A COMPARATIVE ANALYSIS OF VEHICLE TRAFFIC FLOW AT JOMO KENYATTA AND JULIUS NYERERE INTERNATIONAL AIRPORT

BY

BONNYVENTURE SARONGE

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MASENO UNIVERSITY

DECLARATION

I declare that the work presented herein is my original work and has never been presented to any other University for any academic award.

Student

Name: Bonnyventure Saronge **Registration Number:** EL/SPM/00315/2012

Signed……… **Date…**……..

Supervisor:

Dr. Leah Onyango

Department of Urban and Regional Planning, School of planning and Architecture

Maseno University

Signed……… Date…….

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DEDICATION

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ABSTRACT

Traffic flow management is an ever-growing challenge in airports around the world as the number of travellers is continually increasing. Parking availability, in turn, is one of the most significant challenges that airport officials are trying to address. Most airports have similar needs with regards to traffic and parking; traffic incidents and parking problems cause congestion in the airport access roads. International airports over the years continue to experience increase in traffic flow resulting in travel delays, traffic jams, heavy congestion and insecurity. In 2012, the economic costs of delays at three major New York airports documented by consultants were estimated at almost $700 million for business travelers and$1 billion from tourist travelers. The situation is worse in the developing world where there is slow uptake of new technologies for traffic management. An example is Jomo Kenyatta International Airport (JKIA) which experiences serious vehicle traffic management challenges owing to the fact that it is still using traditional manual systems for managing vehicle traffic flow within the airport whereas Julius Nyerere International Airport (JNIA) in the same region has adopted the use of more advanced system to manage its traffic. This study sets out to compare similarities and differences in traffic management between JKIA and JNIA with a view to establishing best practices towards improved traffic management. The main objective of the study was to examine the vehicle traffic flow management at JKIA and JNIA. The specific objectives of the study were to establish the time taken by vehicles into and out of the Jomo Kenyatta and Julius Nyerere airports, to examine the efficiency in the usage of designated vehicle parking spaces at the airports and to examine the security position at the airports. The study adopted a cross sectional study design. The population comprised all people who drive into the airport facility (the assumption is that all people who come to the airport drive or are driven and therefore have knowledge/information on transport related matters). The sample was stratified sampling to obtain the sample size to which a comparative analysis was done. The sample included local travelers, international travelers, taxi drivers, individual visitors, company drivers and export/import drivers. Data was collected using questionnaires, interviews and observation. Descriptive statistics were used to analyze the data. The study established that time taken to get into the airport after arriving at the first security check area was much shorter at JNIA compared to JKIA. At JNIA 67% took less than one minute while at JKIA only 13% took a similar time. The efficiency in the usage of designated vehicle parking spaces was better at JNIA where 95% took less than minute to locate parking at the passenger terminal while at JKIA 19% took a similar time. At JNIA the average efficiency score of parking signage was 63% while at JKIA it was 46%. For JNIA average negative attributes score was 6% while for JKIA it was 39%. The throughput at JNIA is much better than that at JKIA for both the cargo and the main passenger gates and on average travellers would take twice the time to enter and exit the airport at JKIA compared to one at JNIA. Both airports have however not met the accepted international standards. Their uptake of technology is still relatively low compared to other international Airports. The infrastructure at the two airports needs to be improved to allow for multiple options in transportation such as train and underground metros. The results of the study can be used by the decision makers to improve traffic management in their respective airports.

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CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Traffic congestion is a problem in many cities of the World, both in developed and developing countries and it is predicted that it will get worse in the future. According to the Airports Council International (ACI, 2015) vehicle traffic, measured in vehicle kilometers were around 50 billion in 1950, and this figure increased to 400 billion in 1990, more than 450 billion in 2000 and over 500 billion by 2014. The growing vehicle traffic volume especially in areas around the airports presents the problem of traffic congestion in modern society, since increased travel time caused by traffic congestion imposes costs to the road users. The average all day traffic speed within central London for example decreased from 17.2 (km/h) in 1986 to 14.2 (km/h) at comparable times in 2002.

In the US, it has been recently reported that the total direct economic cost of traffic congestion was about $87.2 billion dollars (£54.6 billion) in the 439 urban areas in 2007; and the average cost per traveler during the peak period was $757 (£474) in 2007 with the airports accounting for about 11 % (Mondschein, 2015). The reported cost only includes direct costs, namely additional time and wasted fuel caused by congestion. Therefore, if indirect costs such as opportunity cost of increased travel time were included, the total cost of the traffic congestion would be even larger.

In 2011 more than 104 million passengers used the John F. Kennedy International (JFK), Newark Liberty International, and LaGuardia all of which serve the New York City. In 2012 the economic cost of delays at the three major New York airports were documented by consultants and the report estimated that business travelers lost about $700 million from delays and personal or tourist travelers lost about $1 billion. These estimates were made assuming a value of time that is what travelers would be willing to pay to avoid the delays. These value-of-time estimates were set at $40.10 per hour for business travelers and $23.30 for the personal travelers. This is despite travelers using other modes of transport, which included the rail (Mondschein, 2015)

Other world's major airports like Atlanta in the US state of Georgia, with 94.4 million passengers in 2014, Beijing Capital International Airport, with 83.7 million passengers in 2014

and London Heathrow, where traffic reached 72.3 million in the same year all face the problem of increased vehicle numbers at the airports (IATA, 2014).

According to Airports Council International, most airports have continued to be congested both in developed and developing world. The passenger numbers have continued to increase in North America, Latin America-Caribbean and Europe. African air transport demand has also seen full-year growth of +3.2% in passenger traffic (+4.7% for international traffic) despite the adverse effects of the Ebola crisis in the recent years on air transport in western parts of the African continent. The Northern Africa also rebounded after a bleak period in passenger numbers for 2012 and 2013. This growth has led to congestion, which has an impact on both the speed of travel and the reliability of travel conditions (ACI, 2015).

According to a study by Bashiru and Waziri, 57% of commuters and motorists in Lagos Nigeria spend between 30 to 60 minutes on the road due to traffic congestion every day. They also found that the worst traffic congestion occurred on Mondays and Fridays especially getting from and into the airports (Waziri, 2008). Ghana, like most countries in the developing World is no exception to the above-described phenomenon. Indeed, with its high growth rate and the natural desire among the population to have vehicles of their own (Coleman, 2014) notes with concern that 'the high urban growth rate in the country is outpacing the provision of services thereby making it difficult to plan and program the transport sector in harmony with urban development.

In Tanzania, the public transport system in Dar es Salaam consists entirely of road-based services. For many years, the only company legally allowed to operate transport services was the state bus company Usafiri Dar es Salaam (UDA) Company; however, this never managed to cope with market demands. For this reason, many private operators co-existed with the state company leading to a sudden rise in congestion. From 1983, the market was deregulated and the state company lost even more market share to the private operators, as they were completely free to work. Most of the market now is in the hands of the thousands (approximately 7,000) of Daladalas (small vehicles with a capacity of between 16-36 passengers). This reduction in capacity with an increase in the number of vehicles on the road continues to put more pressure on the roads. The population of Dar es Salaam is increasing at a rate of 4.39% each year. This

rapid expansion of the population has put a considerable strain on the public transport system and led to high levels of congestion in peak periods (Kiunsi, 2013)

In Kenya, the public transport service in Nairobi was made up of conventional buses operated by Kenya Bus Service (KBS) under its Bus Track subsidiary before situation was made more liberal with new entrants. The Matatus, which are typically 12-35 seat mini-buses, are currently the dominant means of transport after KBS wound up in 1992. The rapid expansion of the population of about4.36% per year has not spared Nairobi too from the strain on the public transport system. The reduction of the capacity in the matatus has meant that we now have more vehicles on the roads leading to increased traffic congestion (Jain, 2012). This traffic condition is boldly manifested at the Jomo Kenyatta International Airport.

1.2 Problem Statement

Many cities in both developed and developing world today have serious problems in the smooth running of their daily activities due to traffic congestion. According to Organization for Economic Co-operation and Development [OECD], report (2010) in the last twenty years, the vehicle traffic in Dar es Salaam has continuously increased. This has in turn led to increased traffic within the central business district and mostly at the Julius Nyerere International Airport, which is its largest airport. In the last ten years, the traffic at the Jomo Kenyatta International Airport has increased by more than 50 %; from an average of six thousand vehicles per day to the current average of about ten thousand per day (KAA, 2014). A visit to the Jomo Kenyatta Airport today would either leave you stressed or angry due to the long queues and congestion at its entries, parking areas and exits. The current management system in use does not seem to be adequate leading to numerous problems. According to the Kenya airports authority, cases of vehicles damage has increased between 2009 and 2014. Flights too have continued to be affected by delayed take offs (KAA, 2014). According to a 2014 survey conducted by the International Business Machines Corporation (IBM), Nairobi is one of the world's most congested cities with a corresponding position at its largest airport the JKIA. They indicate that traffic jams cost Nairobi $600,000 per day in lost productivity and wasted fuel with the airport accounting for 20 % of this and the traffic is predicted to continue growing at JKIA through 2030 (IBM, 2014). Similarly,

the city of Dar es Salaam in the same region has not been spared either. Traffic congestion is one of the key problems in the city, especially during the peak hours of the mornings and evenings.

It is a relatively new phenomenon and as recent as in the middle of the 1990s congestion was not a problem at all except for a few roads in the City center. Traffic congestion is becoming worse as the years go by due to the rapid increase in Dar es Salaam population and the number of vehicles. According to a study commissioned in 2011 by the Guardian on the effects of traffic jams and its effect, the situation is having a great economic impact negatively on production and about Tshs.411 billion in revenue is lost every year (Kiunsi, 2012). The traffic data report (KAPS, 2014) shows that in 2014, congestion caused visitors to JKIA to spend a lot of time at the entries, parking areas and exits due to heavy congestion and lack of order. The report recommended that various mitigation efforts like transport infrastructure, dynamic ride sharing systems, mass transit system and traffic management system should be looked into. A significant amount of investment has been looked at as a key requirement in setting up a traffic management infrastructure, which can scale with the increasing traffic. With the increase of traffic numbers at the JKIA, there has been a corresponding rise in the number of security issues recorded especially in the last three years (KAA, 2014). Congestion in Dar es Salaam has continued to be caused by a number of factors include poor infrastructure that has led traffic flowing predominantly in one direction during the morning and evening peak hours (TAA, 2014)

1.3 Objectives of the Study

The primary objective of this study is to compare the vehicle traffic flow management at JKIA and JNIA.

1.3.1 Specific Objectives

1. To determine the time taken by vehicles into and out of the Jomo Kenyatta and Julius Nyerere International airports.
2. To examine the ease with which vehicles can access designated parking spaces at the Jomo Kenyatta and Julius Nyerere International airports.
3. To examine the level of security offered by the current traffic management system at JKIA and JNIA.

1.4 Research Questions

1. How long does it take for vehicles to get into and out of the Jomo Kenyatta International Airport?
2. How long does it take for vehicles to get parking spaces at Jomo Kenyatta and Julius Nyerere International Airport?
3. What is the level of security offered by the current traffic management systems at JKIA and JNIA?

1.5 Justification for the study

At the Jomo Kenyatta international airport, traffic management is a major issue. This situation became worse immediately after the JKIA inferno and the Westgate terrorism incident in 2013. This study may prove significant in understanding the effectiveness of the traffic management system or lack of at Jomo Kenyatta International Airport.

1.6 Scope and Limitations of the Study

This study compares traffic management in Jomo Kenyatta International Airport in Nairobi Kenya and Julius Nyerere International Airport in Dar es Salaam Tanzania. The research is also limited to study specific factors that do not include pedestrians (PED), bicycles (BIC) and None-Motorized Vehicles (NMV).

1.7 Conceptual Framework

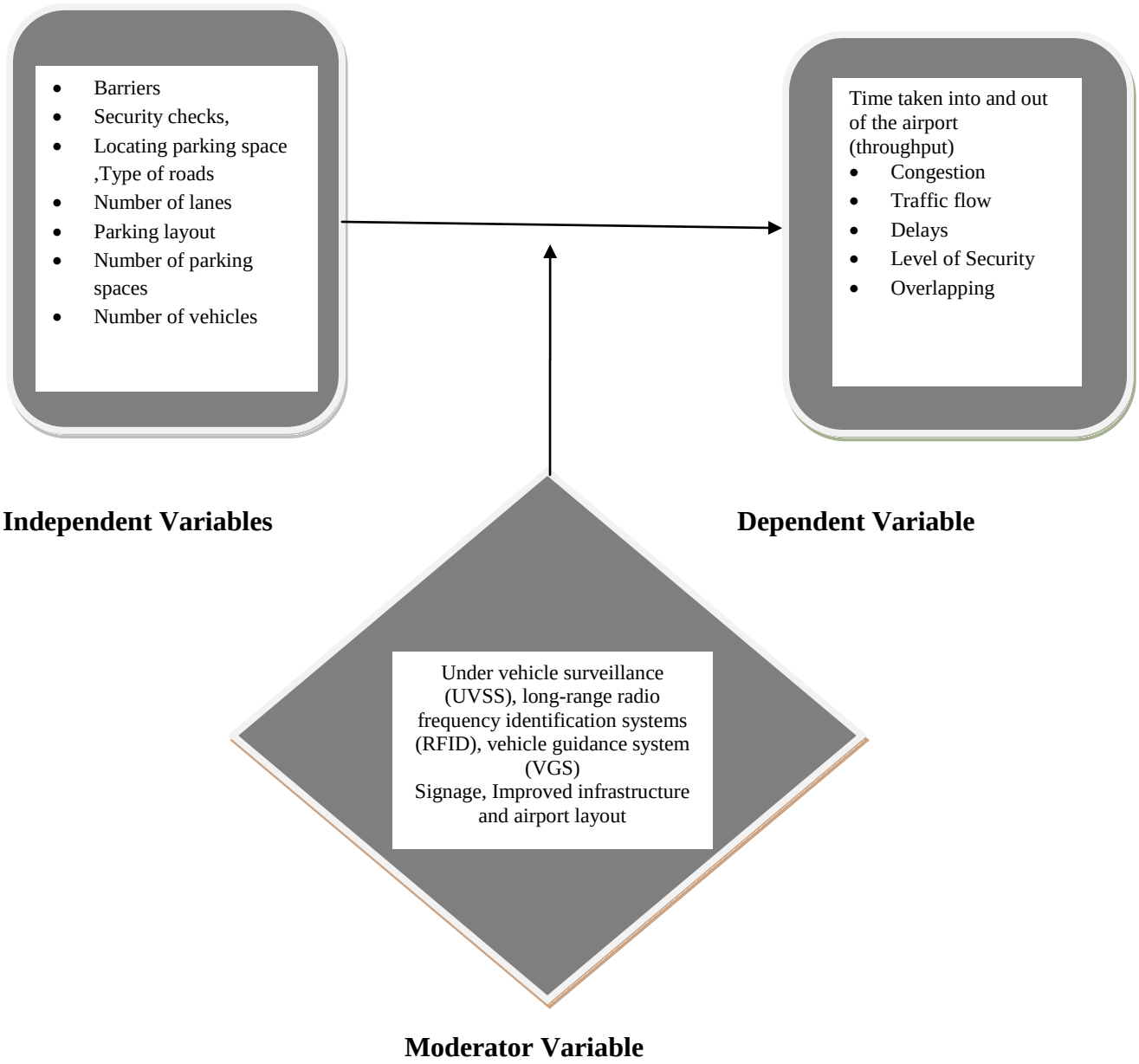

Figure 1: Conceptual Framework

In the above conceptual framework, the independent variables of the study include Barriers, Security checks, Locating parking space, Type of roads, Number of lanes, Parking layout, Number of parking spaces, Number of vehicles, Time taken into and out of the airport (throughout) is dependent on, number of barriers, security checks, and identification of parking. These are the variables that will entail comparison between the two airports of the study. Dependent variables are time taken into and out of the airport inclusive of congestion, traffic flow, delays and security checks. Therefore, the study carried out comparison on the two airports using these variables.

CHAPTER TWO: LITERATURE REVIEW

2.1 Theoretical Literature Review

One method of approximating cycle time or average waiting time in systems is by the utilization of queuing theory and queuing networks. Queuing network theory has been a staple of operations research since Jackson (1963) identified the need for stochastic modeling of queuing in multipurpose production systems and proceeded to establish joint probability distribution and create the M/M/1 queue. Blanchard and Fabrycky (2006) define queuing systems as a Monte Carlo analysis to understand entity arrivals and service of entities based on probability rather than an absolute rate. There are multiple applications of queuing theory from manufacturing, maintenance, tollgates, doctor offices, restaurants, and movie theatres.

Queuing theory allows for an analysis of a system based on a probabilistic model, rather than constant arrival and service times. Queuing networks are compilations of different service processes that are stochastic, or dependent on other processes and times in the work flow (Shanthikumar, Ding, & Zhang, 2007). In this study, queuing network theory is relevant in the time taken between the arrival and exit from the airport for the two areas of the study. This theory therefore guided this study except the adoption of the scientific model due to the comparative nature of the study.

2.2 Empirical Literature Review

In this section, there study reviewed previous studies on vehicle traffic flow management in airports based on the study objectives. This is done starting with time taken into and out of the airports; ease with which vehicles can access designated parking spaces at the airports and finally a review on the levels of security offered by the current traffic management systems at the airports.

2.2.1 Time Taken by Vehicles into and out of International Airports.

Diminished perceived time has been linked to the airport phenomenon known as ‘gate lock’. Levels of stress and anxiety related to airport time constraints can encourage passengers to pass through an airport terminal, ignoring the retail environment and opting to head to their boarding gate considerably earlier than required (Freathy & O'Connell, 1998). Once the passenger arrives

at their boarding gate, it is then extremely difficult to encourage them to return to the main section of the airport terminal and enter the retail environment. In an effort to decrease passenger stress related to actual and perceived time constraints, Australian international airports encourage passengers to arrive two to three hours before their flight's scheduled departure (Brisbane Airport Corporation, 2010; Melbourne Airport, 2013).

Research completed by Kirk (2013) shows that, on average, passengers spend over 60% of their time in an airport terminal as discretionary time. The retail environment is an important location where passengers can choose to spend this discretionary or free time (Rowley & Slack, 1999). In addition, Kirk (2013) shows that, on average, passengers actually spend only 36% of their overall time within the airport terminal (airport dwell time) undertaking these processing activities. The remaining 64% of airport dwell time is spent undertaking non-processing or discretionary activities. This means that most current airport research focuses on understanding and improving only a small fraction of passengers' overall airport experiences.

Airports have the opportunity to harness the potentially positive effects of excess time availability through the conversion of passenger waiting times from wasted time into useful time where passengers can have positive experiences. Lloyd (2003) argues that airport terminals can be transformed from areas that passengers pass through into locations where they actively choose to spend time. To achieve this, the terminal must immerse the passenger in the travel experience, promoting retail expenditure and positive retail experiences or distractions as ends in themselves. In this way, waiting times could be converted from wasted time, in which the passenger experiences boredom and alienation from their environment, into transit time which is filled with positive and useful travel-related experiences (Lloyd, 2003). Airports could create terminal spaces, which promote leisure, and entertainment to mitigate travel related stress, thus improving the passenger's airport experience and potentially increasing their retail expenditure. Domestic and international travellers encounter distinct airport terminal differences and therefore exhibit distinct retail behavioral differences. International travellers inherently spend longer time periods within the airport terminal. During this time they are presented with the opportunity to purchase duty free and tax free products and have a higher likelihood of being accompanied to the airport

by ‘wavers’ - non-passengers who come to the airport terminal in order to say their farewells (Freathy & O'Connell, 2000).

Freathy and O’Connel (2000) reason that business travellers are more likely to make purchases within airport retail outlets as they are generally from a higher socio-economic group than the ‘average’ passenger, and thus have a higher amount of disposable income. Furthermore, they are likely to have a limited amount of time for shopping at their destination, therefore making their dwell time at the airport terminal an ideal time to purchase (Freathy & O'Connell, 2000). Business travellers are also likely to be more experienced travellers and, therefore, are not considered to be representative of the ‘average’ passenger.

2.2.2 Ease with which Vehicles can Access Designated Parking Spaces at International airports

It has been argued, and rightly so, that traffic congestion presents a common if not inevitable facet of traffic activity in a region, particularly in urban areas (Abdul, 2015). Although this phenomenon is human induced and is seen as an integral element in any transport system all over the world, a unanimous definition has defied scholars.

A review of the several definitions reveals three basic recurrent themes. First of all, congestion involves the imposition of additional costs on all users of a transport facility by each user of that facility. Secondly, transport facilities such as road links, intersections, lanes and turning movements have finite capacities to handle traffic, and congestion occurs when the demand to use a facility approaches or exceeds the capacity. Finally, congestion occurs on a regular, cyclic basis, reflecting the levels and scheduling of social and economic activities in a given area. This may be properly termed as recurring congestion. On the flip side, special episodes of congestion may occur at different points in a network due to irregular incidents, such as road works, breakdowns or accidents. This may also be referred to as non-recurring congestion (Abdul, 2015) following this review; a more comprehensive definition which has gained acceptance for use in traffic studies is that of (Harriet, 2013) He notes: “traffic congestion is the phenomenon of increased disruption of traffic movement on an element of the transport system, observed in terms of delays and queuing, that is generated by the interactions amongst the flow units in a traffic stream or in intersecting traffic streams”. He says that the phenomenon is most visible

when the level of demand for movement approaches or exceeds the present capacity of the element and the best indicator of the occurrence of congestion is the presence of queues (Harriet, 2013).

One other theme worth mentioning is that traffic congestion is dynamic and thus varies with space and time. Royte notes that three features that characterize travel demand and supply may account for the occurrence of congestion in all transportation facilities. The reasons are that demand varies over time, supply is relatively fixed over long time periods and output is not storable. Looking further, he notes that travel demand varies significantly with time. For instance, systematic daily and weekly variations in travel demand are informed by work and school schedules, and by the operating hours of businesses, shopping, and entertainment establishments. Also, annual fluctuations in travel demand are affected by the timing and length of school holidays and religious festivals, by sporting event schedules, and by the seasonal nature of outdoor recreational activities. Other social activities such as sporting meets, fairs, and other 'special events', may as well cause travel demand to fluctuate. While demand has been noted to be variable, transportation supply, on the other hand, is static.

Transportation supply consists majorly of infrastructure and the author notes that whereas infrastructure generally has a longer life span it involves lots of capital thus making it very costly and time consuming. Because land is scarce and capacity is expensive, it would be prohibitively expensive to build enough capacity to prevent congestion at all times, hence, the need to use better and efficient systems in management of traffic. Generally, it is agreed that although there is traffic congestion in most major cities of the world, there is no standard definition of it. Congestion occurs when the number of vehicles using the road is greater than the capacity of the available road space, impeding the efficient movement of traffic (Weisbrod, 2003). Rodrique states that, congestion can be perceived as unavoidable consequences of scarce transport facilities such as road space, parking area, road signals and effective traffic management. He argues that urban congestion mainly concerns two domains of circulation, passengers and freight, which share the same infrastructure. The traffic congestion condition on road networks occurs as a result of excessive use of road infrastructure beyond capacity, and is characterized by slower speeds, longer trip hours and increased vehicular queuing (Rodrique, 2001). Narwal also argues

that traffic congestion occurs when the volume of vehicular traffic is greater than the available road capacity, a point commonly referred to as saturation. He describes a number of specific circumstances, which cause or aggravate congestion. Most of such circumstances are concerned with reduction in the capacity of road at a given point or over a certain length, or increase in the number of vehicles required for the movement of people and goods (Narwal, 2016) he further argues that economic surge in various economies has resulted in a massive increase in the number of vehicles that overwhelms transport infrastructure, thus causing congestion on roads in cities.

The massive use of cars does not only have an impact on traffic congestion but also leads to decline in public transit efficiency, thereby creating commuting difficulties in cities. Indeed the over dependence on cars has tremendously increased the demand for transport infrastructure. Unfortunately, the supply of transport infrastructure has never been commensurate with the growth of mobility needs. Consequently, several vehicles spend most of the time in traffic as a result of traffic space limitation (Yan, 2008). Downs also argue that the mingling of many different modes of movement on the same roads is a cause of congestion in developing nations. The mix of old and new transport technologies, highlighted by the shared use of road space by fast moving motorized vehicles and slow-moving human-powered and animal-drawn vehicles such as rickshaws, hand drawn carts famously known as “mkokoteni” in Kenya and animal drawn vehicles, typifies many street scenes of the third world (Downs, 2003).

Drivers are charged based on their contribution to congestion within the designated area. This would vary on the time of day and traffic conditions in the area. One of the decisions in determining the most appropriate technology for managing traffic congestion is whether the technology will be part of only the enforcement system or the charging and enforcement system (Chitti, 2015). The standard policy reaction to road congestion is to build our way out (Arnott, 2010); however, he notes that increased road capacity can divert commuters to the congestible road and this diversion may worsen the situation. This10000 swing in the number of commuters towards the improved road can be seen in our case in Nairobi with the super Thika highway that ended up creating congestion with more people moving along it after its completion. Traffic management could be regarded as a systematic and sustained effort on directing and controlling

all traffics on our roads to make them free from negative effects of the transport system (Adewale, 2012).

Gardner points out that traffic management is an application of traffic engineering and administrative techniques in order to optimally use of the existing infrastructure (Gardner, 2002). Adebisi, 2013) also describe traffic management as a package of actions designed to optimize the available highway network in a well-focused manner (Adebisi, 2013). Newman and Jeffrey say that traffic management is a process of adjusting or adapting the use of an existing road system to meet specified objectives without substantial new road construction. Traffic management can increase the capacity of road networks at much lower cost than new road provision by increasing the efficiency of network use (Newman, 2001).

Gary on his report of experience in urban traffic management and demand management in developing countries stressed that traffic management involves the allocation of infrastructure road space or train slots on a railway network according to strategic operational and policy goals. These include efficiency, safety, environmental, economic and equity objectives. In real terms, meeting them may encompass measures that include giving priority to buses, trams or other vehicles such as emergency services or high occupancy vehicles, increasing space available for pedestrians and cyclists, or providing shared road space. Thus, road-related traffic management has considerable benefits in improving traffic flows, increasing safety and improving services to road users, for relatively little cost compared to that of building new infrastructure. Traffic management" embodies a wider concept and is concerned with the comprehensive management of the road based transport system and deals with policies and measures for the entire urban transport system (Gary, 2004).

According to Chijioke, an effective traffic management system in airports is significantly important in sustaining economic growth in contemporary economies since it provides linkages between different parts of the country and the global world. The success or failure of cities and airports experience in tackling congestion ultimately depend on how well they organize themselves to carry out the task they set for themselves (Chijioke, 2014). This is introduced with the primary or sole objective to reduce congestion by drivers paying for the delay that they inflict

on other road users. It has the secondary benefits of revenue generation and increased traffic flow (Atkins, 2003). Point charging on the other hand, which is considered to be more effective than parking charges as vehicles travel through, but not destined for, the congested area can also be implemented.

2.2.3 Level of Security Offered by the Current Traffic Management System at the International Airports

ANPR is primarily used in the enforcement component of the congestion charging system, although it does have the flexibility of being used as the primary charging system. It makes use of on-site cameras (fixed or mobile) to capture images of the number plates of passing vehicles. These moving images are then sent to a central computer system, where the ANPR systems identify the number plate. The license plate number is then matched to registered vehicles to ensure if the charge has been paid, if not, the violation penalty process then commences (DiNapoli, 2014). Singapore was an early leader in adopting congestion charging. Following a one- year public dialogue in 1975, Singapore implemented a paper system of daily licenses for vehicles entering the central zone during peak traffic periods. The system was implemented as part of an overall strong focus on restraining traffic, including increased vehicle and parking taxes, land- use planning and enhanced public transit (Keong, 2002). Two types of licenses were sold, one valid all day and one valid for midday. Traffic entering the zone dropped by 44 percent after implementation, while travel speeds increased from 11 mph to 21 mph (Keong, 2002). More than 10 years later (1988), traffic levels remained 31 percent below original levels even as employment in the city had increased by a third and vehicle ownership by 77 percent (Keong, 2002) Bus ridership increased about 20 percent due to congestion charging, transit improvement and related policies.

Traffic congestion in Dar es Salaam is felt by most road users and is a burden to the economy and frustrates efforts to improve the lives of the city's residents. The poorly managed traffic incidents have largely contributed to congestion and delay in the central business district of Dar es Salaam. This situation seems to be quite improved at its major airport, JNIA with a daily average traffic of about 7,500 vehicles being served by four lanes at its entries and four at the exits (TAA, 2014). A proceeding by Wilson, Roe, and So (2006) showcased a new DES software

package called Security Checkpoint Optimizer (SCO). The SCO program utilized the mathematical and logical concepts of DES, while adding a graphical user interface to allow TSA researchers to drag and drop equipment into a model. The integration of drag and drop and drawing tools into a DES engine allows for analysis of SSCP performance as well as assessing the feasibility of adding equipment to a finite area.

A study by Hafizogullari et al. (2003) utilized DES to evaluate different SSCP configurations to satisfy the 95-10 requirement, or the performance metric that 95% of all passengers during peak operations must wait no longer than 10 minutes for baggage screening. Scenarios were run with the use of ETDs or Explosive Detection Systems (EDS) and different levels of staffing. While throughput for the EDS was advertised as being greater, the high False Alarm Rate (FAR) caused the ETD machine to be a superior choice during peak operation. Policies on baggage cart utilization were analysed and it was determined that waiting for the baggage carts to fill before taking them to the airplane caused unacceptably long process times.

A study by Pendergraft et al. (2004) used DES to understand operational Dynamics of both checked baggage screening and the SSCP at a major U.S. airport during peak operating hours. PAX arrivals were generated randomly based on historical data, and random probability functions were used to trigger alarms in the WTMD. Alarm resolution was not explicitly modelled in the simulation, yet very accurate results were still attainable. This study was received so well that it resulted in the promulgation of the 85-10 methodology where 85% of passengers wait 10 minutes or less for screening. Likewise, requirements for staffing, equipage, and compliance levels were promulgated from this study.

A study by Wetter, Lipphardt, and Hofer (2010) used DES to assess throughput of SSCPs by examining internal and external factors. Internal factors were factors that were influenced by security personnel such as training and teamwork, while external factors were factors that could not be influenced by security personnel such as passenger arrival and baggage variability. Aside from quantitative data such as throughput and cycle time, subjective data from TSOs was collected to evaluate all aspects of the SSCP process. It was demonstrated that there was a significant effect on throughput by altering the number of manual baggage screenings performed.

Higher WTMD alarms did not decrease throughput, but did increase the TSOs subjective workload ratings. Wetter et al. (2010) speculated that if screening technology increased to where passengers could divest less, then throughput may be seriously increased because of the shortened divesting and vesting times.

2.3 Summary Literature Gap

The above reviewed studies have indicated the time taken at airports by visitors and the vehicles that navigates through, the ease of operation at the airports and the security requirements. However, no study has clearly brought out objectively the expectations of the international standards at the areas of study interests. It was with this concern that the current study sought to fulfil this.

CHAPTER THREE: METHODOLOGY

3.1 Research Design

The research design was cross sectional survey design; data was collected from the two sample sites at one point in time. Cross-sectional survey research design enables cross checking the correlations or differences among different variables during analysis and therefore it was the most appropriate design for the study.

3.2 Study Area

Jomo Kenyatta International Airport in Nairobi, formerly called Embakasi Airport is Kenya's largest aviation facility, and the busiest airport in Eastern Africa. It is the sixth busiest airport in Africa. The airport is located in Embakasi, a suburb to the south-east of Nairobi situated 15 kilometers from Nairobi's Central Business District at the edge of the city's built up area at Longitude 36°55.35'E and Latitude 01°19.07S, 5,375 feet above sea level (KAA, 2013). JKIA serves as the hub for Kenya's flag carrier, Kenya Airways, as well as for low-cost carriers like Fly540, and serves over 40 scheduled airlines. The airport accounts for 75% of the national aviation traffic and is ranked as the sixth busiest airport in Africa with respect to passenger traffic, and the third busiest in Africa with respect to cargo traffic. Kenyatta International Airport's terminal has three units that cater for both arrivals and departures. Units 1and 2 (currently referred to as T-A1 and T-A2) are mainly used for international flights whereas unit 3 currently T-A3 is mainly used for domestic flights.

Julius Nyerere International Airport is the principal airport serving Dar es Salaam, the largest city in Tanzania. It is located about 12 kilometers southwest of the city centre. The airport has flights to destinations in Africa, Europe, and the Middle East. It was formerly officially known as Dar es Salaam International Airport before being renamed in 2006 in honor of Julius Nyerere, the nation's first president. The figure below shows Nairobi and Dar es Salaam.

Figure 2: Map of East Africa, showing position of Nairobi and Dar es Salaam

Source: Google Earth.

Terminals at main passenger area

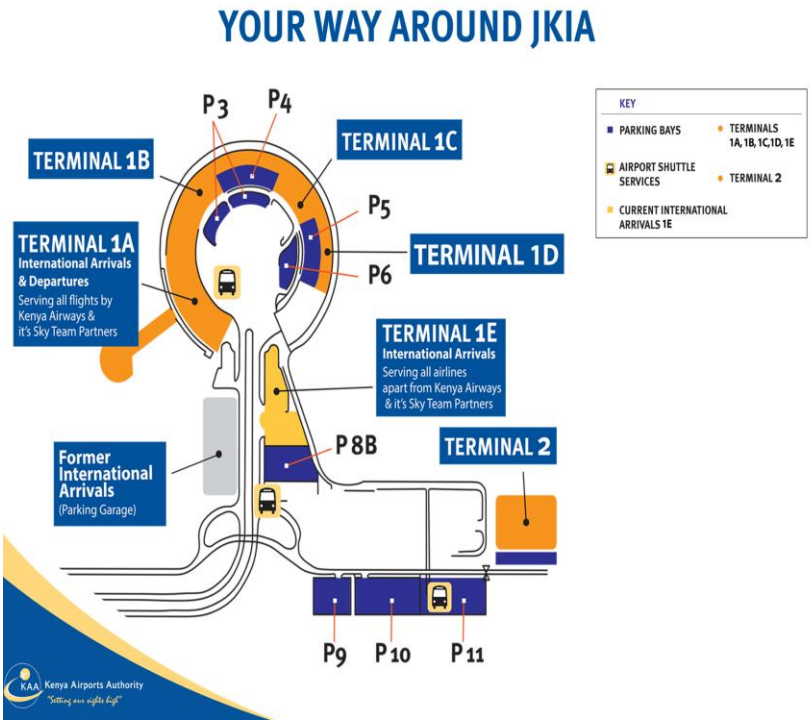

Figure 3: JKIA terminal layout

Figure 4: JNIA terminal layout

Source: KAPS report

3.3 Study Population

The population comprised of all people who drive into the airport facility (the assumption was that all people who come to the airport drive or are driven and therefore have knowledge/information on transport related matters). JNIA has a daily average traffic of about 7,500 vehicles being served by four lanes at its entries and four at the exits(TAA, 2014). In addition, Jomo Kenyatta International Airport serves a daily average of 10,000 vehicles through its six lanes at the entries and six at the exits (KAA, 2014).

3.4 Sampling Frame

The sample frame included a list of all organizations operating at JKIA and Julius Nyerere airports. This list might not be exhaustive but include the government agencies directly involved in airport operations like the Kenya Police, Tanzania Police, KAA, KCAA, KRA, TAA, TCAA, AOC members, Taxi drivers, International and local travellers. There are therefore over 10,000 people operating in the two airports daily from which the sample was drawn.

3.5 Sample Size and Sampling Procedure

Unit of analysis

The unit of measure was the vehicles visiting the airport.

To get the sample size, Taro Yamane's (Yamane, 1973) formula was used; a confidence level of 95 % and 5 % sampling error was considered.

Formula $n=N/1+N\ (e^2)$

Where: n = Sample size

N = Population

e = Level of precision in % (level of precision or sampling error)

$n=N/1+N\ (e^2) = 10{,}000/1+10{,}000\ (0.05^2) = 384.6$; 400 will be considered (JKIA)

$n=N/1+N\ (e^2) = 7{,}500/1+ 7{,}500\ (0.05^2) = 379.7$; 400 will be considered (JNIA)

3.6 Data Collection

The study used both secondary and primary sources of data. Secondary sources included material from the Internet and documents at the airports while primary data entailed the data collected from the respondents at the airports using questionnaires and interviews.

3.7 Data Collection Procedures

The right procedure was adopted in the collection of data at the airport, particularly the primary data. Permission was sought from the relevant authorities and proper follow-ups made to ensure that all the relevant data were attained.

3.8 Instruments for Data Collection

3.8.1 Questionnaires

The primary data was obtained through structured questionnaires and administered on a number of categories of respondents namely the AOC members, Taxi drivers, International and local travellers Kenya Police, Tanzania Police, KAA, KCAA, KRA, TAA, TCAA. The variable considered in the questionnaires was the time they spend getting into the airport, getting out of the airport, time taken to obtain parking space, and security concerns.

3.8.2 Interview with Key Informants

As part of the methods for generating qualitative data for this study, in-depth interviews were conducted on the government agencies directly involved in airport operations like the Kenya Police, Tanzania Police, KAA, KCAA, KRA, TAA, TCAA, AOC members, taxi drivers, international and local travellers. These informants provided useful and insightful details for the study.

3.8.3 Observation and Checklist

With the use of a field notebook, pens, pencils and a photo camera, data was collected first hand. This method of data generation helped identify where, when and why while allowing for an opportunity to verify the data obtained from the key informants.

3.9 Validity of Research Instruments

For face validity, data collection instruments were ensured, the construction of questionnaires was done with close consultation with the supervisors and thereafter submitted to experts in the School of Planning and Architecture; Maseno University for verification. For the interview schedule and the interviewing process, the researcher accessed studies where the interviewing process was demonstrated and judged by the specialists in the department as a practice before doing it in the field.

3.10 Reliability

To establish the reliability of the research instruments, a pilot study was conducted twice. The instruments were given to 50 respondents and again administered to the same respondents after two weeks through test-retest method. The two tests were administered on the same respondents at an interval of two weeks (Mugenda & Mugenda, 2003). Pearson product moment correlation (r) was then used to determine correlation of the instruments, which was judged to be reliable at a value of a magnitude of relationship of 0.7 (Borg & Gall, 2007). A reliability value of 0.83was achieved which was considered suitable to make group inferences that were accurate enough (Fraenkel & Wallen, 2011). Results from the two tests were used to revise instruments before use in the actual study.

3.11 Data analysis Method

Both descriptive and inferential statistics were used to analyze data. This research employed both qualitative and quantitative analysis approaches. The key variables in the study will comprise of the number of vehicles getting into and out of the airport,

3.12 Ethical Considerations

The research was carried out in accordance with standard ethical procedures, these revolved mainly around obtaining informed consent from all participants; informing participants that they could withdraw from the research at any point they wished; handling any material with the strictest confidence and anonymity and reporting on the subject matter in a responsible manner. The Airport's security managers were approached to obtain full approval for the proposed research. The ethics application set out the precise manner in which the research was carried out. Information about me and the aims and objectives of the study and a brief overview of the

research methodology was also provided. Copies of consent forms, invite letters and questionnaires to be used for interviews and surveys accompanied the form for approval. This was done to ensure that respondents were not subject to any unnecessary intrusions into privacy, sensitivities, leading questions, labelling and stigma.

CHAPTER FOUR: FINDINGS AND DISCUSSION

4.1 Introduction

This chapter will present the findings and of the study. It will clearly articulate the primary objective of this study, which was to compare the vehicle traffic flow management at JKIA and JNIA. In addition, it will present the findings of the other specific objectives. The study was to determine the time taken by vehicles into and out of the Jomo Kenyatta and Julius Nyerere International airports; to examine the ease with which vehicles can access designated parking spaces at the Jomo Kenyatta and Julius Nyerere International airports and to examine the level of security offered by the current traffic management systems at JKIA and JNIA.

4.2 Characteristics of the Respondents

A total of 749 respondents participated in the survey where 388 respondents were drawn from Jomo Kenyatta International Airport (JKIA) and 361 respondents were drawn from Julius Nyerere International Airport (JNIA).

Table 4.1: Classification of respondents at JKIA and JNIA

Categories	JKIA		JNIA	
Passenger Airline operators	127	33%	58	16%
Government agencies	40	10%	63	17%
Cargo handlers	50	13%	25	7%
Tours and travel agents	63	16%	40	11%
Taxi and car rentals	63	16%	81	22%
Travelers	45	12%	94	26%
Total	388	100%	361	100%

Source: Survey data, 2017

Table 1 indicates that airline operators took up the largest proportion of the study sample from JKIA (33%) while at JNIA they only took up 17% of the sample. This refers to airline operators that provide passenger transportation service into and out of the airports and are classified into three subcategories (IATA, 2007) Large certified carriers: These carriers have a certificate to

carry 61 passengers or more, payload equal to or greater than 18,000 pounds, or conduct international operations. Small certified carriers: These carriers fly aircraft that carry less than 61 passengers, carry less than 18,000 pounds, and do not conduct international operations. Commuter carriers: These are air taxis with a published schedule of at least five weekly round trips between at least two airports. At JKIA, Kenya Airways (KQ) is the major airline in Kenya with Air Tanzania Company Limited (ATCL) in Tanzania. Others are Precision Air, Air Mauritius, British Airways, Brussels Airline, South African airways, Swiss International Airlines, Turkish Airlines, Condor Airline, Emirates, Air Arabia, Rwanda Air, Qatar Airways, Ethiopian Airlines, Air Mozambique, Lufthansa, Egypt Air, Saudi Arabian Airline, Etihad Airways, Fly 540, African Express Airways, East African Safari Air, Fly Sax and Jubba Airways.

Government agencies directly involved in airport operations at the airports include; Kenya Police, Tanzania Police, Kenya Airports Authority (KAA), Kenya Civil Aviation Authority (KCAA), Kenya Revenue Authority (KRA), Tanzania Airport Authority (TAA), Tanzania Civil Aviation Authority (TCAA), Airline Operators Committee (AOC) members, Taxi drivers, International and local travellers. Table 1 indicates that government agencies made up the smallest portion (10%) of the sample. The government agencies must come to work every day so they can be placed in the categories that visit the airport daily. Table 1 indicates that this category makes up 10% of the sample from JKIA and 17% at JNIA. Cargo handlers are airline operators that provide cargo transportation service into and out of the airports. At both JKIA and JNIA you would find; Astral Aviation, Air France, Emirates, Lufthansa Cargo, Martin Air and Ethiopian Airlines. Table 1 indicates that at JNIA the cargo handlers took up the smallest portion of the sample (7%) while JKIA cargo handlers made up 13% of the sample.

Tours and travel agents make ticket bookings for travellers at the airports, arrange for hotel reservations and hire taxis. They do have offices within the airports and are residents who go in and out of the airports virtually every day. At JKIA they make up a sample of 16% whereas at JNIA the sample of travel & Travel agents are 11%. Taxi and car rental include taxis that are color-coded and reside within the airports and those that are on-line based like the Uber and little

cabs. Taxis are available for immediate hire at these airports and can be hailed at the terminals and also be pre-booked. JKIA had a sample share of 16% and JNIA carried 22% of the sample.

Finally, travellers in both the two airports have two main categories of travellers; international and domestic travellers. Table 1 indicates that travellers made up the largest portion of the sample from JNIA. It is not possible to predict when a traveller will get to the airport therefore the travellers can logically be placed in the category whose visits to the airport are sporadic. At JKIA they make up 20% of the respondents while at JNIA they make up 22% of the sample (Table 2).

Table 4. 2: Frequency of Motor Vehicles visiting at JKIA and JNIA

Frequency	JKIA	JNIA	Difference
Sporadic	20 %	22 %	2%
Once a month	18 %	14 %	4%
Once a week	10 %	16 %	6%
Once every two days	14 %	12 %	2%
Once a day	38 %	36 %	2%

Source: Survey data, 2017

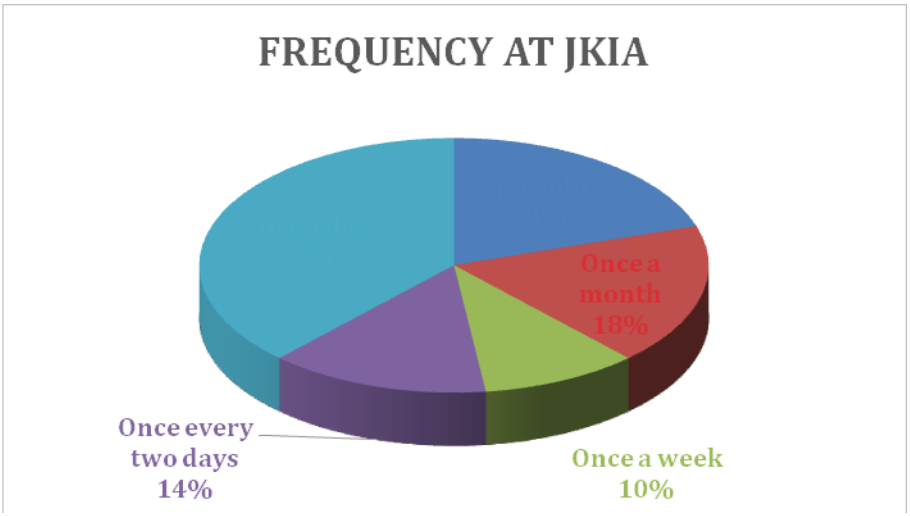

Figure 5: Frequency of visit at JKIA

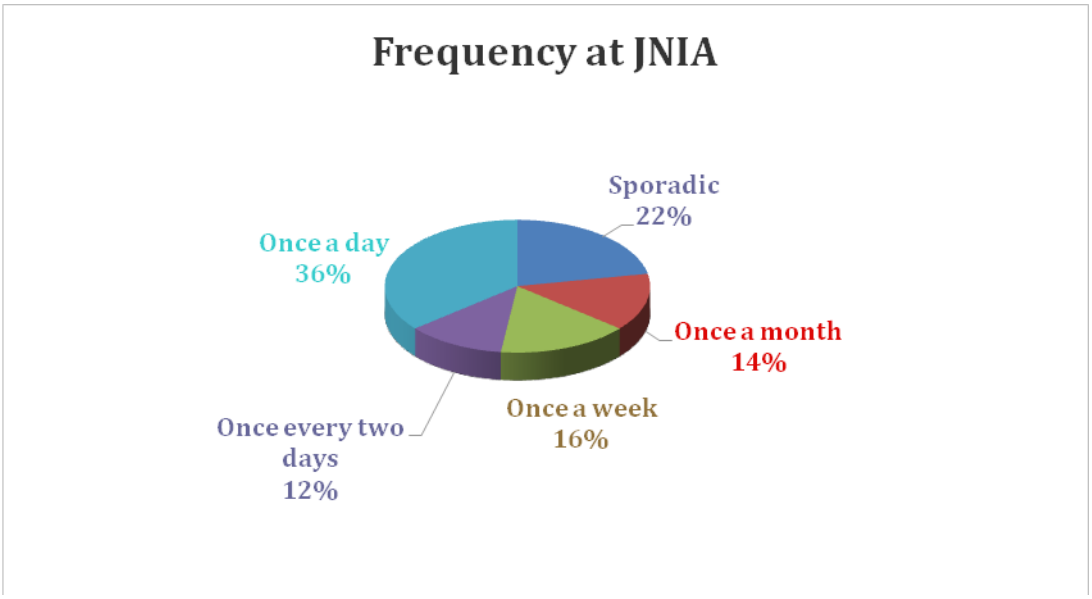

Figure 6: Frequency of visit at JNIA

Source: Survey data, 2017

The data shows that the two airports have more than a third of the traffic visit the airports once a day with about 20 % that is sporadic. According to the respective airport managers of the airports, those who visit once a day include the airline operators and the government agencies that are residents to the airport. Table 2 indicates that this category makes up 38% of the sample from JKIA and 36% at JNIA. They believe that the sporadic group is comprised of the travellers. The categories of visitors appear to be relatively similar in proportion across the two airports and Table 2 shows that there is no category where the difference is more than 6%. Fig 2a & 2b show a striking similarity of the frequency of vehicles visiting the airports.

At Heathrow international airport which is the third busiest airport in the world after Atlanta in the US and Beijing, China, the daily traffic levels are approximately 150,000, with 60% of vehicle movements passenger-related. Taxis represent less than 35% of passenger trips but they contribute to over 90% of passenger-related vehicle movements. As a result, behavioral measures have been developed specifically to reduce these movements, resulting in only marginal increases in passenger-related vehicle trips, despite total passengers increasing. The airport has managed to have a substantial shift in staff travel choices as a result of the proposed

improvements to the public transport offer, by limiting staff car parking supply. These measures have helped to raise employee public transport mode share to 40%, increasing car sharing, and reducing single occupancy car use to below 50%.

3.3 Time taken by vehicles into and out of the Jomo Kenyatta and Julius Nyerere International airports

This section will address the first specific objective of the study, which was to determine the time taken by vehicles into and out of the Jomo Kenyatta and Julius Nyerere International airports. The parameters to be interrogated are traffic destinations and the causes of delay at each point; time taken from the security desk to the terminal; time taken to exit the airport on leaving the terminal; Perception of time taken at the airports.

Table 4. 3: Time taken to get into the airport after arriving at the first security check area

Time taken	JKIA Cargo	Main passenger	JNIA Cargo	Main passenger
Less than 1 Minute	16 %	13 %	71 %	67 %
Between 5 - 10 Minutes	78 %	72 %	27 %	33 %
More than 20 minutes	6 %	15 %	2 %	0 %

Source: Research data 2017

Table 3 indicates that the highest time-band taken by motor vehicles is at JKIA 78% for Cargo and 72% for passengers between 5-10 minutes, whilst JNIA's time-band of 71% for Cargo and 67% for passengers is less than a minute. This could be explained by the capacity of passengers & cargo being handled by the two airports being 7 million and 2.4million passengers respectively for JKIA & JNIA whilst Cargo handled at JKIA 144,140 Tones annually (Source: KAA Cargo traffic report March 2016) and JNIA handles 17,398 Tones annually (Source: Wikipedia) as at end of 2016.

Distinctly this study shows the huge difference between the time taken by motor vehicles going through JKIA and JNIA. Standing out is the more than 20 minutes sitting at 15% for JKIA in comparison to 0% at JNIA. This could be explained by traffic order at the designated parking areas at the 2 airports. JKIA allows for double packing at the passenger dropping zones whereas

at JNIA double parking is not allowed. The parking areas at the 2 airports are managed very differently; this will cover extensively in the next objective findings.

Table 4.4: Summary on the layout of JKIA and JNIA

	JKIA (Source: KAA report)			JNIA (Source: TAA **Report**)		
EXITSA ARI	**CARGO**	**MAIN PASSENG**	**ACTIVITY**	**CAR(**	**MAIN PASSEN**	**ACTIVITY**
Number of Ex Barriers	3	3	Drivers stop to valid	2	3	Drivers stop to validate tickets
Number of En Ticketing Barriers	3	3	Drivers stop to pick Tickets	2	4	Drivers stop to entry tickets
Terminals	1	6	Passengers alight fr vehicles and get on/off aircraft.	1	5	Passengers aligl from/park vehic and get on/off a
Additional Security Chec	1 approx. 15 from the ent ticketing barriers	1 approx. 1 from the er ticketing barriers	Vehicles stop for se check by police/security offic	NONI	NONE	No Activity
Public Parkin Area	1	4	Designated parking Public	1	5	Designated park for the public
Reserved Parl Area	0	3	Exclusive parking a not for the public	1	2	Exclusive parki area for Cargo related vehicles

Source: KAA

The flow of traffic is further chocked by the numbers of motor vehicle ticketing barriers that obstruct the continuous movement of motor vehicles. Table 3 indicates that there are 2 ticketing barriers leading to the cargo terminal and 4 leading to the main passenger terminal at JNIA while at JKIA there are 3 barriers respectively. Whilst JKIA has 1 less ticketing barrier than JNIA at the passenger side, the traffic situation is worsened by the fact one of these barriers is designated

for cardholders who are much fewer. In addition, there is no visible signage clearly indicating to vehicle users which lane to use.

The chairman of the airport taxi association based at the JKIA ground felt that the number of ticketing barriers were few and led to the serious traffic jams experienced everyday by visitors. He said that many visitors missed their flights just trying to get into the airport.

Although JKIA has more passenger terminals, three (3) of them are currently cordoned and not in use due to on-going renovations the respondents felt that by reducing the number of available packing areas, the airport had allowed for congestion and double parking. This creates a further bottleneck to the flow of traffic in and out of the passenger terminal areas. Table 3 findings show that Public parking at cargo area at both JKIA & JNIA are one (1) respectively. The in-charge cargo also indicated that pressure that is felt at the cargo terminals are translated on to the existing parking areas of the airport. Although JKIA and JNIA have one terminal each, the cargo traffic at JKIA was larger and hence the current congestion as sited by the in-charge of cargo at the airport. Most users take long to get their cargo moved from the terminal area to the loading zones, which are currently congested. The Reserved parking at the cargo area is designated at JNIA whereas there is none at JKIA. The current representative of cargo handlers at JKIA believes that lack of reserved parking at the cargo area causes serious inconvenience to its users, airline operators say that delays in flight schedules are largely caused by the fact that cargo handlers spend a lot of time trying to get a place to park. This compounds the bottlenecks caused by ticketing as well as security checkpoints.

At JNIA, most vehicles make it to the terminals within a minute of arrival at the first security point when using the passenger gates with only a third of the number taking more than five minutes. The airport manager says that these are vehicles that are either stopped on suspicion and are taken through rigorous check. For both airports, a few more vehicles getting through the cargo gates arrive after twenty minutes. Both the airport managers at the two airports site the heavy loads carried by these vehicles and need to wait for others leaving the terminals as the main reason for this. However almost twice the number of vehicles takes more than five minutes to arrive at the terminals at JKIA passing through cargo as compared to JNIA.

4.3.1 Time taken to get Parking Space

Table 4.5: Time taken to get parking within the designated parking areas

Time taken	JKIA		JNIA	
	Cargo	**Main passenger**	**Cargo**	**Main passenger**
Less than 1 Minute	14 %	19 %	93 %	95 %
Between 5 - 10 Minutes	58 %	66 %	7 %	5 %
More than 20 minutes	28 %	15 %	0 %	0 %

Source: Survey Data, 2017

From the table above, it is clear that 58% and 66% users at JKIA cargo and main passenger side respectively take between five and ten minutes to get parking for their vehicles. This is due to a number of reasons; the extra security check at the JKIA airport which creates delay, insufficient parking spaces available around the terminal areas, vehicles double-parking within the parking areas making it difficult to get into and out of any free space. According to the security in-charge, the only persons who get to park with ease are the VIPs who include very senior members of the management team who have reserved parking spaces.

At JNIA, most vehicles make it to the terminals within a minute of arrival at the first security point. The airport manager there said that this situation only changes whenever there is a problem with the system at the entry, which happens rarely. The terminals also have ample parking spaces with reference to the average traffic per day.

Figure 7: JKIA parking area

Figure 8: JNIA parking area

Source: KAPS files

4.3.2 Time taken by vehicles to exit the airport upon leaving the parking area

Table 4.6: Time taken to exit the airport upon leaving the parking area

Time taken	JKIA		JNIA	
	Cargo	Main passenger	Carg o	Main passenger
Less than 1 Minute	28 %	18 %	74 %	69 %
Between 5 - 10 Minutes	70 %	66 %	24 %	31 %
More than 20 minutes	2 %	16 %	2 %	0 %

Source: Survey Data, 2017

Table 6 is almost a mirror image of Table 5 with JKIA indicating the highest amount of time taken at both Cargo 70% and passenger 66% areas being way higher than the same time band at JNIA. Indicators of JNIA at Cargo 74% and Main Passenger 69% taking less than 1 minute to exit. This study shows that the impact of the delays at entry is a direct reflection or derivative of the delays at exit. Although the distances between the terminal areas and the main passenger exits are not much different, more than thrice the number of vehicles is able to exit within a minute passing through the passenger main gates at JNIA as compared to JKIA. The operations manager Kenya airports parking services at JKIA believes that this is due to the problem of double parking with further delays experienced at the pay points that are few and not well located with most drivers having to walk to the pay points to make their payments.

For vehicles that leave the terminals through cargo, more than twice the number of vehicles is able to exit within five minutes at JNIA as compared to JKIA. The airport manager at JNIA feels that there are few vehicles going through the cargo side of the airport. On the contrary, his counterpart at JKIA believes that most delay is as a result of congestion at the cargo terminal parking areas with most vehicles having to wait to be given clearance to exit.

Figure 9: Traffic in and out of JKIA

Figure 10: Traffic in and out of JNIA

Source: JKIA/JNIA reports

The throughput in this study is defined as: "the time taken by a vehicle to travel into and out of the airport through the terminals." It is determined by measuring the flow rates for each section of the airport between points of entry, terminals and exits.

From the above two tables (Table 5 and 6), the throughput at JNIA is much better than that at JKIA for both the cargo and the main passenger gates. This is as a result of a combination of Capacity for both Cargo & passenger, number of vehicles passing through, the infrastructure layout and lack of some critical infrastructure such rail, poorly laid out signage, too many security

checkpoints, insufficient parking spaces and lack of efficient and sufficient modern Airport traffic management technology at JKIA. This means that an average traveller would take averagely twice the time to enter and exit the airport at JKIA compared to one at JNIA.

Figure 11: Lagos Airport, Nigeria

In comparison to other African International Airports, the layout of roads into and out of the airports have been laid out in

Source: Google shatterstock images

Such a manner that traffic flow is eased. Lagos international airport in Nigeria for example is laid in such a way that there are points of diversions that lead to specific terminals, reducing clogging of same pathways leading to all terminals clear.

Major airports like Heathrow international airport, Atlanta in the US and Beijing, China have ensured that visitors are able to arrive to the airport with much ease. They have employed the use of modern non-intrusive techniques for security checks that do not require vehicles to stop or users to alight from the vehicles for scanning. They have embraced the use of advanced online booking for parking spaces, ensured that the roads leading into and out of the airports to allow for more than six lanes to ease congestion.

Most of their parking areas are also designed to abide by the generally acceptable international standards where parking angles used at the airport car parks have 90-degree angle parking which aid in two-way movement.

4.3.3 Perception of Time Taken to enter and exit the Airport

Table 4.7: Perception of time taken at the airport

Time	JKIA	JNIA
Too much time	88 %	2 %
A reasonable amount of time	10 %	42 %
Very short time	2 %	56 %

Source: this study

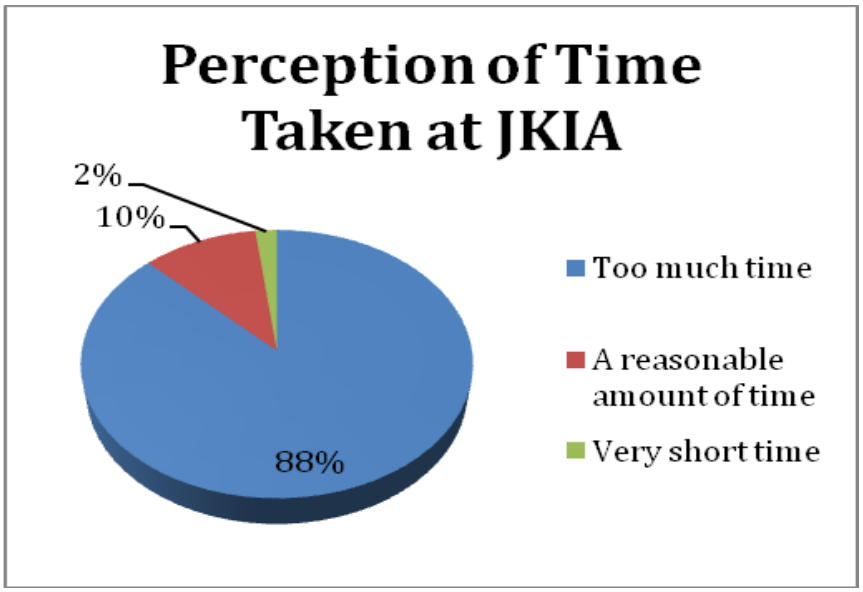

Figure 12: Perception of time taken at JKIA

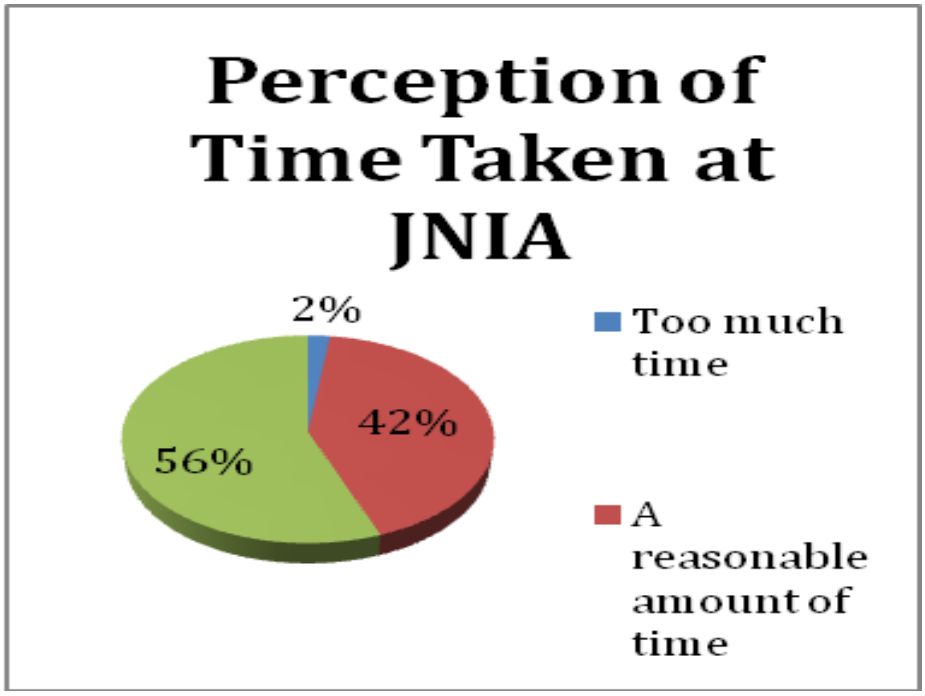

Figure 13: Perception of time taken at JNIA

The figures 6a and 6b above show a sharp contrast in the perception at the time taken at the JKIA and JNIA. Majority at JKIA feel that it takes too much time to enter and exit the airport while on the contrary, at JNIA only 2 % feel the same. Most users feel that it takes a very short time or reasonable amount of time to enter and exit the airport. Only 10 % or less shares the sentiments at JKIA with only 2 % feeling that it takes a very short time. O.R. Tambo International Airport is the largest airport in Africa. This airport has a massive demand on road infrastructure and parking facilities as a majority of travelers get to the airport by motor vehicles. They have managed to reduce their traffic flow time through multiple entry and exit routes, designated parking lots as shown in the rendition below before this average time taken before parking or getting to terminal was 8 minutes). In addition, very clear and visible signages have been of great help guiding drivers to take correct lanes.

4.3.4 OR Tambo International Airport

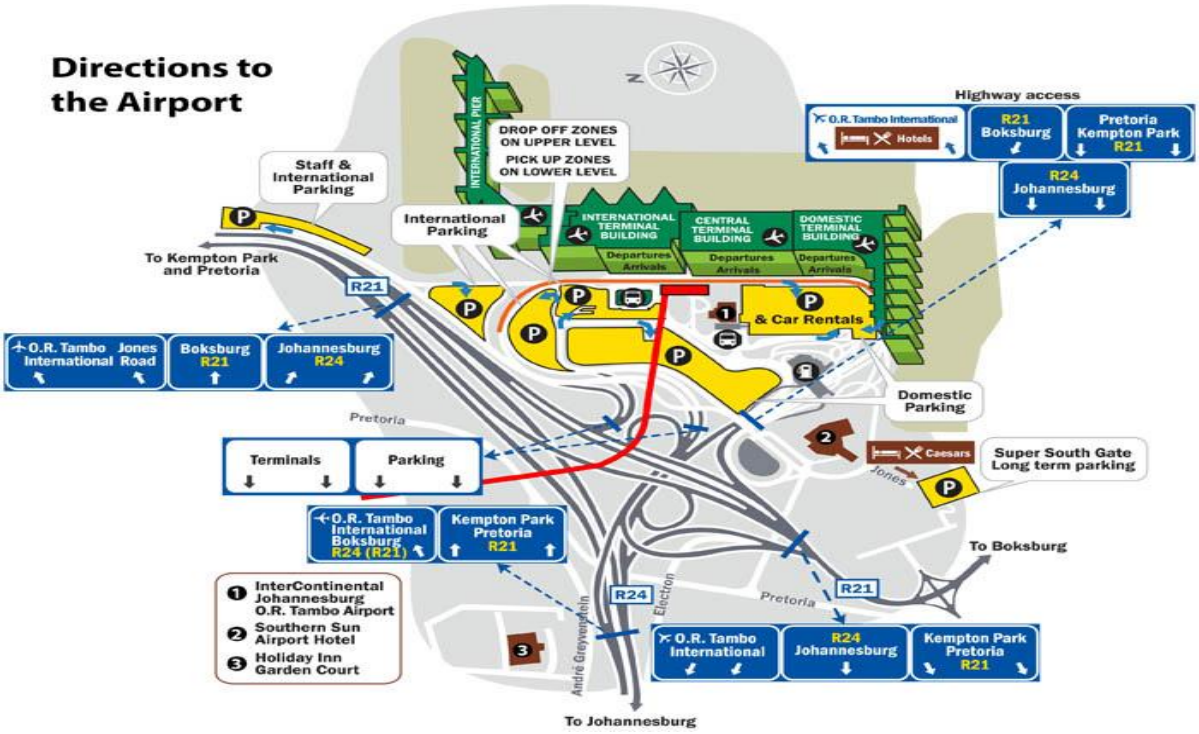

Figure 14: OR Tambo terminal/parking layout

International airports in USA, Europe and Asia use vehicle guidance system (VGS) to make it easy for drivers to locate vacant parking spaces with ease leading to little time wasted between the entries and the terminals. To find vacant spaces, drivers look at LED display boards, which indicate how many vacant spaces, are available and in which designated parking areas.

Major airports like Heathrow international airport, Dubai, Atlanta in the US and Beijing, China have ensured that visitors are able to arrive to the airport with much ease. They have employed the use of advanced online booking for parking spaces, ensured that the roads leading into the airport are large enough to allow for more than six lanes, ensured that all the lanes are fitted with long range radio-frequency identification to avoid stopping of vehicles and encouraged the use of other means such as train and buses to ease congestion.

Figure 15: Dubai International Airport

Figure 16: Beijing International airport

Figure 17: Heathrow International airport

Source: Google shatterstock images

The world's top three busiest airports, Dubai International Airport, Beijing Capital International Airport, and London Heathrow Airport have addressed such problems by ensuring that there are more than six lanes to be used by vehicles both at the entry and the exits. Also The Airport Surface Movement Program (ASMP) is put in place to provide familiarization with the layout of the terminals and taxi areas, airport signage, marking and lighting, proper aviation communication procedures and general procedures are also put in place. All the parking areas have proper signage that conforms to the international standards in terms of size and color.

They have ensured that security checks are non-intrusive and done by underneath scanners that do not require vehicles to stop or passengers to disembark from the vehicle. Most international airports have devised and implemented solutions that enhance free flow of movement in and out of the airports such as separate bus lanes; at JKIA and JNIA this is not the case as all lanes are shared, designated central bus stations; there are none as both airports only have bus stops, trains between terminals and in and out of the airports; the two airports in the study do not have any such infrastructure, increased seating capacity for trains that are double deck (Zurich) and double deck buses (London), encourage carpooling and sharing, and finally a special road pricing and tax on departure and arrival terminals/levels. It is therefore clear that whilst JNIA seems to be managing better than JKIA, which has about three times more passenger traffic; both airports are way below the international standards. The two airports need to put into consideration the free flow of traffic in their infrastructure planning. The study also shows that the time taken to move in and out of

JKIA is too long and requires re-evaluation of the enablers of streamlined traffic movement. In addition, considerations should be given to alternative means of transportation to service the airports and the terminals.

4.4 Efficiency in the Usage of Designated Vehicle Parking Spaces at the Airports

The second objective of the study was to examine the efficiency in the usage of designated vehicle parking spaces at the two airports. The parameters to be interrogated were; parking spaces used, time taken to get parking space, clarity of parking signage, negative attributes of parking at the airports, positive attributes of designated parking spaces at the airport, ease of exiting the parking areas, the views on time taken to get parking space at the airport and tariffs charged.

4.4.1 Parking spaces at JKIA and JNIA

The study sought response on parking space through interviews, questionnaires and observations. The findings are presented as shown in table 8.

Table 4.8: Parking spaces/arrangement classification at JKIA and JNIA

Designation	JIKA Marking	No. of Spaces	JNIA Marking	No. of Spaces
Long Term Parking	P3	250	P4	300
Free/Card Holders Only	P4	270		0
Casual Parkers 1	P5	300		0
Casual Parkers 2		0	P1	400
AOC Members	P6	260	P2	600
Staff Only	P8	320		0
Staff and AOC members		0	P3	900
Casual Parkers	P9	200		0
Casual Parkers	P10	700		0
Casual Parkers	P11	800		0
	Total	**3100**		**2200**

Source: Research Data, 2017

Table 8 clearly articulates the glaring differences in parking allocations and the number of designated parking spaces. Whereas JKIA has a 30% more designated spaces compared to JNIA most of the parking spaces are not in use and the difference of 25% more in number of vehicles

serviced makes the situation even worse. Based on the study findings in objective 1, JKIA has been suffering from traffic snarl-ups due to these parking lots that are inactive because they have been cordoned. The Passenger numbers as cited in the objective one show that JKIA handled about three times more passengers compared to JNIA as at end of 2016 yet the parking spaces are not proportionate with only the difference of about 30 % with some inactive.

The arrangement of the parking spaces at the two airports is quite different, with three parking areas cordoned off after the inferno in 2013 and not in use, JKIA has a greater part of the remaining parking areas a distance from the terminal areas. The two large parking areas P10 and P11 whose location is far from the terminals have no means available to move visitors between the parking areas and the terminals. They are rarely in use as most visitors avoid walking for long distance with their luggage to and from the terminal area.

JNIA on the other side has fewer parking areas but large in size and all of which are located around the terminal area and in use. The casual parking area around the terminal area has more than thrice as much the number of spaces compared to that at JKIA. This means that most visitors getting into the airport are able to get parking spaces with ease.

4.4.2 The volume of traffic at the Cargo and the Main Passenger gate at JKIA

Table 4.9: Gate usage at JKIA and JNIA

	JKIA		JNIA	
	Cargo	Main Passenger	Cargo	Main Passenger
Weekdays	40 %	60 %	20 %	80 %
Weekends	25 %	75 %	15 %	85 %

Source: Research Data, 2017

From the above table 9, it is clear that there is a higher proportion of traffic flowing through the main passenger gates at JKIA compared to the cargo gates; during the weekends, the numbers are higher with 75 % of the traffic flowing through the main passenger gates. This leads to a lower throughput during the weekends for vehicles that are passing through the main passenger gates.

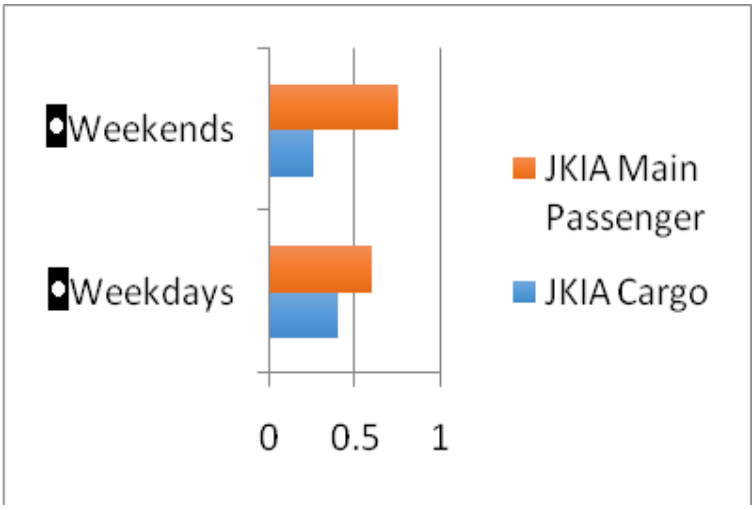

Figure 18: Gate usage at JKIA and JNIA

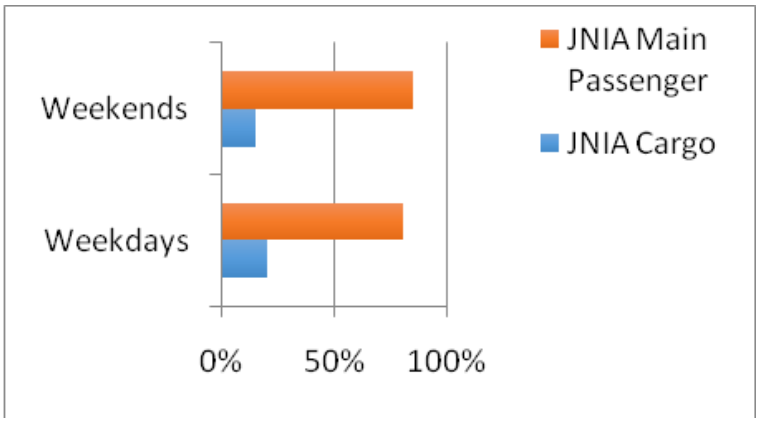

Figure 19: Gate usage at JKIA and JNIA

Source: Research Data, 2017

4.4.3 The volume of Traffic at the Cargo and the Main Passenger Gate at JNIA

The table 9 shows that the proportion of traffic flowing through the main passenger gates is much higher than that going through the cargo gates with almost similar numbers for both weekdays and weekends. This leads to a much higher throughput for vehicles going through the cargo gates.

Conditions of designated parking signage

Table 4.10: Clarity of Parking Signage

Signage	**JKIA**	**JNIA**
Adequate	70 %	82 %
Legible	45 %	40%
Well Positioned	60%	90 %
Adequate Signage on disabled/ambulance	10 %	40 %
Average efficiency score for parking signage	42%	63%

Source: Research Data, 2017

While most respondents at both JKIA and JNIA 70 % and 82 % respectively felt that the level of parking signage was adequate they said that that of disabled and reservation for ambulance 10 % for JKIA and 40 % for JNIA. Almost a similar number of respondents in both airports felt that the available signage was not legible as they were clouded by commercial adverts.

At JNIA the average efficiency score of parking signage was 63% while at JKIA it was 46%. This implies that signage at JNIA is more helpful than at JKIA for traffic that is searching for parking.

Figure 20: JNIA signage condition

Figure 21: JKIA signage condition

Source: KAPS files

4.4.4 Perceived ease of locating parking

Table 4.11: Ease with which to locate parking signage

	JKIA	JNIA
Very easily	12 %	65 %
Easily	37 %	23 %
Difficult	39%	12 %
Very difficult	12 %	0 %

Source: Research Data, 2017

There is quite a big difference on how the visitors at the two airports feel about the ease or lack thereof locating parking spaces. At JNIA, the majority is happy and feels that it is very easy to find a parking space with only 12 % having a contrary view. On the other hand, at JKIA, the majority; more than 50 % feel that it is quite difficult to locate a parking space.

4.4.5 Negative attributes of parking at the airports

Table 4.12: Negative attributes

Attributes	**JKIA**	**JNIA**
Congestion at the entries/exits	62 %	11 %
Delays due to lack of order at the terminal parking areas	21 %	3 %
Difficulty finding parking space due to Insufficient signage	35%	5 %
Average score of negative attributes	39%	6%

Source: Research Data, 2017

Some of the negative attributes of parking at the two airports noted included; congestion at the entries and exits. This was noted especially at the JKIA where the majority felt that there was always congestion at both the entries and exits. At JNIA, only a few visitors complained of congestion especially during rush hours when more than one flight arrives and when flights are about to depart. Quite a number of visitors at JKIA complained of delays due to lack of order at the terminal parking areas. At JNIA, very few 3 % felt that this was the case. A good number of visitors at JKIA felt that whenever they visited the airport, they were faced with difficulty in finding the correct parking area/spaces due to insufficient signage as residents occupied most parking areas. At JNIA, most visitors were happy with the level of signage and had ease in locating the correct parking area/space.

Negative attributes of parking such as; congestion at the entries/exits; delays due to lack of order at the terminal parking areas; difficulty finding parking space due to Insufficient signage; average score of negative attributes were interrogated and an average score of negative attributes derived. For JNIA average negative attributes score was 6% while for JKIA it was 39%. This implies that the respondents perceived JNIA to have fewer negative attributes, which can be interpreted to mean the parking, is more user friendly and efficient.

4.4.6 Positive Attributes of Parking at the Airports

Table 4.13: Positive attributes

	JKIA	JNIA
Convenience due to parking vehicle at the terminal for a long time	68 %	65 %
Security of vehicle while at the parking	71 %	83 %
Ability to self-drive	95%	92 %
The average positive attributes score	78%	80%

Source: Research Data, 2017

Some of the positive attributes of parking at the airports included the convenience visitors felt especially when they park at the designated long term parking area. Almost equal number of visitors at both the airports felt the same about this. We had more visitors at JNIA who felt that the level of security offered at the parking areas was good enough as compared to JKIA where about 12 % less felt the same. However, it was important to note that a most visitors at both the two airports were very happy to be able to self-drive to the airport during their visit. Positive attributes of the of parking such as; Convenience due to parking vehicle at the terminal for a long time; Security of vehicle while at the parking; Ability to self-drive were interrogated and an average score of positive attributes derived. The average positive attributes score was 78% for JKIA and 805 for JNIA. There is very little difference between the scores, which implies that there are an almost equal amount of positive attributes in both airports. It was clear that the efficiency in the usage of designated parking spaces at the airport was high when there was order, clear signage located at the right points with sufficient spaces allocated for users.

The differences in the emerging patterns are majorly brought about by the difference in the level of available parking spaces with reference to the level of traffic at the respective airports. The other reason is the difference in the level of signage put up within the airports with JKIA having a longer signage presence. The similarities on the other hand for the patterns was due to the similarity in the type of visitors at both airports and almost a similar pattern in the layout of the two airports with each having one end for the passengers and the other for cargo handling. The major similarity is brought about by the fact that the only means of accessing the airports is

through road transport with less than ten lanes for both passenger and cargo included for entry and exit.

4.4.7 Tariffs

Table 4.14: Tariffs Current exchange rate 14-Oct-16

Duration	JKIA (U JKIA (USD) SD)			JNIA (USD) JNIA (USD)		
	Salon cars	SUVs	Lorries/ Buses	Salon cars	SUVs	Lorries/ Buses
0-60 min	0.6	0.9	1.2	0.4	0.4	0.4
1-2 Hours	1.2	1.5	1.8	0.8	0.8	0.8
2-3 Hours	1.8	2.1	2.5	0.8	0.8	0.8
Additional hour thereafter	0.5	0.8	1	0.2	0.2	0.4
12-24 Hours	7.5	10	13	4.5	4.5	4.5
Unclamping fees	10	10	10	0	0	0
Seasonal payments (Only for authorized persons)	28	45	60	19	19	19

Source: KAPS Report 2015

4.4.7 Perception on the cost of parking at the two airports

Table 4.15: Cost of parking at the two airports

Perception	JKIA	JNIA
Very low	0 %	4 %
Low	1 %	13 %
Fair	9 %	74 %
High	55 %	7 %
Very high	35 %	2 %

Source: Research Data, 2017

From the data analysis, more than 90 % of the respondents felt that the cost of parking at the JKIA was either high or very high while less than 10 % felt the same at JNIA. The amount to be paid at JKIA compared with that at JNIA increases with time to a point where staying between 12-24 hours has a ratio of 2:3 with JKIA on the high point for the salon cars category. This difference is much wider for the lorry/busses category with a ratio of 1:2 in the 2-3 hour band and 1:3 for the seasonal packers category.

4.4.8 Global Trends

Globally, most airports much larger than the two, JKIA and JNIA have visitors access the airports not only by road but also rail, which reduce the level of vehicles getting into the airports. Most of these airports have large parking garage, which provide ample parking spaces for the vehicles. The garage are located a distance away from the airport terminals with buses availed to move visitors to and from the terminals. The system used within the garage is the valet in which visitors leave their car keys behind and designated drivers park vehicles on their behalf. This saves the visitors a lot of time that would otherwise be lost while parking the vehicles.

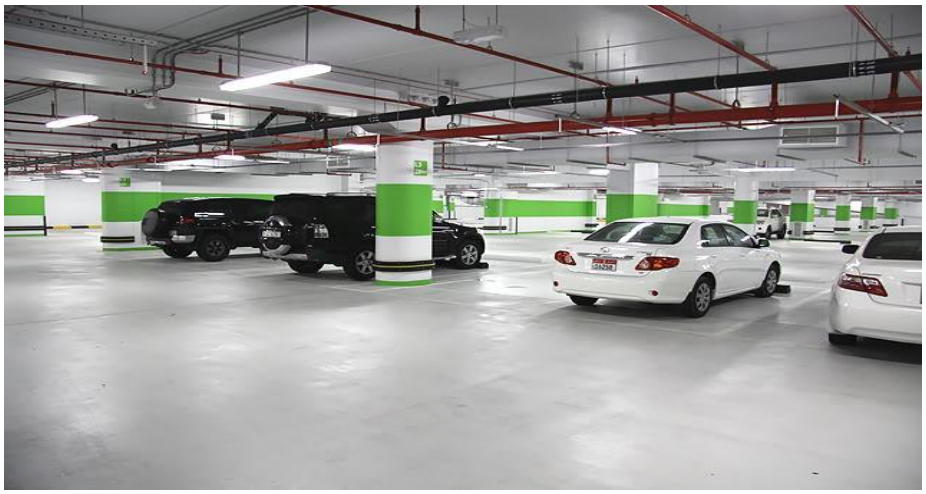

Figure 22: Dubai international airport

Figure 23: OR Tambo international airport

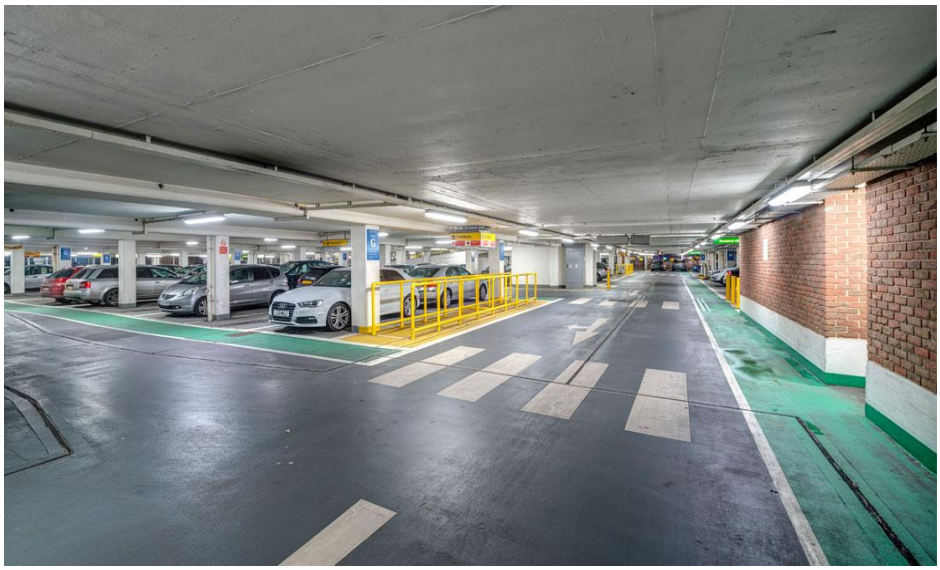

Figure 24: Heathrow international airport

Source: shatterstock images

According to the international standards, signage is used to control and guide traffic and to promote safety within the airport and should only be used where they can usefully serve these functions. There are three main classes of road signs and each class has its basic shape and the use of certain colors is restricted to particular classes of signage. The three classes are:

Regulatory Signs, which include all signs, which give notice of requirements, prohibitions or restrictions. They may be either mandatory or prohibitory. Regulatory signs are basically circular in shape and may be supplemented by plates beneath them augmenting the message given by the sign. The signage at both the two airports is of the same color and shape; for example, at JKIA the signage is all blue to reflect the authority's color while at JNIA the signage is yellow.

Figure 25: Standard regulatory signs

The second case entails the warning signs, which give warning of a hazard ahead. The design of most warning signs is based on an equilateral triangle having its apex uppermost. Rectangular plates giving additional information as may be necessary sometimes supplement them. The

existing warning signs at both the airports are rectangular in shape and do not conform to the standards.

Figure 26: Standard-warning signs

Finally, there are Informatory signs, which normally give road users information about the route and about places and facilities of particular value or interest. Most informatory signs are rectangular but direction signs usually have one end pointed. The informatory signs at both airports do provide users with the desired information although JNIA has a higher level coverage with 82% of visitors agreeing with the level of coverage as compared to JKIA which has 70% of visitors feeling the same (Table 10).

Figure 27: Standard traffic signs

At Atlanta International Airport like most major airports, the cost of parking is considered by users as friendly. Hourly Rate has a free for the first 30 minutes; $1.00 per hour with a maximum daily rate of $ 6.00, and daily rate of $1.00 per hour with a maximum daily rate of $ 6.00. **Long Term/Remote Parking** Rate of $3 per 24-hour period is designed for travellers parking for 48

hours or longer for improved convenience while **Curbside Valet at the r**ate of $4.00 is designed for the first 30 minutes and $1.00 for each additional hour with a maximum daily rate of $19. Finally, **Business Valet is designed for a r**ate of $4.00 for the first 30 minutes, $1.00 for each additional 30 minutes and $10 for first 24-hour period. **Global standards indicate that a**ll parking space requirements for the total number of parking spaces required shall be rounded to the next highest number of usable parking spaces. JNIA seem to be fine in this regard but may be strained in the near future with increase of traffic. JKIA on the other hand is far off the set standard due to insufficient parking spaces. The standards also note that each terminal should have its own parking area with adequate parking spaces to serve the traffic. Both JKIA and JNIA have not followed this standard as they have a general parking area that serves all the terminals. Finally, it is required that all parking areas must have a visible vehicle parking system to allow drivers to find empty parking space.

Both JKIA and JNIA have a design in the parking areas that encourage congestion since all the parking areas are located in the same areas around the terminals. Although JNIA is currently able to handle the traffic well within the parking areas, both the two airports have very few parking spaces with reference to the traffic that they are handling and might have to handle in the near future. It is also very difficult for a driver to tell where there is a free parking and therefore leads to a lot of time wastage.

Figure 28: Parking area using VGS sensors

Figure 29: VGS screen

Figure 30: Ultrasonic LED Sensors

Source: OR Tambo case study - Report No. 090806051117

The two airports especially JKIA should avail means of moving visitors to and from the terminals, while the design of the parking areas should be a redesigning of the parking areas to allow for each terminal to have its own parking areas.

4.5 Level of Security offered by the Current Traffic Management system at JKIA and JNIA.

The third objective of the study was to examine the level of security offered by the current traffic management system at JKIA and JNIA. The parameters to be interrogated were protection level, security standards, and threat level and risk acceptance.

4.5.1 The level of security offered by the traffic management

Table 4.16: Level of security at JKIA and JNIA

	JKIA		**JNIA**	
	Cargo	Main passenger	Cargo	Main passenger
Secure	71 %	64 %	67 %	64 %
Not Secure	16 %	14 %	7 %	5 %
Very Secure	13 %	22 %	26 %	31%

Source: Research Data, 2017

Table 16 indicates that the respondents at both JKIA and JNIA Airports felt secure. Most visitors at both airports felt that the level of security was higher at the cargo side (JKIA 71% & JNIA 67%) as compared to the passenger side, which were at par with both JKIA and JNIA scoring 64%. At JKIA however, fewer visitors were not secure given the security standards and protection offered compared to JNIA where less than 10% felt not secure. JKIA has additional security checks or both cargo and passenger terminals that do not exit at JNIA. This is located about 150 meters from the entry ticketing barriers and are a cause of delay. Although the head of airport security insisted that having an extra security check was very necessary, most the operation's manager with the Kenya Airports parking services differed and felt that this was a serious cause of delays, as passengers have to exit from their vehicles and walk through the metal detectors that are located away from the drive lanes. They said that whenever the traffic was high, they had to wait for their vehicles after going through the metal detectors for unnecessarily long time.

There is a difference in the cargo traffic flow between JKIA & JNIA. Table 3 shows the number of ticketing barrier entries at the cargo side at JKIA are 3 whereas JNIA has 2 ticketing entry barriers. In comparison to the handled cargo, JKIA is under pressure based on the tonnage handled which is approximately three (3) times. Logic would be to have three times the number of entry ticketing barriers to allow free flow of vehicles. The airport manager at JKIA admitted that the three ticketing barriers at cargo side were currently under a lot of pressure from the traffic and was not sufficient since the airport is a major port serving a number of countries' cargo other than its own.

4.5.2 The number of visitors who have lost their vehicles, property at the airport or had vehicle damaged

Table 4.17: Loss of property and vehicles at JKIA and JNIA

Losses	**JKIA**		**JNIA**	
	Cargo	Main passenger	Cargo	Main passenger
Loss of property	3 %	1 %	1 %	0 %
Loss of vehicle	0 %	0 %	0 %	0 %
Damage on vehicle	11 %	7%	5 %	3%

Source: Research Data, 2017

Both JKIA and JNIA had no confirmation of cases of lost vehicles however a good number said that they had their vehicles damaged at the parking area. JKIA reported a slightly higher figure as compared to JNIA although in both cases it was clear that the cargo area was more affected than the main passenger area; at JKIA cargo had 3 % compared to main passenger side while at JNIA cargo had 1 % with none at the main passenger side.

4.5.3 Perception on safety at the airports whenever there is traffic jam

Table 4.18: Safety during traffic jam

Safety	JKIA	JNIA
Unsafe	48 %	5 %
Safe	51 %	73 %
Very safe	1%	22 %

Source: Research Data, 2017

Most visitors at JKIA felt that they were unsafe whenever there was traffic jam; JNIA on the other side had a majority feeling that traffic jam did not make them feel unsafe. While only 1 % of the visitors felt very safe at JKIA during such times, at JNIA, more than 20 % felt very safe.

4.5.4 Global Trends

Globally, most major airports adhere to very high standards of security, airports such as Hartsfield Jackson Atlanta International Airport (ATL) with an average traffic of one hundred million passengers per year, Beijing Capital International Airport (PEK) with an average of ninety thousand passengers per year and Dubai International Airport (DXB) with an average of eighty thousand passengers per year have all use biometric readers, face recognition solutions, thermal PTZ cameras which keep a close eye on targets with 14X continuous optical zoom cooled thermal camera that can detect human at 4-5km.

Figure 31: Facial recognition system

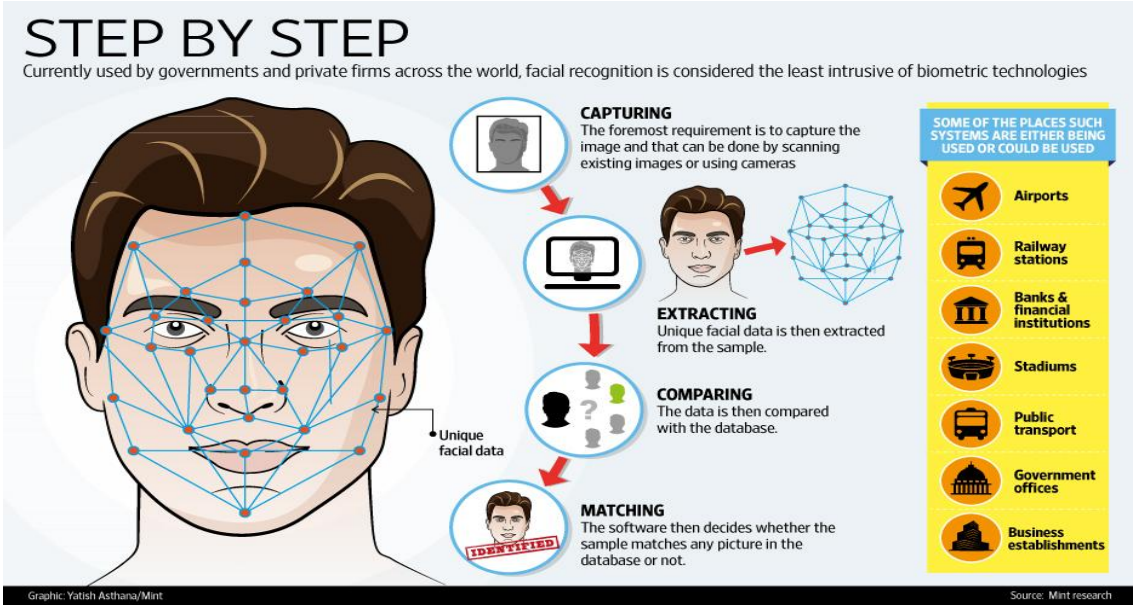

Figure 32: Thermal PTZ camera

Figure 33: Security surveillance system Dubai airport

At Heathrow and OR Tambo international airports, all places upon the airport, unless specifically established or designated for vehicular parking, is "No Parking / Tow Away" areas, and no person can stop, stand, or park a vehicle any place upon the airport other than places specifically established or designated for vehicular parking. At the entries, suspected vehicles are moved a special lane for further checking away from fast moving lanes.

Figure 34: Security check at OR Tambo

From the findings, it is clear that security at both Airports; JKIA and JNIA is satisfactory to most visitors since only 3 % or less have lost their property at the two airports. This however does not meet the global standards, JKIA has installed an under vehicle surveillance systems (UVSS) and an automatic number plate recognition (ANPR) system but integrated with each other. The UVSS solutions are designed to scan, monitor, and digitally record crisp, clear digital video images of the entire width of a vehicle's undersides all with one permanent or portable system

JNIA on the other side is still using manual handheld vehicle scanners and may need to do more to step up towards attaining the global standards.

Figure 35: Security monitoring system at OR Tambo

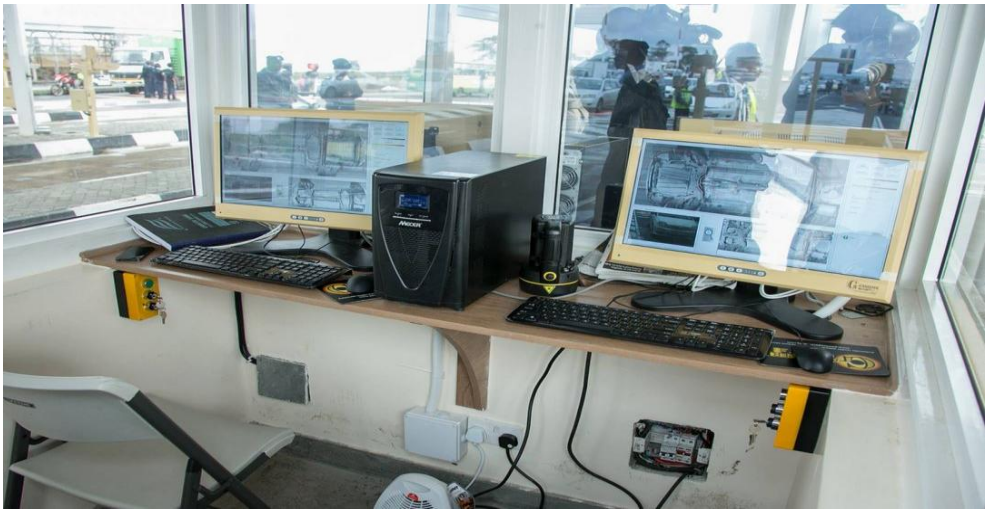

Figure 36: Security set up at OR Tambo

Source: Google shatterstock images

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMEDATION

5.1 Overview

This section of the report presents a summary of the findings per objective; it also presents the conclusions and recommendations drawn from the findings.

5.2 Summary of Findings

The first objective of the study was to determine the time taken by vehicles into and out of the Jomo Kenyatta and Julius Nyerere International airports. The study established that at JNIA 59 % of the sampled traffic was made up of travellers on self-drive, taxis, car rentals or tours and travels while at JKIA it was only 44 %. The throughput in this study is defined as: "the time taken by a vehicle to travel into and out of the airport through the terminals." It is determined by measuring the flow rates for each section of the airport between points of entry, terminals and exits. The throughput at JNIA is much better than that at JKIA for both the cargo and the main passenger gates. This is as a result of a combination of Capacity for both Cargo & passenger, number of vehicles passing through, the infrastructure layout and lack of some critical infrastructure such rail, poorly laid out signage, too many security checkpoints, insufficient parking spaces and lack of efficient and sufficient modern Airport traffic management technology at JKIA.

This means that an average traveller would take averagely twice the time to enter and exit the airport at JKIA compared to one at JNIA. The study established that time taken to get into the airport after arriving at the first security check area was much shorter at JNIA compared to JKIA .At JNIA, a majority (67%) of the respondents took less than one minute while at JKIA only 13% took less than one minute to the passenger terminal. Those going to the cargo terminal also took a shorter time at JNIA where 71% of the respondents took less than one compared to only 16% at JKIA. A majority of the respondents (78% cargo, 72% passenger) at JKIA took between 5-10 minutes. While at JNIA there were no respondent who indicated that they took more than 20 minutes to get to the passenger terminal, yet 15% of the respondents at JKIA indicated that they took more than 20 minutes to get to the passenger terminal. At JNIA only 2 % felt that the time taken to enter and exit the airport was too much while at JKIA 88 % felt the same. The

layouts for the two airports are generally similar in terms of number of entries and exits. However, a possible explanation for this difference is the additional security feature at JKIA where vehicles stop for security checks by police/security officers. Both airports can still improve on their traffic flow time through multiple entry and exit routes, designated parking lots as has been done by other international airports such as Oliver Tambo International Airport where the average time is 8 minutes. The world's top three busiest airports, Dubai International Airport, Beijing Capital International Airport, and London Heathrow Airport have addressed such problems by ensuring that there are more than six lanes to be used by vehicles both at the entry and the exits.

The second objective of the study was to examine the efficiency in the usage of designated vehicle parking spaces at the two airports. The study established that JKIA has a parking capacity for 310 vehicles while that of JNIA is 2200.Ths study also established that it takes a shorter time to get parking at JNIA compared to JKA. At JNIA most respondents (95%) took less than minute to locate parking at the passenger terminal and 93% at the cargo terminal. At JKIA only 19% took less than one minute to locate parking at the passenger terminal and 14% at the cargo terminal. There were respondents from JNIA who took more than 20 minutes to locate parking in either passenger or cargo terminals while at JKIA there were 28% and 15% respectively for the cargo and passenger terminals. Effective signage is expected to make it easy for traffic to identify/locate parking space within the airport. Both airports have adopted the internationally recommended signage in terms of shape and color. The study interrogated adequacy, legibility, positioning of the signage and used it to derive an average efficiency score of parking signage. At JNIA the average efficiency score of parking signage was 63% while at JKIA it was 46%. This implies that signage at JNIA is more helpful than at JKIA for traffic that is searching for parking. The study also established that 88% of the respondents at JNIA were able to locate parking signage very easily while at JKIA only 49% were able to do this.

Negative attributes of parking such as; congestion at the entries/exits; delays due to lack of order at the terminal parking areas; difficulty finding parking space due to Insufficient signage; average score of negative attributes were interrogated and an average score of negative attributes derived. For JNIA average negative attributes score was 6% while for JKIA it was 39%. This

implies that the respondents perceived JNIA to have fewer negative attributes which can be interpreted to mean the parking is more user friendly and efficient. Positive attributes of the of parking such as; Convenience due to parking vehicle at the terminal for a long time; Security of vehicle while at the parking; Ability to self-drive were interrogated and an average score of positive attributes derived. The average positive attributes score was 78% for JKIA and 805 for JNIA. There is very little difference between the scores, which implies that there are an almost equal amount of positive attributes in both airports. The parking tariffs were perceived as high by 90% of the respondents at JKIA and only 95 at JNIA. Both JKIA and JNIA employ the system of hourly charge only meaning that all the visitors must arrive at the airport in order to determine where they will park their vehicles and in addition, all parking facilities include handicap accessible parking spaces.

Some of the world's largest airports like Dubai and Heathrow are accessed not only by road but also by rail and this reduced the demand for parking space. The pressure on parking space at JKIA and JNIA is compounded by the fact that the only means of access to the airport is road. Most major airports use vehicle guidance system (VGS) to make it easy for drivers to locate vacant parking spaces with ease. Most major airports use vehicle guidance system (VGS) to make it easy for drivers to locate vacant parking spaces with ease. Both JKIA and JNIA do not use this system and it is also very difficult for a driver to tell where there is a free parking.

The third objective of the study was to examine the level of security offered by the current traffic management system at JKIA and JNIA. The parameters to be interrogated were protection level, security standards, and threat level and risk acceptance. The study established that level of security offered by the traffic management was the same at both JKIA and JNIA where 64% of the respondents indicated they felt the traffic management was secure. Not many respondents recorded loss of property (3% JKIA Cargo terminal and 1% JNIA cargo terminal). There were no reports from the passenger terminal of JNIA and only 1% at JKIA. Most respondents (95%) from JNIA felt safe in traffic jams in the airport but at JKIA only 52 felt safe in the traffic jam. Both JKIA and JKIA have closed circuit televisions cameras installed at all the parking areas that not only act as deterrence but also assist with security reviews. Whereas JKIA has installed a Global Standard Motor Vehicle Drive–in security scanners and the counterpart JNIA is still using

manual handheld vehicle scanners. The larger airports of the world use modern technology to enhance security including mechanisms such as; Under vehicle surveillance systems (UVSS) to enhance the efficiency of vehicle check in and out of the airports; Camera control system to scan the horizon, alter the viewing angle and allows for change of the zoom level; Long-range radio frequency identification systems (RFID) to improve the speed of vehicles in and out of the airport.

5.3 Conclusion

The throughput at JNIA is much better than that at JKIA for both the cargo and the main passenger gates. This means that an average traveller would take averagely twice the time to enter and exit the airport at JKIA compared to one at JNIA. Both airports have however not met the accepted international standards. Their uptake of technology is still relatively low compared to other international Airports. The study concludes that there is better efficiency in the usage of designated vehicle parking spaces at JNIA compared to JKIA in spite of JKIA having a bigger packing capacity. An efficiency score of parking signage and a score of negative attributes generated for this study confirmed this position. However, efficiency is compromised by the limited use of technology and the fact that road transport is the only means of accessing the airport. The low level of infrastructural development also compromises efficiency in the use of parking spaces at both airports. The security situation is generally satisfactory at both JKIA and JNIA but the passenger terminal is less secure. The use of technology is very low compared to other international airports.

5.4 Recommendations

Planning: The two airports should ensure that there are several lanes in and out of the airports (best practice six lanes Beijing). Designated lanes for different types of vehicles (taxis, buses, personal vehicles) and airport visitors (staff, passengers with and without luggage and disabled persons).

The infrastructure at the two airports needs to be improved to allow for multiple options in transportation, which would include train and underground metros.

Signage: Standard, visible, clear and well positioned signage should be placed at the correct points to improve the capacity of the drivers to move with ease into the airports, around the terminals and out of the airports.

Technology: The two airports should use modern technology such as high speed under vehicle surveillance systems (UVSS) both at the entries and exits to enhance the efficiency of vehicle check in and out of the airports.

JKIA should employ the use of long-range radio frequency identification systems (RFID) to improve the speed of vehicles in and out of the airport.

The two airports need to employ the use of relevant technology to allow drivers to locate free parking spaces with ease a good example would be the use of vehicle guidance system (VGS) using electronic sensors to detect vehicle presence through ultrasound technology. The sensors display bay availability using coloured LED lights.

More attention should be devoted to predicting, planning, monitoring, and assessing the cumulative impacts of roads existing infrastructure.

It is recommended that both JKIA and JNIA:

Implement the proposed traffic management strategy (as detailed in Fig 11- Fig 15) in its entirety in conjunction with continued monitoring of development, traffic growth and road user needs at the airports.

Revisit the proposed strategy annually, to update its works program as appropriate.

Undertake consultation with key stakeholders prior to the detailed planning and design of any element being finalized and / or implemented.

5.5 Areas for Further Research

There is need to establish the value of the additional security checkpoint at JKIA.

The effect of moving the parking areas away from the terminals.

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APPENDICES

APPENDIX I

FIRST CONTACT EMAIL

June 2016

Dear _____;

My name is Bonnyventure Saronge; I am a student at Maseno University. I am doing research on a comparative analysis of vehicle traffic flow at Jomo Kenyatta and Julius Nyerere International Airports. Jomo Kenyatta airport is currently struggling to control the vehicle traffic. This has led to congestion and serious delays at the airport. Through my research I am hoping to contribute to the underdeveloped area of research related to the understanding of the issues surrounding traffic management systems at the two airports.

You have been identified as an individual who would meet the criteria for my research. I would be grateful if you would agree to participate in my study. The survey will take approximately 15 minutes to complete. Please be assured that your responses will remain strictly confidential and that all data will be reported in aggregate and no individual information will be reported.

Please let me know if you have any questions. Feel free to call me on (254) 722 – 391-786.

Thank you again for your time.

Bonnyventure Saronge.

APPENDIX II

INFORMED CONSENT FORM

PURPOSE OF THE RESEARCH

The purpose of the study is to examine the role that Automatic Number Plate Recognition surveillance plays within traffic management and public reassurance at the airports.

The specific objective of this study is to explore the ANPR systems as perceived by the Airports Authority on its effectiveness in reducing crime, increasing operational efficiency and the confidence level of the public/visitors to the Airports.

PROCEDURES

Your participation in the research is voluntary and will take about fifteen to twenty minutes to complete. Once you confirm participation you agree you will be asked to complete the survey. After the matching procedure is competed your name will be removed to preserve your anonymity. All data will be reported in aggregate and no individual information will be reported.

RISKS OR DISCOMFORTS

There are no known risks to you as a participant. In the event of problems resulting from participation in the study, kindly inform Bonnyventure Saronge, telephone (254) 722 – 391-786.

BENEFITS

You may find the learning experience enjoyable.

CONFIDENTIALITY

Your name and other identifying information will be kept in strict confidence.

All individual results will be reported as group results. The information obtained in this study may be published in scientific journals or presented at conferences pertinent to the area. The individual identifying information will be removed and replaced with a unique numeric.

COMPENSATION

There will be no compensation for participating in this research.

OPPORTUNITY TO ASK QUESTIONS

Participants shall have the right to ask questions at any point throughout the study and the right to have those questions answered. If there are any questions or concerns about the research that cannot be answered, the participant may contact the, Bonnyventure Saronge, telephone (254) 722 – 391-786.

FREEDOM TO WITHDRAW

You are free to decide not to participate in this study or to withdraw at any time without harming your relationship with the researchers or your respective institutions. Your decision will not result in any loss or benefits to which you are otherwise entitled.

CONSENT, RIGHT TO RECEIVE A COPY

You are voluntarily making a decision whether or not to participate in this research study. Your signature certifies that you have decided to participate having read and understood the information presented. You will be given a copy of this consent form to keep.

Signature of Participant

_____

APPENDIX III

QUESTIONNAIRE

Date_____

Person Administering_____

Questionnaire Number_____

Location: [1] JKIA

[2] JNIA

Instructions

Please respond to all questions and kindly note that all responses are valued.

Section A

Category of respondents

1. Please pick the category that best describes your position at the airport

   [ ] Airline operator

   [ ] Government agency

   [ ] Cargo handlers

   [ ] Ground handlers

   [ ] Duty free and retail shops

   [ ] Tours and travel agents

   [ ] Taxi and car rental

   [ ] Forex bureau and banks

   [ ] Traveller

   [ ] Other (please specify): _____

Section B: Through-put-off vehicle traffic at the airport

2. How often do you visit the airport? (Please tick one)

   Sporadically ☐

   Once a month ☐

   Once a week ☐

   Once every two days ☐

Once a day ☐

More than once a day ☐

3. How long do you take to get into the airport after you arrive at the first security check area (please tick one)

   Less than 1 minute ☐

   Between 5- 10 minutes ☐

   More than 20 minutes ☐

4. How long do you take to exit the airport upon leaving the terminal area: (please tick one)

   less than 1 minute ☐

   Between 5- 20 minutes ☐

   More than 20 minutes ☐

5. Which entry/exits do you use? (Please tick all that apply)

   Cargo ☐

   Main passenger gate ☐

6. Which of these statements most reflects your view of the time spent getting in and out at the airport?

   Too much time ☐

   A reasonable amount of time ☐

   Very short time ☐

Section C: Conditions of designated parking lot(s) at the airport.

7. What is your view of the signage at the designated parking areas and the surrounding (please tick one)

   Adequate ☐

   Legible ☐

   Well Positioned ☐

   Adequate Signage on disabled/ambulance ☐

8. When looking for a parking space at the airport, please rate the ease with which you are able to locate the parking signage.

   Very easily ☐
   Easily ☐
   Difficult ☐
   Very difficult ☐

9. When looking for a parking space at the airport, describe the ease with which you are able to access the designated parking spaces.

   Very easily ☐
   Easily ☐
   Difficult ☐
   Very difficult ☐

10. Briefly describe some of the issues that make you uncomfortable or rather annoys you while parking at the designated areas of the airport

_____

_____

_____

11. What is it that impresses you most at the designated packing areas of the airport?

_____

_____

_____

12. Which parking area do you use? (Please tick all that apply)

   Staff parking ☐
   General Parking area ☐
   Taxi parking area ☐

13. How long do you take to get parking space within the airport upon arrival at the designated parking area (please tick one)

Less than 1 minute ☐

Between 5- 10 minutes ☐

More than 20 minutes ☐

14. Which of these statements most reflects your view of the time spent getting a parking space at the designated parking area at the airport?

Too much time ☐

A reasonable amount of time ☐

Very short time ☐

Section D: Security challenges related to traffic management at the airport.

15. Have you ever lost your vehicle at the airport?

Yes [ ]

No [ ]

16. Have you ever lost any property from your vehicle at the airport?

Yes [ ]

No [ ]

17. Have you ever had your vehicle damaged at the airport?

Yes [ ]

No [ ]

18. If Yes, specify_____

19. Do you know if any of your friends or relatives have lost their vehicle at the airport?

Yes [ ]

No [ ]

20. If Yes, specify_____

21. Do you know if any of your friends or relatives have lost property from their vehicle at the airport?

Yes [ ]

No [ ]

22. If Yes, specify the lost property_____

23. Which of the statements best describes how you feel about your safety at airport when there is traffic jam?

Unsafe [ ]

Safe [ ]

Very safe [ ]

No change in my feeling [ ]