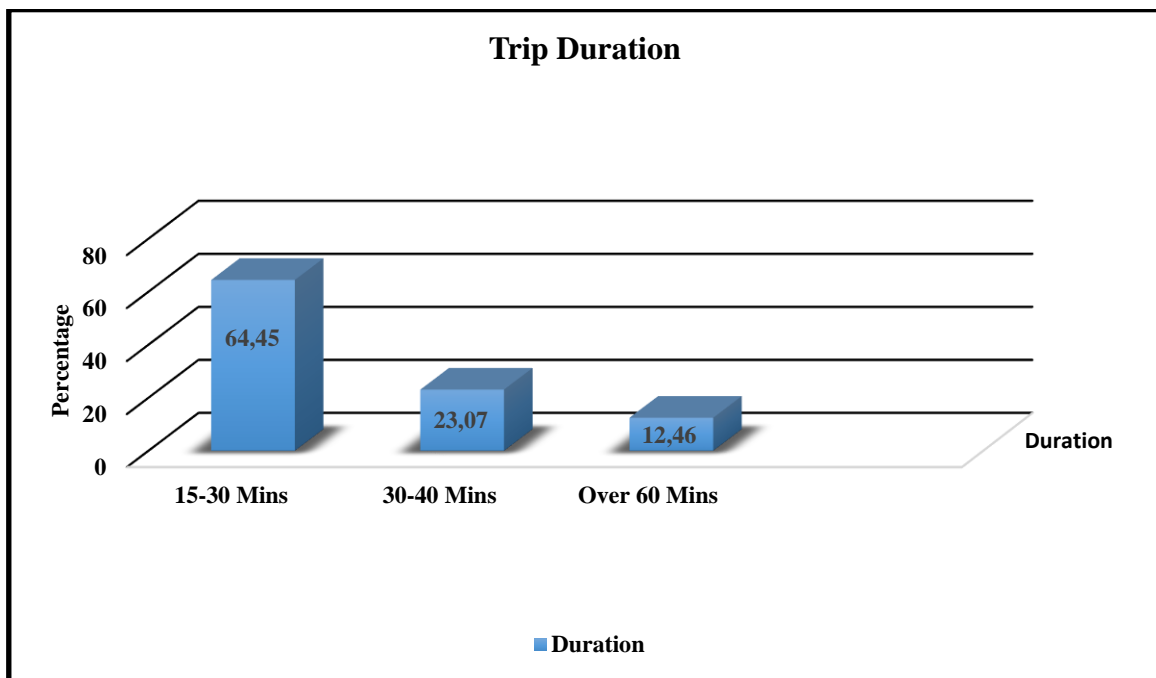


Figure 4.13 above depicts the five aspects of satisfaction and the levels of satisfaction.

Figure 4.13: Trip duration



A significant number (234, 64.45%) indicated that the trip duration usually takes 15-30 minutes ($\chi^2 (2) = 170.695, p < .0005$). These students probably reside close to the respective campuses therefore the trip is under or 30 minutes. A significant number (87, 23.07%) indicated that the trip duration usually takes 30-40 minutes ($\chi^2 (2) = 170.695, p < .0005$). These students probably reside a greater distance from the location of the campuses or probably inland in the areas that they are from. A significant number (47, 12.46%) indicated that the trip duration usually takes over 60 minutes ($\chi^2 (2) = 170.695, p < .0005$). These students probably reside in the outer lying areas that are either far south or far north of Durban.

4.3 Bivariate Analysis

Bivariate analysis makes certain that more than one variable is measured using scales of interval and ratio (Cooper and Schindler, 2010:509). This analysis will be used to examine analysis of variance, chi-square and cross tabulation.

4.3.1 Cross tabulation

Table 4.5 Cross tabulation of the use of buses between campuses

			Bus		Total
			Yes	No	
2 Campus	Howard college	Count	73	119	192
		Expected Count	81.5	110.5	192.0
		% within 2 Campus	38.0%	62.0%	100.0%
		Std. Residual	-.9	.8	
	Medical school	Count	9	23	32
		Expected Count	13.6	18.4	32.0
		% within 2 Campus	28.1%	71.9%	100.0%
		Std. Residual	-1.2	1.1	
	Westville	Count	78	75	153
		Expected Count	64.9	88.1	153.0
		% within 2 Campus	51.0%	49.0%	100.0%
		Std. Residual	1.6	-1.4	
Total	Count	160	217	377	
	Expected Count	160.0	217.0	377.0	
	% within 2 Campus	42.4%	57.6%	100.0%	

Table 4.6 Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.787 ^a	2	.012
Likelihood Ratio	8.874	2	.012
Linear-by-Linear Association	5.562	1	.018
N of Valid Cases	377		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 13.58.

H₀₁: There is no association between the bus transportation mode and the campus locations.

H_{A1}: There is association between the bus transportation mode and the campus locations.

Table 4.5 demonstrates the relationship between the use of buses and the different campuses. The p value (0.012) is less than the level of significance (0.05). The decision is therefore to reject the null hypothesis and accept the alternate hypothesis. A significant number of students from the Westville campus indicated that they use the bus to get to campus ($\chi^2(2) = 8.787$, $p=.012$). The results reveal that the students use the bus from the Westville campus.

Table 4.7 : Cross tabulation of the use of taxi’s between campuses and Chi-Square test

			Taxi		Total
			Yes	No	
2 Campus	Howard college	Count	60	132	192
		Expected Count	42.3	149.7	192.0
		% within 2 Campus	31.3%	68.8%	100.0%
		Std. Residual	2.7	-1.4	
	Medical school	Count	5	27	32
		Expected Count	7.0	25.0	32.0
		% within 2 Campus	15.6%	84.4%	100.0%
		Std. Residual	-.8	.4	
	Westville	Count	18	135	153
		Expected Count	33.7	119.3	153.0
		% within 2 Campus	11.8%	88.2%	100.0%
		Std. Residual	-2.7	1.4	
Total	Count	83	294	377	
	Expected Count	83.0	294.0	377.0	
	% within 2 Campus	22.0%	78.0%	100.0%	

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.662 ^a	2	.000
Likelihood Ratio	20.369	2	.000
Linear-by-Linear Association	19.022	1	.000
N of Valid Cases	377		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.05.

H₀₂: There is no association between the private vehicle transport mode and the campus locations.

H_{A2}: There is an association between the private vehicle mode of transportation and the campus locations.

Table 4.7 above shows the relationship between the uses of taxis and the different campuses. The p value ($p < .0005$) is less than the level of significance (0.05) thus the null hypothesis is rejected and the alternate hypothesis is accepted. The data from the tables above reveal that a significant number of students from the Medical School use private vehicles to travel to and from campus ($\chi^2 (2) = 18.450, p < 0.005$). The student population of the Medical school is much smaller than the Westville and Howard campuses therefore not many lift clubs will operate.

Table 4.8 : Cross tabulation of the use of private vehicles between campuses

		Private vehicle		Total
		Yes	No	
2 Campus	Howard college Count	25	167	192
	Expected Count	32.6	159.4	192.0
	% within 2 Campus	13.0%	87.0%	100.0%
	Std. Residual	-1.3	.6	
Medical school	Count	14	18	32
	Expected Count	5.4	26.6	32.0
	% within 2 Campus	43.8%	56.3%	100.0%
	Std. Residual	3.7	-1.7	
Westville	Count	25	128	153
	Expected Count	26.0	127.0	153.0
	% within 2 Campus	16.3%	83.7%	100.0%
	Std. Residual	-.2	.1	
Total	Count	64	313	377
	Expected Count	64.0	313.0	377.0
	% within 2 Campus	17.0%	83.0%	100.0%

Table 4.9 Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	18.450 ^a	2	.000
Likelihood Ratio	14.818	2	.001
Linear-by-Linear Association	.910	1	.340
N of Valid Cases	377		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.43.

H₀₃: There is no association between the private vehicle mode of transportation and the campus locations.

H_{A3}: There is an association between the private vehicle mode of transportation and the campus locations.

Table 4.8 above shows the relationship between the use of private vehicles and the different campuses. The p value ($p < .0005$) is less than the level of significance (0.05) thus the null hypothesis is rejected and the alternate hypothesis is accepted. The data from the tables above reveal that a significant number of students from the Medical School use private vehicles to travel to and from campus ($\chi^2 (2) = 18.450$). The student population of the Medical school is much smaller than the Westville and Howard campuses therefore there wont be many lift clubs.

Table 4.10 : Cross tabulation of times students leave campus (between 2)

			20 What time do you usually leave campus?					Total	
			before 12	12:01 - 13:00	13:01 - 15:00	15:01 - 16:00	16:01 - 17:00		after 17:00
2	Howard Campus college	Count	1	1	31	65	76	18	192
		Expected Count	.5	1.5	30.0	62.6	69.8	27.5	192.0
		% within 2 Campus	.5%	.5%	16.1%	33.9%	39.6%	9.4%	100.0%
		Std. Residual	.7	-.4	.2	.3	.7	-1.8	
Medical school	Count	0	1	9	11	8	3	32	
	Expected Count	.1	.3	5.0	10.4	11.6	4.6	32.0	
	% within 2 Campus	.0%	3.1%	28.1%	34.4%	25.0%	9.4%	100.0%	
	Std. Residual	-.3	1.5	1.8	.2	-1.1	-.7		
Westville	Count	0	1	19	47	53	33	153	
	Expected Count	.4	1.2	23.9	49.9	55.6	21.9	153.0	
	% within 2 Campus	.0%	.7%	12.4%	30.7%	34.6%	21.6%	100.0%	
	Std. Residual	-.6	-.2	-1.0	-.4	-.3	2.4		
Total	Count	1	3	59	123	137	54	377	
	Expected Count	1.0	3.0	59.0	123.0	137.0	54.0	377.0	
	% within 2 Campus	.3%	.8%	15.6%	32.6%	36.3%	14.3%	100.0%	
	Std. Residual								

The table shows that a significant number of students from the Medical school that leaves between 12:00 and 15:00. The data also reveals that a significant amount of students from the Westville campus leave after 17:00 ($\chi^2(10) = 19.135, p = .039$).

4.4 Analysis of variance (ANOVA)

The analysis of variance is a statistical method that is used to determine an independent variable. The variance is used to make comparisons with other factors (Pallant, 2010:249).

Table 4.11 ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
21.1 Speed/Time	Between Groups	8.505	2	4.253	3.942	.020
	Within Groups	403.505	374	1.079		
	Total	412.011	376			
21.2 Cost	Between Groups	11.145	2	5.572	3.681	.026
	Within Groups	566.139	374	1.514		
	Total	577.284	376			
21.3 Convenience	Between Groups	17.753	2	8.877	6.991	.001
	Within Groups	474.905	374	1.270		
	Total	492.658	376			
21.4 Reliability	Between Groups	8.768	2	4.384	3.548	.030
	Within Groups	462.102	374	1.236		
	Total	470.870	376			
21.5 Impact on studies	Between Groups	1.221	2	.611	.398	.672
	Within Groups	573.993	374	1.535		
	Total	575.215	376			

There is a significant difference across campuses in the satisfaction with speed/time of travel ($F(2,374) = 3.942, p=.020$). There is more satisfaction with this aspect from Westville students than from Howard College students.

The cost aspect shows that there is also a significant difference between the Medical school and the Howard campus ($F(2,374) = 3.681, p=.026$). There is more satisfaction with the cost aspect from the Medical school students than the from the Howard campus students.

The convenience aspect of transportation reveals a significant difference as well between the Medical school, Westville campus and the Howard campus ($F(2,374) = 6.991, p=.001$). This means that there is a greater level of satisfaction from the Medical school and the Westville campus than from the Howard campus.

Finally the reliability aspect of transportation also reveals a significant difference between the medical school and the Howard campus ($F(2,374) = 3.548, p=.030$). The data shows that students from the Medical school experience greater reliability their transportation.

4.5 Reliability

Reliability refers to the consistency of a measure of a concept and is used to determine consistency using Cronbach's Alpha (Bryman and Bell, 2007:158).

Table 4.12 Reliability Statistics

Cronbach's Alpha	N of Items
.810	5

Reliability measure the test of goodness and table 4.11 shows that the Cronbach's Alpha is 0.810 which is less than 1. The level thus indicates a moderate to high level of internal consistency of reliability with the use of independent variables listed at 5 items. This indicates that these four parts of satisfaction with means of transport can collectively form a reliable measure for the construct.

4.5 Chapter Summary

It is imperative that measuring instruments are used when information is being analysed. Data was interpreted and the results were formatted by using the univariate and bivariate analysis. The univariate analysis makes use of descriptive statistics and frequency distribution, the use of graphics and charts make it easier to understand the data. The bivariate analysis utilises cross-tabulation with Chi-Square and analysis of variance (ANOVA). Results will be further interpreted by utilising the research objectives. The results will also be discussed by the use of literature.

Chapter Five

Discussion of Results

5.1 Introduction and motivation for the research

The problem statement of this research focuses on the transportation networks and the challenges exhibited regarding capacity constraints and increasing demand of student transportation. The exploration of the capacity constraints and travel patterns of students requires an extensive understanding of the transportation challenges. The study is aimed at exploring student's travel patterns and exposing any challenges which may exist. Chapter four presented the data that was collected from the students. The discussion of results is divided into four sections, each of which deals with one of the four objectives of this study.

5.2 Research objective one

To explore the transportation challenges and capacity constraints impeding the travel of off-campus students at the University of KwaZulu-Natal

The first objective of the research study was to explore the transportation challenges and capacity constraints impeding the travel of off-campus students at the University of KwaZulu-Natal. Questions were structured appropriately in order to ascertain the challenges and capacity constraints which off-campus students experience whilst travelling to and from university, such as their experience relating to traffic congestion. The respondents were subjected to dichotomous questions.

Do you experience traffic congestion problems often?

Traffic congestion is a common travelling challenge which commuters face. Students alike are exposed to and faced with this challenge. It is a common yet important question. It is imperative to understand if traffic congestion is something which students from all the different geographic locations experience, or just some. Experiencing traffic congestion can result in a constraint or bottle neck of the student's journey. According to the survey undertaken, statistics reveal that a larger a larger percentage (61.5%) has indicated that traffic congestion is in fact experienced. This is a challenge that is in fact encountered by the greater part of the sample population. This question was analysed by conducting a binomial test and the researcher opted for analysis to test if a significant proportion of participants selected one of a possible two responses. The

binomial test was selected to evaluate and determine if the respondents selected one of two possible responses, which were either: yes or no.

Do you feel safe travelling to campus with your means of transportation?

Safety can be a challenge and will depend on the individuals' location as well as the travel route that students utilise. High crime rates may vary in accordance to different geographical locations. The other hazard faced in terms of safety, is with the actual transportation mode utilised by students. Students may come across vehicles that are not road worthy. Speeding can be a hazard to the students and a serious safety issue. A greater percentage of the students (78.2%) have indicated that they do in fact feel safe travelling to and from campus. However, there was also a small percentage of students (21.8%), who indicated that they do not feel safe travelling to and from campus. These statistics reflect and are indicative of just the sample population. A cross tabulation was completed in order to compare the safety while travelling among the campuses and it was found that a significant number of students from the Howard campus don't feel safe whilst travelling. The researcher opted for cross tabulation because it allows for two variables to be computed simultaneously.

Is there a lack of transportation to get to campus from your home?

Transportation is widely available but can be posed to be a challenge to some. The above question was aimed in order to evaluate if students face this challenge and to what extent. The data revealed that 32.1% of the students indicated that this is a challenge while 67.9% of the students indicated that this not a challenge. This again is a reflection of the sample population.

Do you have to wait long to get transportation to campus?

Waiting a long period of time in order to get transportation to university can be a challenge. This lost time could be used in a more productive and profitable manner for academic purposes. The data revealed that 26.5% of the students indicated that they do have to wait a long time to get transportation. The results will depend on multiple factors such as the geographical location and type of transportation used. A binomial test was conducted by the researcher to determine if the respondents selected one of two possible responses.

5.3 Research objective two

To establish the correlation between the constraints of public and private transportation scheduling systems on students' academic activities.

The second objective of the research study aims to find a link between the public and private transportation scheduling systems on students' academic activities. Students were required to rate various aspects such as:

Timetable: Students were required to rate if the schedules of the various transportation systems were to their advantage. Did it suit their needs? Students responded according to their individual needs. 41.6% of the students answered positively, stating that the scheduling systems suited their needs.

Reliability: This was the second factor which students were required to rate. The reliability of the type of transportation that students used were rated. The data reveals that 47.5% of the students have rated positively on the reliability of the transportation that is used. Due to the daily commuting by students, the reliability factor is extremely important to that of the rate.

Hours of operation: The operational hours of the transportation systems used are one of vital importance to be investigated. The academic activities at university can differ in terms of time schedules, therefore the importance of the hours the transportation service operate is vital. The hours of operation in general would affect the public transportation sector. Students that use public transportation must be able to commute throughout the day based on their needs and time. The data shows that 43% of the students are satisfied with the hours of operation.

Route: The route that the students utilise to travel back and forth to campus, is the next factor considered and students were asked to rate this. The route used can be a good indicator of the duration of a trip to campus. A substantial amount of students (48.3%) have indicated that the route that is used is to their liking. The route that is being used can either save travelling time or take up the valuable time of students.

Journey time: This factor is a follow up to the previous one (route). The journey time is of vital importance in order to understand and determine the duration students spend travelling to campus. Time that is wasted could be utilized profitably on academics in order to improve a student's academic performance. The data reveals that 48.1% of students indicated that they are in favour and pleased with their journey time.

5.4 Research objective three

To establish students travel patterns in an attempt to effectively balance the scheduled demand for and capacitated supply of transportation.

The place of residence of a student can give the researcher vital information in understanding the travel patterns. Students were asked for the place of residence in question 4 of the survey instrument. It was found that students travel from 29 areas that are in and around the Durban area. Identifying major areas that students reside in can assist the necessary stakeholders in the balancing of the scheduled demand to the capacitated supply of transportation. The travel patterns can be established and utilised to plan routes as well as plan efficient transportation systems to and from the university. Questions 19 and 20 can be used to answer this objective. Question 19 asks the time that students arrive at campus and question 20 asks the time that students leave campus. These questions can assist the researcher to understand the times that students require transportation the most. The demand for transportation can be determined by the peak times as required by students.

5.5 Research objective four

To determine the extent to which the different geographical locations in which students reside correlate with their academic performance

Students reside in different areas. Some areas are of close proximity to the campuses that students attend whilst others are great distances from the university. The proximity to a campus will dictate the duration of the trip. Students that reside closer to the campus have a minimum travelling time as compared to those students who reside further away. Question 22 of the questionnaire asks the respondent how long does the trip to campus usually take. The data reveals that a significant 64.5% of the students have indicated that the trip to campus usually takes approximately 15 to 30 minutes, 23.1% have indicated the trip to campus usually takes approximately 30 to 40 minutes and 12.5% indicated the trip usually takes over 60 minutes. The travel time could be used more profitably. Students could be using the travel time study and increase their overall study time thus increasing their academic performance. Students that reside at a campus residence have an advantage over off-campus students.

Question 21 asks students to rate the levels of satisfaction with the various aspects of the trip.

The first aspect is:

- a) Speed.

The data has reveals that there is significant satisfaction with the speed. This is evident because the mean value is greater than 3.

The second aspect is:

b) Cost

The data reveals that there is satisfaction due to a mean value of 3.22.

The next aspect is:

c) Convenience

This aspect also yields satisfaction with a mean value of 3.56.

The next aspect that was rated is:

d) Reliability

This aspect shows significant satisfaction.

The final aspect is:

e) Impact on studies.

The aim of this factor was to investigate if travelling to campus impacted on the students' academic studies.

Students were asked to rate their level of satisfaction with the above aspects of their trip. The impact on the student's studies were one of those aspects and the data revealed that most students are satisfied with the impact that travelling has on their studies and academic performance.

5.6 Chapter Summary

This discussion is able to answer the research objectives set for this study. The objectives identify goals associated with each of the research questions. The objectives of the study were achieved by utilising a carefully designed questionnaire that extracted the necessary information from the students that was required and was discussed together with the relevant questions from the questionnaire. The challenges and capacity constraints were discussed together with the results obtained. The scheduling systems and the factors pertaining to the scheduling systems were discussed including the travel patterns and the geographic locations of the place of residence of the students. The results were discussed with each of the objectives and put into perspective. The results obtained can be used by the University and other stakeholders to ensure that there is proper planning and management of student transportation.

Chapter Six

Recommendations and Conclusion

6.1 Recommendations

This research study pursued to explore the transportation networks and students travel patterns and challenges which may exist in student commuting. The study explored constraints in the transportation system by using the theory of constraints to identify potential constraints in the system. This research engaged in exploring different strategic factors such as the geographical locations that students reside in, private and public transportation and impacts on academic activities.

The study recommends that:

1. The University management must involve the various transport service providers (both private and public) and government to negotiate with each other on issues involving student transportation when drafting proposals.
2. Feasibility studies should be under taken to construct additional on-campus residence so that there is a reduction in off-campus students who may face travelling challenges.
3. Research should be conducted to access cycling as a means of transportation to the universities campuses.
4. There should be a joint effort of policing and patrolling between the SAPS and the campus security to regularly patrol the external parameters of the campuses to ensure that students feel safe on their destination to the bus and taxi terminals.

6.2 Objectivity and Statement of problem

The statement of problem of this study expressed the challenges which exist and the increase in demand for student transportation. The literature review of the study took on an analysis of existing challenges that off-campus students face while commuting to and from university. This study focused mainly on exploring existing challenges and uncovering new ones. The research objectives (four objectives) conferred the ambition of this research towards exploring how students commute to and from university and the challenges that exist.

The respondents of the study are students from the University of KwaZulu-Natal, Howard College (51%), Westville campus (41%) and the Medical School (8%). Off-campus students

from these campuses are the target population and proved to be extremely useful in shedding insight into the structures of students' transportation systems.

6.3 Contribution of the study

Off-campus students require reliable and sustainable transportation to commute to university and back. Reliable transportation is imperative to students to get to university daily and attend lectures. The study is designed to provide knowledge and insight on the travel patterns of students and the transportation networks used by students. This study can be used to discover and determine challenges and gain insight on transportation system for tertiary students.

6.4 Limitations and delimitations

This research was confined to the University of KwaZulu-Natal and therefore constricted to students residing in the Durban area, thus other universities were not included in the study. Due to the on-going strike action not many students were at campus. The study did not cater for students that ride a motor cycle or cycle to university. The delimitation is that the researcher is a student at the University of KwaZulu-Natal. This ensured students were more willing to participate in the study.

6.5 Opportunities for further research

The research study has recognised numerous prospects that can be used for further research. The limitations and results of this study is a good starting point for further research.

Furthermore, similar studies can be conducted to include more campuses, both in Durban and on a provincial level. The study can also be adapted to explore the transportation networks and travel patterns of school learners. Future studies should include both motorcyclists and cyclist to evince all the modes of transportation.

Studies should be conducted for green travel, the world is moving towards low carbon emissions. Studies should be conducted to find or develop sustainable modes of transportation that embodies green travel which is sustainable.

6.6 Conclusion

The University of KwaZulu-Natal like other universities around the country and the world houses a very small percentage of the total student population on the campus residence. Most students find accommodation off-campus that is of close proximity to the campus. Students therefore are in need of more on-campus residence in order to cater for and house a greater percentage of the student population.

Travelling by bus contributes a significant percentage (42.4%) as a means of transportation used by students to commute to campus. Other means of transportation such taxis and private vehicles also contribute a significant share of transportation used by the student of the University of KwaZulu-Natal. A large percentage of the students indicated that the trip to campus is between 15 to 30 minutes.

The geographical location of the campus appears to be a contributing factor to the mode of transport utilised to that specific campus. The geographical location of a campus also appears to be a factor that affects the student's perception of safety while travelling to the campus.

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Appendices

Appendix A: Frequency Distributions

Table A.1- Year of study

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1 st	141	37.4	37.4	37.4
2 nd	94	24.9	24.9	62.3
3 rd	103	27.3	27.3	89.7
4 th	34	9.0	9.0	98.7
6 th	5	1.3	1.3	100.0
Total	377	100.0	100.0	

Table A.2 Campus

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Howard college	192	50.9	50.9	50.9
Medical school	32	8.5	8.5	59.4
Westville	153	40.6	40.6	100.0
Total	377	100.0	100.0	

Table A.3- Study Status

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Undergraduate	349	92.6	92.6	92.6
Postgraduate	28	7.4	7.4	100.0
Total	377	100.0	100.0	

Table A.4 : Place of residence

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Durban North	12	3.2	3.2	3.2
	Reservoir Hills	42	11.1	11.1	14.3
	Phoenix	22	5.8	5.8	20.2
	Umlazi	21	5.6	5.6	25.7
	Pinetown	12	3.2	3.2	28.9
	Glenmore	7	1.9	1.9	30.8
	Westville	19	5.0	5.0	35.8
	Montclair	12	3.2	3.2	39.0
	Overport	10	2.7	2.7	41.6
	Chatsworth	23	6.1	6.1	47.7
	Glenwood	18	4.8	4.8	52.5
	Durban	47	12.5	12.5	65.0
	Sydenham	7	1.9	1.9	66.8
	Verulam	11	2.9	2.9	69.8
	Tongaat	7	1.9	1.9	71.6
	Berea	10	2.7	2.7	74.3
	Umbilo	15	4.0	4.0	78.2
	Umhlanga	4	1.1	1.1	79.3
	Musgrave	8	2.1	2.1	81.4
	Mayville	6	1.6	1.6	83.0
	Newlands West	9	2.4	2.4	85.4
	Kloof	4	1.1	1.1	86.5
	North Coast	9	2.4	2.4	88.9
Durban South	17	4.5	4.5	93.4	
Yellowwood Park	4	1.1	1.1	94.4	
Queensburgh	9	2.4	2.4	96.8	
Bluff	4	1.1	1.1	97.9	
Kwadukuza	4	1.1	1.1	98.9	
Chesterville	4	1.1	1.1	100.0	
Total		377	100.0	100.0	

Table A.6: Type of transport

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Public	177	46.9	46.9	46.9
	Private	200	53.1	53.1	100.0
	Total	377	100.0	100.0	

Table A.7: Bus

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	160	42.4	42.4	42.4
	No	217	57.6	57.6	100.0
	Total	377	100.0	100.0	

Table A.8: Train

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	2.4	2.4	2.4
	No	368	97.6	97.6	100.0
	Total	377	100.0	100.0	

Table A.9: Taxi

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	83	22.0	22.0	22.0
	No	294	78.0	78.0	100.0
	Total	377	100.0	100.0	

Table A.10: Private vehicles

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	64	17.0	17.0	17.0
	No	313	83.0	83.0	100.0
Total		377	100.0	100.0	

Table A.11: Lift clubs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	53	14.1	14.1	14.1
	No	324	85.9	85.9	100.0
Total		377	100.0	100.0	

Table A.12: Dropped off

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	37	9.8	9.8	9.8
	No	340	90.2	90.2	100.0
Total		377	100.0	100.0	

Table A.13: Multimodal Transportation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	350	92.8	92.8	92.8
	2	25	6.6	6.6	99.5
	3	2	.5	.5	100.0
Total		377	100.0	100.0	

Table A.14: The number of days travelled to campus a week

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	.5	.5	.5
	2	7	1.9	1.9	2.4
	3	19	5.0	5.0	7.4
	4	29	7.7	7.7	15.1
	5	254	67.4	67.4	82.5
	6	54	14.3	14.3	96.8
	7	12	3.2	3.2	100.0
	Total	377	100.0	100.0	

Appendix B : Formal letter and Questionnaire



UNIVERSITY OF KWAZULU-NATAL SCHOOL OF MANAGEMENT

Master of commerce – Supply Chain Management Research Dissertation

Researcher Mr Renaldin Ponnán 0749540764 renaldinponnan@yahoo.com

Supervisor Dr T.P Mbhele 0312607524 Mbhelet@ukzn.ac.za

Hi,

REQUEST TO PARTICIPATE IN A VOLUNTARY, CONFIDENTIAL RESEARCH PROJECT

My name is Renaldin Ponnán and I am a student in the School of Management, IT and Governance at the University of KwaZulu-Natal, doing research on transportation networks and students travel patterns: the case of the University of Kwazulu-Natal for my BCom Masters qualification.

You have been selected as a potential respondent for participation in a voluntary, anonymous survey that I am conducting. I would appreciate your participation and your permission to use your responses for official research purposes only.

Your personal identity will be treated with the utmost confidentiality throughout the survey and will at no stage appear in print. The data will be stored securely throughout the study, archived safely for a period of 5 years and destroyed thereafter.

If you have any queries or concerns about completing the questionnaire, or about participating in this study, feel free to contact me, or my supervisor at the numbers listed above.

If you are willing to participate, please accept the accompanying declaration of consent that gives me permission to use your responses, and thereafter please complete the accompanying questionnaire. It should take only about 10 minutes of your time to do so.

In the event of any problems or concerns/questions you may contact Renaldin Ponnán or the UKZN Humanities and Social Sciences Research Ethics Committee whose contact details as follows:

HUMANITIES AND SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001

Durban 4000 KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557- Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

CONSENT:

I, _____ (Name: optional) hereby confirm that I understand the content of this document and the nature of the research project, and I consent to participate in the research dissertation.

I understand that participation is voluntary and I am at liberty to withdraw from the process at any time, should I so desire

Participant's signature _____ **Date** _____



Protocol Reference Number: HSS/1048/016M

Section One

The questions below ask about your personal profile.

1 Year of study?

2 Which UKZN campus do you belong to?

3 Which option best describes your study at campus?

4 Place of residence? _____

5 Do you use public or private transportation to get to campus?

6 How do you travel to campus?

Bus Private Vehicle
Train Lift Club
Taxi Get dropped off

7 Do you use multimodal transportation to get to campus? For example if you use more than one of the above to get to campus.

8 How many days do you travel to campus a week?

9 Which days do you travel to campus?

Monday	<input type="checkbox"/>	Tuesday	<input type="checkbox"/>	Wednesday	<input type="checkbox"/>	Thursday	<input type="checkbox"/>	Friday	<input type="checkbox"/>
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Section two

This section aims to obtain information on dichotomous questions (*Yes or No*) with regards to transportation challenges and capacity constraints. Please circle or tick on the appropriate box(es) below.

10	Do you experience traffic congestion problems often?	Yes	No
11	Do you feel safe travelling to campus with your means of transportation?	Yes	No
12	Is there a lack of transportation to get to campus from your home?	Yes	No
13	Do you have to wait long to get transportation to campus?	Yes	No

Section three

The following questions are related to the correlation between the constraints of public and private transportation scheduling systems on a student’s academic activities. Based on your experience, please encircle the appropriate number (“1” as strongly disagree, “3” as neutral and “5” as strongly agree).

14	Timetable	5	4	3	2	1
15	Reliability	5	4	3	2	1
16	Hours of operation	5	4	3	2	1
17	Route	5	4	3	2	1
18	Journey time	5	4	3	2	1

Section four

The following questions aim to determine the different geographical locations in which students reside correlate with their academic performance.

19 What time do you usually arrive at campus?

Before 07:30	<input type="radio"/>
07:31 – 08:00	<input type="radio"/>
08:31 - 09:00	<input type="radio"/>
09:31 - 10:00	<input type="radio"/>
After 10	<input type="radio"/>

20 What time do you usually leave campus?

Before 12	<input type="radio"/>
12:01-13:00	<input type="radio"/>
13:01 -15:00	<input type="radio"/>
15:01 - 16:00	<input type="radio"/>
16:01 - 17:00	<input type="radio"/>
After 17:00	<input type="radio"/>

21 How satisfied are you with your means of travelling? Please rate your level of satisfaction with the following aspects of your trip

	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
a) Speed/Time	1	2	3	4	5
b) Cost	1	2	3	4	5
c) Convenience	1	2	3	4	5
d) Reliability	1	2	3	4	5
e) Impact on studies	1	2	3	4	5

22 How long does your trip to campus usually take?

15 - 30 minutes	<input type="radio"/>
30 - 40 minutes	<input type="radio"/>
Over 60 minutes	<input type="radio"/>

End of the Questionnaire

Thank you for taking the time to complete this questionnaire

Appendix C: Confirmation of ethical clearance



16 August 2016

Mr Renaldin Ponnar 210504501
School of Mangement, IT Governance
Westville Campus

Dear Mr Ponnar

Protocol reference number: HSS/1048/016M

Project Title: Transportation Networks and Students Travel Patterns: The case of the University of KwaZulu-Natal

Full Approval – Expedited Application

in response to your application received 12 July 2016, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....
Dr Shenuka Singh (Chair)
Humanities & Social Sciences Research Ethics Committee

/pm

Cc Supervisor: Dr TP Mbhele
Cc Academic Leader Research: Professor Brian McArthur
Cc School Administrator: Ms Angela Pearce

Humanities & Social Sciences Research Ethics Committee

Dr Shenuka Singh (Chair)

Westville Campus, Govan Mbeki Building

Postal Address: Private Bag X54001, Durban 4000

Telephone: +27 (0) 31 260 3587/8350/4557 Facsimile: +27 (0) 31 260 4609 Email: ximban@ukzn.ac.za / snymanm@ukzn.ac.za / mohunp@ukzn.ac.za

Website: www.ukzn.ac.za



Flagged Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

Appendix D: Editors Letter

16 Chaucer Road
Claremont
Cape Town 7008
19 November 2016

Dr T.P. Mbhele
Department of Commerce
University of KwaZulu-Natal

This is to confirm that I have edited Renaldin Ponnán's Proposal and three chapters of his Master's thesis: 'Transportation Networks and Students' Travel Patterns: the Case of the University of KwaZulu-Natal'.

The editing included proof reading, grammar/style improvement, some restructuring, and formatting.

I have 13 years' experience in editing theses and academic articles and am a full member of the Professional Editors Group (professional-editors-group-south-africa@googlegroups.com).

The authorship and the final responsibility for the edited draft of the thesis lie with my client.

Yours sincerely



Ms Rose Jackson

19 November 2016

editorose@gmail.com

Appendix E: Editors Letter

Dr T.P. Mbhele

This is to confirm that I have edited Renaldin Ponnann's chapters 4, 5 and 6 of his Master's thesis: 'Transportation Networks and Students' Travel Patterns: the Case of the University of KwaZulu-Natal'.

The editing included proof reading, grammar and style improvement, some restructuring of sentence construction, and formatting.

I am a level 1 educator who has M+4 qualification with English, Science and Technology as majors. I am currently employed and have 22 years of teaching experience.

Yours sincerely

Vanessa Bechan (Mrs)

20 November 2016

Email Address: vanessagovender12@yahoo.com