The impact of customer focused innovative technologies on passenger growth for a domestic low-cost carrier airline

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Declaration

I confirm that the work for this research paper titled: "The impact of customer focused innovative technologies on passenger growth for a domestic low-cost carrier airline" is my own work and I hereby declare the following;

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
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MODISHA MARIBE:_____ DATE:_____

Abstract

The technological innovations that are increasingly available to air travel have increased significantly over the years since the deregulation of the airline industry within South Africa and the African continent at large. Within the low cost carrier sector of the airline industry, the competition is extremely tough and the longevity of the low cost airline is prompted by the innovative ideas that direct customers to the “no frills” mode of air travel that low cost carriers centre their business model around. The purpose of this research study is to determine the impact of customer focused innovative technology implementations on the passenger numbers of a low cost carrier airline in South Africa. The research focuses on one particular domestic low cost carrier that is known to be technologically forward thinking and that consistently endeavours to use advanced technology in the increasing competitive market within which it operates. The report provides an overview of the business models used by low cost carriers across the world and those employed by the low cost carrier at the focus of the study in South Africa. As the data is of time series in nature, the granger causality statistical model is employed to assess how the customer technology projects affect the customer numbers. The results indicate that there is a causal relationship over time between the implementation of technology and the growth of passenger numbers.

Key Words;

Low cost carrier airlines, customer focused technology, airline deregulation, airline distribution systems, computer reservation systems

To my family, thank you for the encouragement and enlightenment throughout the years.

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Nomenclature

This section defines the key terms used in this research paper.

KEY TERM	DEFINITION
LCC	Low cost Carrier
Pax	Passenger number
O.R. Tambo International Airport	Oliver Reginald Tambo International Airport situated in Johannesburg South Africa
SaaS	Software as a Service – Software provided over the cloud as a service for customers
XML API	Simple Extensible Markup Language document included in an internet protocol message body.
B2B	Business to Business Transactions
B2C	Business to Customer Transactions
EDI	Electronic Data Interfaces
ICT	Information Communication Technology
IT	Information Technology
OAG	A global travel data provider with headquarters in the UK
CRS	Computer Reservation Systems
FFP	Frequent Flyer Programme
Edcon	Edcon (Pty) Ltd is the leading clothing, footwear and textiles (CFT) retailing group in South Africa trading through a range of retail formats.
SST	Self Service Technologies
CEO	Chief Executive Officer
IBM	IBM is an American multinational information technology company headquartered in Armonk, New York, with operations in over 170 countries

SABRE	Sabre Corporation is a travel technology company based in Southlake, Texas. It is the largest Global Distribution Systems provider for air bookings in North America.
ANOVA	is a collection of statistical models and their associated estimation procedures used to analyze the differences among group means in a sample.
SITA	is a multinational information technology company providing IT and telecommunication services to the air transport industry
CAPA	Centre for Aviation

CHAPTER 1

1 INTRODUCTION

1.1 Research Background and Context

In 1991 the deregulation of the South African airline industry opened doors for the entry of low cost carrier (LLC) airlines to operate in the domestic transport environment. Since August 2001 when the first low cost carrier airline began operations several other LCC airlines have entered the domestic market thereby increasing the competitiveness of the airline industry (Mhlanga, 2017). In South Africa the competition is even more intensified as both full service and low-cost carriers are in competition for the same market (Fernando, Mat Saad and Sabri Haron, 2012), the same routes and operating from the same hubs. This suggests that LCC's have to do more to remain competitive and sustainable in order to service.

The airline studied in this report started operations in 2001 as South Africa's first low-fare airline. When it entered the market in that year with domestic market share of 4% and now currently enjoys a market share of about 20% (Lubbe, 2011). The airline was able to fill its available 750 000 seats per year in a short time period (Paelo and Vilakazi, 2016).The airline operates on major domestic routes from its hubs at O.R. Tambo International Airport and Lanseria International Airport both in Johannesburg (Comair Limited, 2018). Today the airline identifies as more than just an airline, offering customers an entire travel experience. Its ancillary offerings such as car hire, hotel bookings, holiday packages and chauffeur-driven airport cabs can all be booked online, in one easy transaction (Comair Limited, 2018).

At its inception the airline did not have much of an information technology strategy. Over the years, the application of technology in the business grew. The airline implemented small disparate systems to run their business until the decision was made to implement an airline enterprise resource planning system. In 2012 the airline implemented a new technology to manage their airline reservation system from Sabre Airline Solutions (Sabre). Sabre is an airline solution that offers a broad range of software and data solutions to help airlines market themselves, sell products, serve customers and operate more efficiently (Sabre Airline Solutions, 2018a). These encompass an airline reservations system, and a full suite of marketing and

commercial planning software and enterprise operations solutions. Sabre provides its services to about 225 airlines globally including low-cost carriers, primarily through Software as a Service (SaaS) and hosted models platforms (Sabre Airline Solutions, 2018).

1.2 Research Problem Statement

The low-cost carrier (LCC) airline market is highly competitive and becoming more so every year. Since the deregulation of the airline industry in South Africa in 1991 some LCC's have entered the market over the years and have had to compete rigorously to remain in the market(Paelo and Vilakazi, 2016). In 2012 two LCC airlines ceased operation and with the introduction of a new LCC in 2014 the domestic competition has again intensified. Airlines need to improve their sustainability through innovative means (Paelo and Vilakazi, 2016). For the sustainability of LCC's there is much to be considered for success of its continued operation and the airlines main objective of revenue optimisation and improving customer relations (Kelemen, 2003). Organisations have identified the use of IT to gain a competitive advantage by providing new and useful services to their customer base (Feeny and Ives, 1990). Technology is, thus, one such innovative tool that a LCC can use to enhance its operations and product offerings and maintain relevance to its consumers.

Many companies invest and transfer vast amount of resources (i.e. money, human capital, facilities, time) for their self-service technologies (SST's) to provide and enhance their services. They need to extract as much benefits in return for their efforts. Therefore, providing, maintaining and increasing the customers' actual usage of SST is very important for the companies (Gures et al., 2018).

Technological advances have made innovations in passenger processing (including in-flight entertainment) possible, at a continuously increasing pace particularly over the past ten years. Airlines need to consider such innovations and how they can derive value from them. The main questions the airlines have had to ask themselves are (Belobaba et al., 2009):

1. will investment in these new technologies reduce costs, improve productivity and/or increase revenue
2. can implementation lead to greater passenger satisfaction and even improve brand loyalty

The rationale for the study is to investigate whether customer focused innovative technology[1] contributes to the passenger growth of a LCC airline. The airline that was researched will be referred to in this report as Standard Air.

1.3 Research Question

Based on the research problem statement outlined above, the following research question is to be considered:

What is the relationship between implementation of customer-oriented innovative technology and the passenger growth for low-cost carrier airlines?

1.4 Research Objectives

1.4.1 Main Objective

The main objective of this research study is to determine whether there is a relationship between the implementation of innovative customer-oriented technologies and the growth of passenger numbers of a specific low-cost carrier airline between 2007 and 2017.

[1] Innovative technology is new, advanced, and/or creative technology
https://definedterm.com/innovative_technology

1.4.2 Specific Objectives

The following specific objectives have been developed from the main objective of the study;

1 To quantify the passenger numbers before the month in which customer-oriented technology changes were implemented and in the month(s) after
2 To determine the impact of customer-oriented technology implementations on passenger numbers
3 To determine the impact of customer-oriented technology implementations on revenue generated over the same time period.

1.5 Summary of Research Methods

A quantitative research method was employed for this research. An analytic approach was taken to investigate the numerical data that would be collected. The type of data collected was derived or compiled data as it was from existing data gathered from different data sources. An informal conversation interview was held with a subject matter expert to gain insight of the data, review and understand the meaning of the data. Once the required data was collected it was transformed to a desired format to be better analysed and used in a selected statistical analysis tool.

Ethics clearance was obtained though the School of Mechanical, Industrial and Aeronautical Engineering Ethics Committee. The Ethics clearance number is MIAEC 025/20.

1.6 Delimitations

This research only looked at the different technology implementations that introduced only solutions that customers of the airline can directly engage or interact with. The research will not assess the impact on passenger numbers or revenue of the following technology implementations;

1. infrastructural upgrades;
2. implementations to improve airline ground operations and
3. implementations that customers do not directly interact with even if they enhance the customer experience.

Academically, literature on the African air transport market is scarce even though air transport in Africa shows promising future prospects. Data, particularly for the area of research is mostly not available or quite fragmented making it a challenge to analyse (Meichsner et al., 2018).

The limitation in the exploration of the research material is that although low cost airlines across the globe have introduced different technologies and technology aided business partnerships, no studies could be identified on the effect of customer facing technology on customer growth of that airline.

There are also other existing confounding variables that may affect the assessment of the impact of the technology intervention implemented through the sample size. Confounding variables may obscure and confuse another observed variable and may make unclear if the actual treatment caused the effect (Ewert and Sibthorp, 2009). These include marketing communications, Sales day and public holidays or major events in and around the cities where Standard Air flies to.

1.7 Outline of Chapters

The table below will outline the chapters of this document and give a brief description/structure of the content of the chapters.

Table 1: Outline of Chapters and content description

SECTION	CONTENT
CHAPTER 1	**Introduction & Background** Background and high level context Problem Statement Research Question and Objectives Summary of Research Method
CHAPTER 2	**Literature Review** Literature review of the research
CHAPTER 3	**Research Methodology** Research design overview Sampling and Instrumentation Data collection and analysis procedures Reliability and Validity

	Ethical Issues ad Clearance
CHAPTER 4	**Data Analysis and Results** Statistical Analysis of the data Documentation of the results
CHAPTER 5	**Discussion** Interpretation of the documented results
CHAPTER 6	**Conclusions and Recommendations** Present conclusions derived from the interpreted results Recommendations of future work

1.8 Conclusion

Chapter 1 introduced the reason for the study and provided background information of the topic. This chapter also presents the research problem, question, objectives and delimitations of the study. An outline of the chapters in this paper are also provided in this chapter.

CHAPTER 2

2 Literature Review

This literature review will explore innovative technologies and internet technologies that are geared more at customers of the low-cost carrier airline industry and how they affect passenger growth in this segment of the airline industry.

2.1 **Low cost carriers in the African context**

Until deregulation in 1991, almost all African airlines were state owned and primarily run as government entities. They had strong entrenched purist policies combined with a poor commercial focus and solely dedicated on providing full service carrier products to its customer base (Meichsner et al., 2018).

Low-cost carriers are slowly starting to penetrate Africa's regional international market. LCCs currently only account for about 0.2% of international capacity within Africa, the last frontiers for the global LCC sector. By October 2013, LCCs had accounted for about 11% of total capacity (domestic and international) within Africa, compared to a system-wide LCC penetration rate of approximately 37% within Europe, 30% within North America, 34% in Central/South America and 24% within Asia-Pacific, according to OAG data (CAPA, 2013).

The graph below highlights the LCC capacity share, as a percentage of total seats, within Africa between 2001 and 2013.

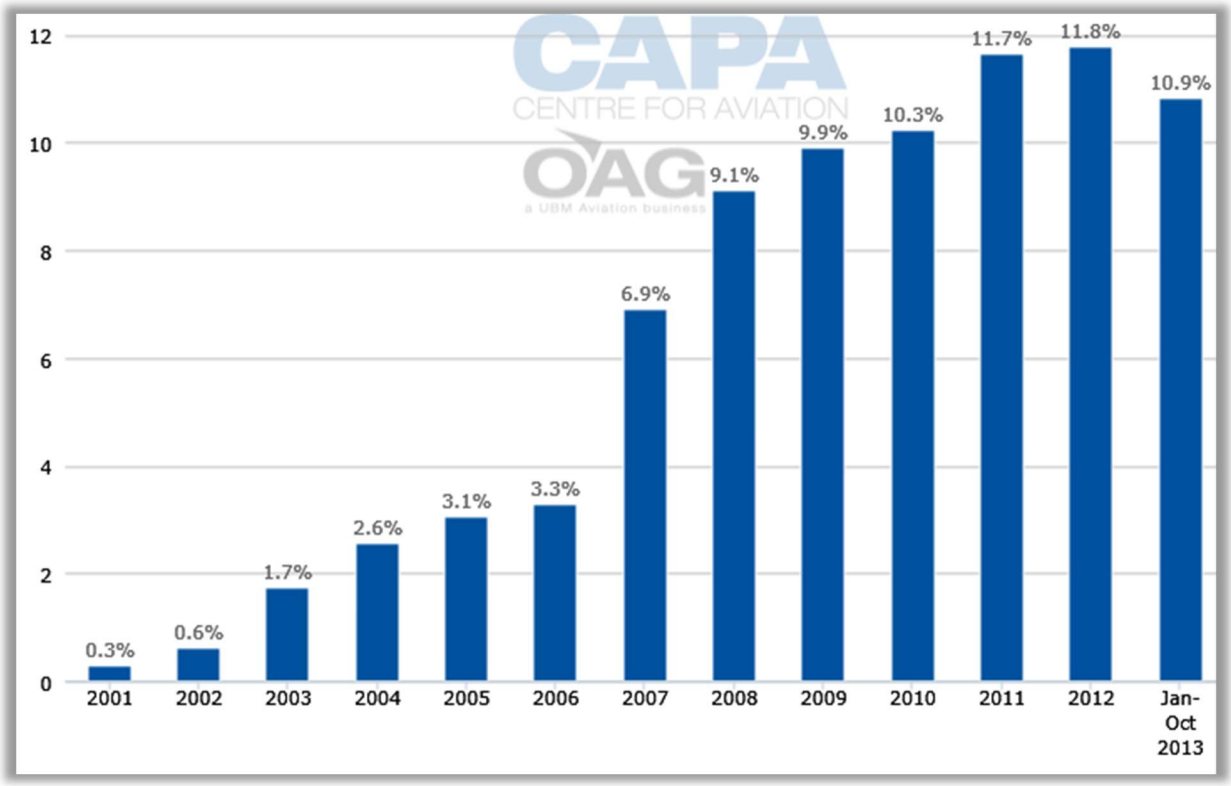


*Figure 1: LCC capacity share (% of total seats) within Africa: 2001 - 2013**

Source: (CAPA, 2013)

*Note: * for 2013 figure for first 10 months of the year is provided*

Almost all of the LCC capacity within Africa is found in South Africa. LCCs currently account for about 40% of domestic capacity in South Africa. Fastjet is one of several companies that has been looking to launch a South African low-cost carrier since the collapse of 1time and a smaller and shorter-lived LCC, Velvet Sky in 2012.

As the airline industry entered the new millennium, the shift to internet distribution channels provided the airlines an unprecedented to simultaneously take increased control of the distribution of their own products and further reduce distribution costs (Belobaba et al., 2009)

Table 2 below lists all the airlines that have been formed, primarily for the domestic market, in South Africa since the deregulation of the industry in 1991. It also indicates the duration of operation of these airlines and whether or not they are still in operation.

Table 2: The history of airlines in South African domestic market after deregulation in 1991 (Mhlanga, 2017)

		OPERATIONAL	
	AIRLINE	**FROM**	**UNTIL**
1	SA Airlink	March 1992	Still operating
2	Flitestar	October 1991	April 1994
3	SA Express (SAX)	April 1994	Still operating
4	Sun Air	November 1994	August 1999
5	Phoenix Airways	December 1994	August 1995
6	Atlantic Airways	August 1995	October 1995
7	Nationwide Airways	December 1995	April 2008
8	Kulula.com	August 2001	Still operating
9	1Time	February 2004	November 2012
10	CemAir	March 2006	Still operating
11	Mango	October 2006	Still operating
12	Velvet Sky	March 2011	February 2012
13	Fly Go Air	February 2012	Still operating
14	FlySafair	October 2014	Still operating
15	Skywise	March 2015	December 2015
16	Fly Blu Crane	September 2015	Still operating

Deregulation of the airline industry in South Africa has significantly impacted the country's air travel market by introducing competition on domestic and regional routes particularly the extremely popular Golden triangle routes (Johannesburg, Cape Town & Durban). This has resulted in lower and more affordable fares and a significant growth in passenger numbers across the airlines. Deregulation also enabled the entry of low cost carriers in the domestic South African market. By 2016 the air travel market had grown by over 50% revitalising the tourism industry in previously less travelled to place like the eastern Cape (Mhlanga, 2017). The low-cost carrier (LCC) airline market has, thus, become highly competitive and is becoming more so every year. Since the deregulation in 1991 some LCC's have entered the market over the years and have had to compete rigorously to remain in the market (Paelo and Vilakazi, 2016).

2.2 Characteristics of the Low Cost Carrier (LLC) operating environment

Low cost carriers are operating in a growth market for budget air travel placing pressure on full-fare airlines. Low cost carriers rely on high volumes and reduced cost structures to be able to attract more passengers at lower fares who would normally use other modes of low cost transportation such as buses and trains (Lubbe, 2011). LCCs are seemingly aggressively putting their biggest emphasis on innovating new technologies with cost saving potential. Unlike full service airlines who generally provide inclusive services in their ticket fare, LCCs also stress their innovation on ancillary revenue streams (Rothkopf and Wald, 2011).

At the core of the success of using innovative technologies, it is important to build a framework to support the technology innovation strategy for the low cost airline business model. The combination of the technology innovation strategy and the business model leads to competitive advantage (Baden-Fuller and Haefliger, 2013). The diagram below shows the e-business model of Standard Air in review to illustrate how the business model integrates and is propelled by technology.

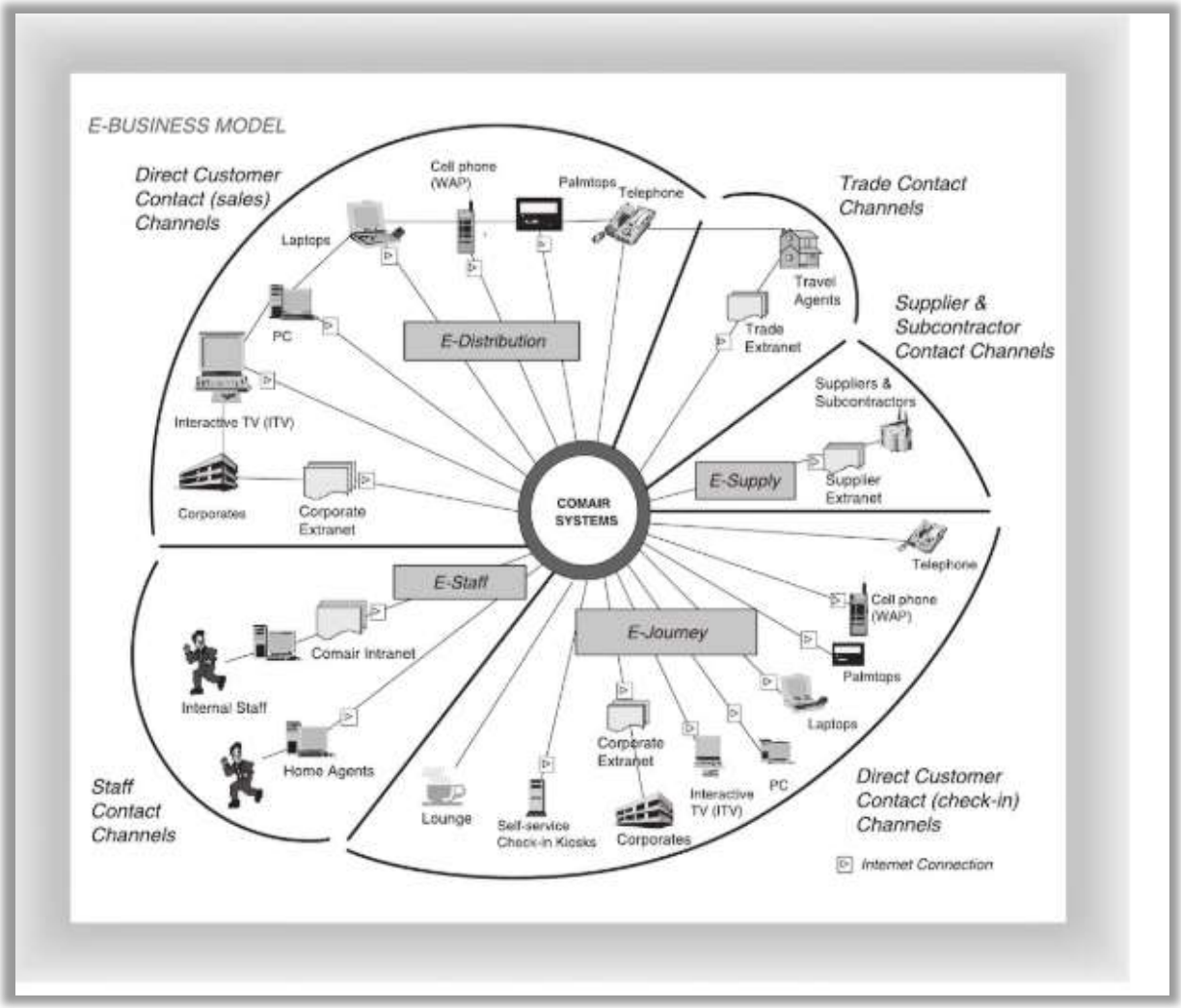


Figure 2: The e-business model of Standard Air (Lubbe, 2011*)*

Using the Airkiosk system in 2006, Standard Air set a trail of airline marketing "firsts" and fast became the largest online retailer in South Africa. By account of Airkiosk, this airline was the first airline in Africa to offer the following (Lubbe, 2011);

- Online reservations changes (first airline in the world);
- Low fare finder calendar-based search;
- Ancillary products sales on the web (hotel, car rental, tax service);
- Web based hold and pay later option;
- Private web access to corporate clients and

- XML API for sales through other websites.

As a result of using the Airkiosk system, it was reported that Standard Airs transactions grew ten-fold with online bookings during fares promotions exceeding 3000 segments per hour including sales of ancillary products. At Standard Air, they see its technology future as providing for enhanced platform robustness, scalability and flexibility. The convergence of customer access technology and devices (mobile and desktop) is achieved through merging of technology standards with software being used across multiple platforms, deployment and adoption of wireless technology and increased capability of mobile devices (Lubbe, 2011).

There is an indirect and complex underlying relationship between ICTs and profitability but it is a challenge to quantify and generalise. Few other industries other than travel depend on many partners to collaborate with closely to deliver their products. By using ICTs travel organisations are able to differentiate their product offerings by customising and adding value in line with individual customer requirements (Buhalis, 2004).

2.3 Information Technology Development in the airline Industry

Information Communication Technologies (ICTs) are able to provide powerful strategic and tactical tools for organisations. When managed and implemented properly, they can bring great advantages by promoting and strengthening the organisations' competitiveness (Buhalis, 2004). Modernisation of ICT provides powerful tools for how organisations can significantly influence the operation, the business structures and strategy (Algethmi, 2014). Along with ICT, innovation is also a need to make a positive difference in airline operations and help them maintain a competitive advantage (Nicolau and Santa-María, 2012). An innovation must solve a problem experienced by a group of users or create a competitive advantage for that user group for it to be of value. Technology is a crucial driver of innovation and in the airline context, three types of technological innovation are relevant; next generation aircraft type, advanced information technology solutions and distribution and terminal handling devices (Franke, 2007). Technological innovations must be used both for operational and strategic management of the

airline as they have direct impacts on competitiveness of the business by determining differentiation and cost advantages (Buhalis and Law, 2008).

2.3.1 History of computerised reservation systems

Computerised reservation systems (CRS) began their development in the 1950's with the partnership of American Airlines and IBM to create the Semi-Automated Business Research Environment (SABRE) which allowed airline reservations agents to manage the distribution processes. SABRE became the pioneer of automated real-time business application of computer technology. By the 1970's several airlines had developed their own CRSs for use by travel agents to be able to view flight schedules and fare information for not only that airline but for practically all airlines and allowed these travel agents to make reservations and sell airline seats directly to the customers on behalf of the airlines (Belobaba et al., 2009)

2.3.2 Airline Distribution Systems

The airline distribution function is responsible for selling the airline's services to its customers (which includes travel agents) and allows the customers to be able to retrieve and review information about the flight schedules, available seats and listed fares. Customers are able to make bookings and purchase tickets for themselves. For any airline, especially the LCCs, the airline distribution function is crucial to the management of its flights and seat inventory, to the tracking of sales and revenue collected (Belobaba et al., 2009).

2.3.3 Technology development in the airline industry

Through technology airlines are adding more functionality, particularly to customer service spaces and integrations to internal and external systems as well as focusing on e-commerce. Online services can be configured to specialist applications like content management and customer personalisation software for individual users. Internet technology is recognised as an enabler in the aviation industry to work effectively and achieve cost reductions, one of the strategic goals of carriers' especially low cost carriers. The future of internet technology and airline technology is increased profitability and improved customer service and the value proposition to the customer (Kelemen, 2003).

Low cost carriers are much more technologically innovative than full service airlines and rely very much exclusively on ICTs for displaying their schedule availability, communicating and transacting with their customers (Buhalis, 2004). The figure below highlights some of the main reasons why low cost carriers have found success in their internet booking platforms.

Table 3: Reasons for Low Cost Carrier airlines success in Internet bookings (Buhalis, 2004)

Simpler Product	Often A-B-A itineraries and tickets One class off service Each segment priced individually No catering on board No pre-allocation of seats
Simple Distribution Channel	Single distribution channel through own calling centres and Internet Financial incentives to book online and disincentives for phone bookings Net rate across all channels No commitment to existing distribution channel members Partnership with popular off-line media (e.g. newspapers)
Advanced CRM and aggressive direct marketing	Email and SMS driven Customer Relationship Management Aggressive banner advertising policies Context-based advertising Data and email acquisition through online and off-line campaigns

Aggressive pricing and yield management	Individual priced seats Minimal fare restrictions Proactive and reactive pricing Proactive pricing starting from offering free flights
Advanced Information Technologies	No legacy systems No commitment to Global Distributions Systems Paperless office and efficient procedures Interconnectivity with technologically advanced partners
Dynamic packaging and value added services	Proactive approach in selling complementary services, such as hotels and car rentals through white labelling Additional value added services such as flight watch, destination guides, etc.

Web services are an enabling technology used to achieve efficiency and operational gains in the booking reservation and purchasing of airline inventory and ancillary products especially between organisations (Business to Business transactions) over the internet. Web services enhance existing applications and improve the collaboration of e-commerce processes through Electronic Data Interfaces (EDI) facilities to enable clients to fulfil payments of their products they have reserved on the airlines website or mobile applications (Vidgen et al., 2004)

Airline operators are using the internet to provide innovative exchange technologies and transactions structures where the offering of a range of products and services is creating industry convergence that has serious implications for the formulation of corporate strategy. The use of internet technologies to integrate and leverage these resources in a more innovative and powerful

way than their competitors will become a significant source of value and creation of product proliferation and improvement (Mcivor, O 'reilly and Ponsonby, 2003).

The illustration below (Figure 3) shows some of the reasons why internet technologies have been used in the air transport industry. It unpacks the impact of success on four categories perceived by the industry namely, efficiency, complementarities, lock-in and novelty.

Table 4: Impact of Internet technologies on the value of the air transport offering (Mcivor, O 'reilly and Ponsonby, 2003)

Source of value	**Key findings in aviation context**
Efficiency: (e.g. search costs; selection range; symmetric information; simplicity; speed; scale economies)	1. Real-time decision-making mechanisms 2. Up-to-date information for buyers and sellers 3. Reductions in customers' search and transaction costs 4. Reductions in the communication and transaction costs of the seller
Complementarities: (e.g. between products and services for customers; between on- and off-line assets; between technologies; between activities)	1. Bundling products and services through vertical and horizontal collaboration/ /partnerships/alliances to form more valuable holistic travel package 2. Offering additional services not directly related to the core travel offering (e.g. financial services) 3. Reducing communication and promotion costs 4. Taking equity stakes in on-line agencies
Lock-in: (e.g. switching costs—loyalty programmes, dominant design, trust, customization; positive network externalities—direct and indirect)	1. Offering low(er) prices/discounted fares (e.g. for on-line bookings only, or relationship-based pricing) 2. Customizing offerings to suit individual

	customer needs 3. Amalgamating rewards/bonuses for loyal customers within business networks 4. Building consumer trust
Novelty: (e.g. new transaction structures; new transactional content; new participants) Key	1. New transaction structures play integral role in lowering transaction costs for airlines and customers 2. Disintermediation and reintermediation of the travel agent 3. Emergence of novel retail partners (e.g. Internet cafe's)

The air travel industry has been at the forefront of IT innovations for product distribution, leading the move from electronic hierarchies to electronic markets firstly through Business to Business (B2B) and with the advent of the internet revolution development Business to Consumer (B2C) electronic markets (Granados et al., 2007).

Granados et al (2007) suggest that new and innovative technologies allow for airlines to offer lower prices and higher levels of price transparency thus challenging the status quo of the industry and improving the customers' ability of choice (Granados et al., 2007). The internet, intranet and e-business solutions are playing a crucial role in transportation including air transport. Air transport as an industry is continuously evolving and vendors are integrating industry solutions and applications to traverse every possible traveller journey (Kelemen, 2003). These solutions are value-adding and improve the passenger experience (Kelemen, 2003).

2.3.4 **Early Adopters**

In the travel and tourism business, airlines have been early adopters of the information and communication technologies. There has been an increasing flow of on-line technologies that airlines are introducing to their clients to better service them (Lin and Filieri, 2015). This airline was selected for this study because they are one such organisation that invests in technology to make their customer's self-sufficient whilst improving the value add to the customer. There is a focus on value creation other than just operational efficiency to target new and existing customers by making a concerted effort to introduce new technologies to improve the value propositions to their customer base (Markides and Anderson, 2006). In the South African context, Standard airline is seen as an early adopter of information technology in its industry. It is also seen as a strategic innovator in their willingness to experiment early in the implementation of emerging information and communication technologies that are both customer facing and back-end driven. Over the years the low cost carrier has had to develop technologies themselves than wait for customised off the shelf solutions to address their operational requirements as these have not been available for a low cost carrier in the South African context and to cater for the level of "sophistication" of their specific market (Markides and Anderson, 2006).

As written by Markides and Anderson (2006), successful innovators and early adopter organisations need to have their CEOs be the technology evangelists for the implementations of ICT strategic initiatives that often must traverse multiple business processes and functional areas. When projects are undertaken in this environment they are often challenging to implement successfully without the unmistakable and obvious commitment from senior management of the organisation. The CEO of the parent company of Standard Air is a business leader that is not a formally trained technology expert, but fully appreciates and has an understanding of the importance of using ICT to strategically encourage the organisation to pursue the technology journey and endeavour for an innovation competitive advantage (Markides and Anderson, 2006).

Standard Air was also selected because its parent company has consistently made profit for over 70 years that it has been in the industry. It is also recognised amongst industry experts that

Standard Air is a leader in the airline space in Southern Africa for spearheading technology innovations to improve both customer and operational efficiencies.

The Figure 4 below, shows the development of the different service purchasing trends in the airline industry. These trends indicate the percentage of the various channel platforms and the types of products purchased per channel. The diagram shows the trend from 2015 to a forecasted maturity of use by the end of 2018.

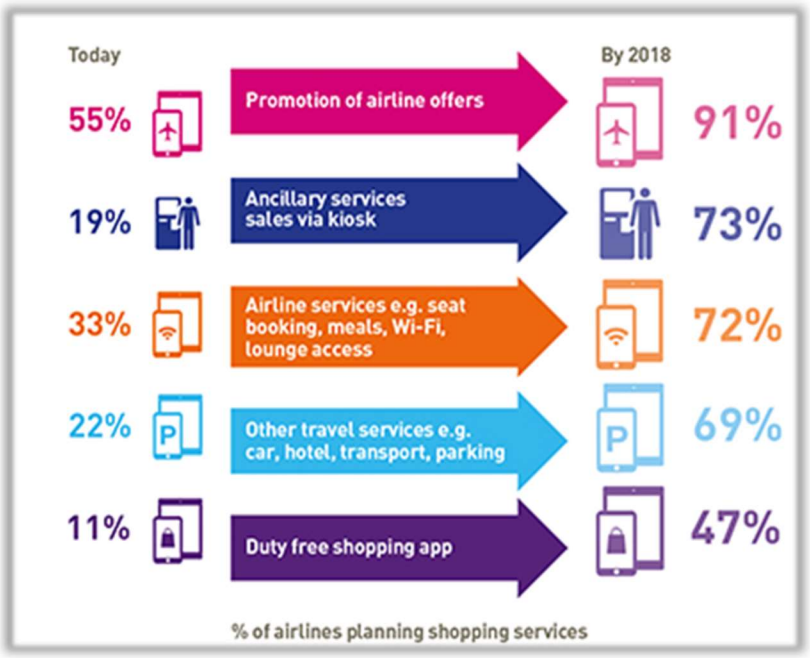


Figure 3: Technology enabled shopping channels (SITA, 2015)

Innovative technologies

Innovative technologies (Including internet technologies) are the key strategies that LCC's have to invest in in order to remain competitive and a sustainable entity in this ever increasing competitive market (Franke, 2007). Since the 1950's, Airlines have been using technology for distribution and collaboration with business partnerships for many years and LCC's are highly reliant on information and communication technology (ICT) to transact (Buhalis, 2004). The acceptance and utilisation of technology at the customer interface is becoming a vital catalyst in

the transformation of the airline industry (Mcivor et al., 2003) and therefore LCC's need to become strategically innovative with the interfaces that they develop to display and sell their product offering through an intuitive and customer-centric retail experience . EasyJet and Ryanair were early adopters of internet technology from their fledgling stages and by 2002 these LCC's were taking the majority of their bookings through this channel and in 2003 more than 92% for both airlines. Thus the internet and additional ICT tools introduced new technology innovations and helped re-engineer processes in the airline industry (Buhalis, 2004).

Ancillary Revenue

With increased technology, the fares have become more transparent and therefore encouraging customers to shop around more with not only the fare price in mind (Warnock-smith et al., 2017). On their booking tool, Ryanair provides a link to hotels that allows its customers access to a selection of hotels of varying star ratings and the ability to book a rental car at preferred deals from their car rental partner, Hertz (Mcivor et al., 2003).The enablement of these functions requires the alignment of business strategies and the integration of technologies along the varied platforms to provide a one stop point of service from the LCC booking platform. This integration of technologies can be between the airline and strategic business partnerships (Vidgen et al., 2004).

Ancillary revenue, defined by O'Connell and Warnock-Smith (2013), as "income beyond the sale of tickets that is generated by direct sales to passengers, or indirectly as part of the travel experience" (Warnock-smith et al., 2017), is playing a greater role in the product offering of an airline to generate more revenue. To be able to offer these ancillary products to the customer in a self-service technology platform, the IT systems used for booking tickets need to be developed and integrated with third party technology where needed to allow for their purchase. Through strategic partnerships of business networks and integrated value chains, financial services such as travel insurance were offered by Ryanair and Virgin in a seamless transaction (Mcivor et al., 2003).

Mobile Technology

Budd and Vorley (2013) have assessed that mobile technology is becoming more available to the technology savvy airline customer. Mobile technology offers the customer an unencumbered purchasing experience from anywhere as long as they have mobile internet connection. More airlines are embracing mobile technology and have taken the lead in developing and providing to their customers a range of experience enhancing mobile software applications (apps) (Budd and Vorley, 2013a). In 2014 in South Africa, Mango launched the first mobile application that can be used across all platform (Android, Apple, and Blackberry 10) to reduce the manner in which service capacity cannot be stored for sale in the future thus allowing customers to book and pay for their flights using their smart phones (Poulsen et al., 2016).

These mobile software applications have increased access to social media platforms which has in turn seen a rise of commentary on the daily experiences of people (Budd and Vorley, 2013b). Customers on social media platforms often share their airline experiences, especially to make complaints (Poulsen et al., 2016). With the use of technology to perform text mining through the labyrinth of data, LCC's can better analyse customer sentiment about their products and services, customer demographics and the prediction of future trends. One of the largest LCC's in Malaysia, AirAsia, and a significant contributor to that country's economic growth has explored the use of test mining techniques to examine and identify customer sentiment (Yee et al., 2014). With this knowledge, faster and more proactive informed decisions can be made by LCC's to address and improve the customers booking and travel journey.

Marketing and Campaigns

Marketing initiatives in the airline industry are being adopted and improved on. Initiatives such as creating frequent flyer programmes (FFP) are aimed at trying to bond the customer to the airline's brand proposition (Gilbert, 1996). According to Mason, the availability of a FFP in a LCC carrier ranks low to customers indicating why it is not a marketing strategy of LCC's (Mason, 2001) . The LCC's are instead using strategic partnership to diversify their distribution channels to reach more customers who may not have the required online currency to pay for tickets. Through the Computicket (a ticket booking platform for events and travel options owned by Shoprite), Mango and Standard Air.com have been able to further reach a wider audience that can pay with cash or debit cards. Mango has even taken the flexible payment option further by

partnering with Edcon (a clothing retail giant, parent company to Edgars) to allow customers to purchase Mango ticket's on Edcons' customer account cards further increasing access to the size of the South African customer base (Poulsen, Fowler and Trapp, 2016).

Press, television and internet advertising can also be used to manage demand as well as specific customer targeted emails to website subscribers. Research that has begun to investigate the impact of these demand management and competitive tools is sparse as the focus is usually on price and income elasticities (Pitfield, 2009). Of late, as Poulsen et al (2016) suggest, LCC's are starting to embrace social media as part of their marketing strategy. EasyJet is one such airline that has seen the potential of these platforms to engage with their customers and attempt to provide greater service, advertise better deals and get their customers talking about their airline. Ryanair however does not use social media as a marketing strategy, although they are represented by their customers on their personal social media platforms. The abstinence from social media as a marketing strategy has not diminished their rising passenger numbers and load factors nor profits (Poulsen et al., 2016). With all these marketing strategies being explored, Acha-anyi (2016) has asserted that in South Africa marketing is still one of the biggest weaknesses of the airlines as they propagate elitist marketing that does not filter adequately to the majority of the population (Acha-anyi, 2016).

Self-Service Technologies

These days' passengers are more comfortable with using technology with increased independence and freedom from time and space constraints. Therefore the demand for self-service technologies (SST) has increased significantly with over 80% of airlines worldwide focusing on applying SST and investing on research and development of these technologies. SST are technological interfaces that enable customers to produce a service independent of direct employee interaction. Some examples of SST include airport kiosk, online and mobile check-in technologies and apps for managing bookings as a suite of pre-flight services (Gures et al., 2018). The use of SST provides many advantages for both airlines and their customers including standardising service delivery, expanding service delivery options, increasing productivity, efficiencies and customer satisfaction as well as reducing costs. Also convenience, speed of delivery, cost saving, ease of use are factors that enable the customers' use of SST more (Gures et al., 2018).

The benefits of the competition in the airline sector are shown through the available data of the prices of air travel on the different domestic routes. The deregulation of the airline industry and the entry of various airlines has had the effect of reducing process for general air travel as well as the increasing appetite for air travel in the South African domestic market (Paelo and Vilakazi, 2016).

Online Booking Platforms

As documented by Paelo and Vilakazi (2016), until the liberation of the domestic market in 1991 South African Airways (SAA) was a monopoly since 1934. New airlines would find it difficult to compete with SAA, which at the time had 95% of the market share.

One of the largest online booking agencies operating in South Africa is Travelstart. It published in 2015 significant decreases in the prices of air travel on the different routes following entry of new competitors, particularly Flysafair. Travelstart analysed that the fares had reduced by as much as 39% by that year since the airlines entered the market (Paelo and Vilakazi, 2016).

Harnessing the power of technology to excel in the business environment is not only about the decision to buy the technology, but also requires a huge change in the attitudes to the role of technology, organisational structures and culture. To quote Nawal Taneja, an author and aviation expert, the time now has come for the industry "to have a better business discipline to capitalise on emerging technology to generate sustainable shareholder value for itself " (Taneja, 2016: xii)

The availability of information provides customer empowerment giving them access to a great deal of information on competitors, prices, products and seat availability is made possible because of the Internet. In some regions on the globe, customers are expectant of transparent business processes with respect to information available about the airline, products and services. Increasing customers want to know greater detail of the inventory of the aircraft, how to apply frequent flyer rewards and flight conditions that will help them make better decisions and their travel journey more predictable (Taneja, 2016).

Taneja (2016) has observed that deregulation is transforming the airlines form lethargic and reactive monopolies to more fast-moving and proactive competition. The proliferation of the internet is also playing a role as a catalyst in the heightening of competition within the airline industry by maintaining a perpetual online presence. New competitors are constantly entering the

marketplace forcing established airlines to take on a defensive approach by introducing, if they already don't have one, a low-cost carrier subsidiary that are technology intensive in order to reduce distribution costs and the reliance on orthodox modes of ticket booking and payment (Taneja, 2016).

Offering more customised services at reduced prices often helps stimulate additional demand for the products that the organisation has to offer. The deployment of new technologies to increase the speed and the reliability of processes is said to have a positive impact on the customer satisfaction as well as improvements to operational competence. Updated technology, fixed and mobile, are helping to smooth the high demand during peak times and thus reduce waiting time and access to passenger information during the customer journey from pay to fly (Franke, 2007).

For airlines there are options to use technology to cut costs, introduce new functionality, reduce time to market or improve customer experience. The idea is that people in the airline organisation at their different levels are able to obtain relevant and timely information and then converting it to intelligent solutions for passenger related problems in order to become more customer centric (Taneja, 2011).

More and more, Information and technology are becoming available for airlines to interact with their passengers in real time, to learn about their problems and to provide meaningful solutions to them. Passengers are increasingly expecting airlines to develop comprehensive mobile strategies in which a wide spectrum of mobile devices is able to connect to systems that provide customised and relevant solutions for them. New generation information and technologies are becoming available for low cost airlines to be able to interline or code-share with the traditional full service network carriers without adding previously expected complexity. New-generation information and enabling technology provide passengers and the airline with an increasing number of solution choices (Taneja, 2011).

Innovative Payment Platforms

Through mobile devices and innovative technology to enable ticket payments, Kenya Airways in 2009, became the first airline in the East African region to accept payment via a popular mobile money transfer service called M-Pesa. M-Pesa is widely used across East Africa for to cater for the "unbanked". Low cost carriers also started adopting this payment type and it is in this market that the alternative distribution channel has the greatest potential particularly because LCC's traditionally have more affordable prices and therefore more attractive to the 'unbanked". By 2016 M-Pesa sales accounted for 30% of revenue for Fastjet, one of the LCC's that operates on the African continent (Bowen, 2019).

In the technology sphere there has been concepts such as customer centricity through mass customisation where businesses become providers of solutions and value integrators for their customer base. The main idea of the concept is to explore the products and services that could be customised and personalised for the individual customers but created at low cost thereby leading to low prices. Within the airline industry the concept is reinforced by mass market penetration to address at least the following four reasons; (Taneja, 2011)

1. Passengers are interested in solutions that will solve their complex travel requirements
2. Competition is increasing amongst the existing airlines
3. Lower margin passengers are on the increase
4. Increasing uncertainties and volatilities of the global economy and other challenges

Technology has the prospective ability to enable airlines to adapt to the shifting dynamics of the industry and the customer and plays the role of both a driver and an enabler of business strategies. The availability and implementation of technology can enable small airlines, especially the low cost carriers, to effectively compete with larger, more developed and incumbent airlines (Taneja, 2002).

Driving Customer Value

When the technology focuses on the customer in order to drive value to the customer for the products and services on offer then the perception of value is realised. It has been noted that customer value is a factor that impacts the growth of demand at micro level for the offering and is influenced by the evolution of new airline business model and innovative technological advances (Bieger et al., 2007). Over time the significance of customer value in air transport has enhanced and many organisations and industries have adopted to the *customer responsive* ideology by re-engineering the value proposition to the expectations and desires of the customers. Businesses have placed their focus on applications that encourage further increases of the customer – vendor interface to generate new forms of competitive advantage and grow the consumer and purchase base (Jarach, 2002).

Amazon.com is one such organisation that entered the market as an application solution provider and a business solutions provider in warehousing and distribution focusing on providing customer value for future customer lock-on. Amazon.com is now amongst the top players in the cloud computing industry and had evolved over the years with a business model that encouraged a high level of diversification and a broad spectrum of technological innovations to become transform itself from just an online bookstore to the largest online retailer in the world (Lindič and da Silva, 2011).

Many successful companies have been maximising how their customers spend with them by broadening the depth, breadth and diversity of their spending. Through technology and innovation organisations were able to have a greater share of the customer's wallet, increase revenue from easier access to value add-ons, being able to stretch into new areas of their customer's lives than before (Van der Merwe, 2000). Van der Merwe (2000) identified that customer focus can direct an organisation to realise the locking on of a customer specifically through innovative technology growing the number of customers and therefore creating more revenue generating opportunities.

The rewards of innovative activities in an organisation have been determined by a market process that involved the activities of the innovator as well as the feedback of the customers and the competition. According to economic theory, the creation of a new supply of functionality and the outward move of the current functionality supply can lead to greater output levels leading to

revenue growth. The relationship between innovation and profitability exits but is also dependent on the reaction of the competing organisations to the organisations technological innovations (Koellinger, 2008).

Iberia Airlines has shown that innovations helped companies increase their market value and identified that advanced customer segmentation and new technologies had a greater positive effects on returns than new business models did (Van der Merwe, 2000).

With the right technology implementation and technology partners airlines gathered the right intelligence to offer the customers the right product or service, at the right time and on the right offering channel. The necessary tools made airlines more effective and drove increased sales through the up-sell or cross-sell techniques (Taneja, 2017).

The airline industry is very dynamic and has known many changes where airline companies have had to show their customers value when they flew with them. The fierce competition amongst the airlines brought and raised creativity of the management staff to levels that would entirely benefit the customers and their value perception. Technology has made all the difference (Avram, 2013). Airline managers have discovered that to be future fit the need for customer value awareness was necessary. Customer value was an increasingly important driving factor for continued growth. This encouraged that product innovation based on new customer areas and new technology should be propelled based on the preferences of airline passengers (Bieger et al., 2007).

2.4 Conclusion

The literature review discusses the airline industry in general and also focuses on low cost carrier airlines business models both domestically and internationally. This chapter uncovers some of the technology strategies that have been employed by low cost carrier airlines as well as innovations that have helped drive customer value and the impact that has had on the business of the airline and the industry at large. The findings of the review generally suggest that technology supports the growth of a low cost carrier airline and has a positive value impact on the customer.

CHAPTER 3

3 Research Methods

3.1 **Research Design**

Research design is the plan, structure and strategy of investigation conceived to obtain answers to the research questions and to control the variance. There are two broad types of quantitative research design, exploratory research and conclusive research. Exploratory research is the initial research which forms the ground work for the conclusive research, however exploratory research cannot provide a conclusive answer to research problems and are frequently not regarded useful for decision making.

Conclusive research is further broken down into descriptive and causal research. Causal research is a research design method where the emphasis is to determine a cause and effect relationship, which variable might be causing a certain behaviour (Singh, 2007).

The research design approach for this paper was to follow a causal research design and was quantitative in nature as the information collected was numerical (hard data) (Neuman, 2014). Singh (2007) points out that, in quantitative research, the key aim is to determine the relationship between an independent variable and other sets of dependent variables in a sample population. A retrospective record review of technology implementations information, revenue data and passenger numbers was collected and analysed. According to Neuman (2014), this type of study is used to attempt to verify a relationship or hypothesis under investigation.

Kothari (2004) has explained the criteria of good research is that it must possess two main qualities. That the research was ***systematic***, by being structured with specified steps taken in a specified sequence in accordance with the well-defined set of rules and that the research was ***logical***, guided by the rules of logical reasoning and the logical process of induction and deduction are of great value in carrying out that research and more meaningful with regards to decision making.

Another design consideration for producing objective research was to consider the variables or factors that have a possibility of affecting the outcomes. According to Kothari (2004), factorial

designs are used in experiments where the effects of changing more than one factor are to be determined. Where there were more than two varying factors on a dependent variable, a complex factorial design was considered.

3.2 Research Hypothesis

A hypothesis is an uncertain postulation derived from knowledge and theories used to guide in the investigation of other facts and theory that are yet unknown. A hypothesis plays an important role in research and is a central core of the study. It directs the selection of the research data to be collected, the research design, the statistical analysis and the conclusions arrived at from the study. Also to note, is that a study can be dedicated to testing one major hypothesis, a number of subsidiary hypotheses or both (Singh, 2006). Hypothesis testing is a statistical procedure in which a choice is made between a null hypothesis and an alternative hypothesis based on information in a sample (Stephens, 2012).

Null Hypothesis (H_0): Customer focused innovative technology has no impact on the passenger growth of low-cost carrier airline

Alternative Hypothesis (H_1): Customer focused innovative technology has an impact on the passenger growth of low-cost carrier airline

The hypotheses identified was a result of an extensive literature review that provided a tentative assumption that drew out and tested the logical or empirical consequences thus providing the focal point of the research. The hypotheses also had an effect on which tests were conducted in the analysis of the data and therefore indirectly the quality of the data required for analysis. It was important to note that the hypothesis needed to be unambiguous and constrained to the area of research at hand which was to be tested ensuring the researcher was kept on the right track (Kothari, 2004).

3.3 Sampling

Standard Air belongs to a parent company that has several subsidiary companies under its umbrella. The sample data only included data for the low cost airline between January 2007 to December 2017 and did not include any data that relates to other airline brands. This was the target sample population and formed the sampling range that adequately matches the study's purpose and data (Neuman, 2014) . Probability samples were used as they save time and cost for the level of accuracy achieved. Neuman (2014) also indicates that a well-designed probability sample in quantitative research can be very efficient. When using probability samples, each element takes on a known probability of being included in the sample whereas non-probability samples did not permit the researcher to adequately determine this probability. Probability samples were based on these sampling techniques; simple random, systematic, stratified and cluster/area (Kothari, 2004). This research employed simple random sampling.

Determining a large enough sample size, allowed for the assumption that the inconvenient variables were evenly distributed among the groups increasing confidence in the equivalence of those groups (Marczyk et al., 2005).

The following formulas were used for the sample size calculation (Naing, 2003):

1**. Sample Size (n_0)**

$$n_0 = \frac{Z^2 pq}{e^2}$$

Equation 3.1

Where Z = abscissa of the normal curve that cuts off an area α at the tails = 1.96

p = the estimated proportion of an attribute that is present in the population = 0.5

q = 1-p = 0.5

e = desired level of precision = 0.05

n_0 = 385

2. **Finite population correction** (Naing, 2003)

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Equation 3.2

Where n_0 = sample size = 385

N = population size = 192 (total months of operation of the LCC)

n = 128

3.4 Data Collection and Instrumentation

Data collection is the accumulation of specific evidence that will allow the researcher to analyse the results of the activities outlined during the research design and procedures. The key purpose of the data collection is to prove research hypotheses. (Singh, 2006).

According to Kothari (2004), primary data can be obtained through observation or direct communication with the respondents in one form or another or by personal interviews with knowledgeable resources of the data being collected. For this research the data was collected from the Finance, e-Commerce and Project Office departments. The data that was required were the booking numbers of passengers per month for Standard Air and the revenue for the matching month. These were collected from the Finance department. The number of projects that were deployed in a particular month was collected from the project office. These projects had to be specific to customer focused innovation. Also collected from the e-Commerce department were the recorded marketing campaigns that Standard Air ran for each month.

Standard Air's financial year starts from the 1st July to the 30th June the following year. This research reviewed the information gathered by calendar year for a period of 10 years from January 2007 to December 2017. Each department approached was requested to provide the needed data from January 2007 to December 2017 from their records. Records for each month were collected where it existed. Where the data was not found, a value of zero was recorded.

The data was then inputted into an observation grid which was categorised by the year, the month, the number of technology implementation, passenger numbers (tickets purchased),

revenue (value of the tickets sold) and campaigns/marketing initiative data for the identified study period.

After collection, the data was processed so that it was made responsive for analysis where the relationships and/or variances whether supporting or conflicting with the hypothesis were assessed (Kothari, 2004).

3.4.1 **Overview**

Revenue data and passenger numbers were collected from the Finance department and the Commercial distribution department's information management systems.

Data from the technology update implementations were collected from the Project Management Office and its information management systems. Marketing campaigns and Sales days' information were also identified and collected as part of the observation data.

According to Cudeck (2000), the observation of the variables can be correlated with each other as they are determined in part by common but unobserved influences. A form of factor analysis was employed to determine the fundamental influences intrinsic to a domain variable and to attempt to quantify the magnitude to which the identified variables are associated with the factors (Cudeck, 2000).

Because of the nature of the data, a time series analysis statistical model was be employed. This 'time series' more clearly can be defined as a series of successive observations of the given phenomenon over a period of time are referred to as time series. The analysis of time series is done to understand the dynamic conditions for achieving the short- term and long-term goals of business (Kothari, 2004).

Exploratory data analysis (EDA) is a known statistics and scientific approach to data analysis for improving the understanding and receptiveness of the results. Some tools and techniques of EDA have been used for data visualisation such as histograms, density plots and scatter plots among others to explore distribution patterns. Commonly used to show frequency distributions are histograms which show how often the number in each class appears in a continuous data set (Li Vigni et al., 2013).

These density plots are types of histograms that represent the distribution shape of numeric variables and illustrate the probability density function of the variable. They visualise the data over a continuous time period (Ross, 2011).

Regression analysis was used to assess significant relationships between dependent variable and independent variable and/or indicates the strength of impact of multiple independent variables on a dependent variable. Regression analysis was used because in real world terms, one variable is unlikely affected by only one other variable. Therefore, to better predict variable [A], consideration of other possible variables that may influence variable [A] should be made (Jackson, 2009).

3.5 Statistical Tool

For the statistical data analysis for this research, the tool that was used was RStudio and R programming language. RStudio is a cross platform application commonly referred to as an Integrated Development Environment (IDE) that provides a common graphical user interface across multiple major operating systems (de Vries and Meys, 2015) . R is an integrated suite of software functionalities for data manipulation, used for a multitude of types of calculation and graphical display. It has an effective data handling and storage facility and a collection of operators for calculations on arrays, in particular matrices. R has a large and intelligible integrated collection of tools for data analysis, graphical facilities for data analysis and is able to display either directly at the computer or on hardcopy (Venables and Smith, 2019).

3.6 Data Analysis

3.6.1 Multivariate Data Analysis

Statistical techniques that simultaneously analyse more than two variables on a sample of observations is characterised as a multivariate technique. Multivariate analysis is a collection of methods for analysing data where a number of observations are available for each object of interest such that the techniques take account of the various relationships among variables. Multivariate techniques are mainly empirical and possess the ability to analyse a collection of massive complex data with the intention to provide realistic results in a simplified way (Kothari, 2004).

3.6.2 **Factor Analysis**

Factor analysis is a group of techniques to explain the relationships among variables in terms of more vital attributes known as factors. Factor analysis propagated from the observation that variables from a carefully formulated areas are often correlated with each other. Its objective is to gain an understanding as to why the results are as they appear and to determine the number of influences underlying a domain of variables. As described from the factor analytic view, the variables correlate because they are determined in part by common but unobserved influences (Cudeck, 2000).

3.6.3 **Granger Causality**

Granger causality is a theoretical framework based on conditional independence of assessing directional dependencies between time series. Granger causality is normally tested in the context of linear regression models and measures the statistical dependence between the past of a process and the present of another process and is based on the premise of conditioning in the probability theory. The theory suggests that "a cause must occur before the effect , and that causality is relative to the knowledge that is available" (Amblard and Michel, 2013).

As Granger causality was formulated for linear models, its direct application to nonlinear systems has varying suitability, depending on the specific problem. For some cases, the linear Granger causality is able to identify the right patterns of interaction for multiple nonlinear time series, but in some other cases, it may unfortunately fail to do so (Chen et al., 2004).

The technique of identifying causal relations among multiple linear time series is based on linear prediction theory. For a stationary time series x(t), the following autoregressive (AR) prediction of the current value of x(t) based on m past measurements is represented by the equation below (Chen *et al.*, 2004):

$$\mathrm{x(t)} = \sum_{j=1}^{m} \alpha j \, x(t - j) + \varepsilon x(t)$$

Equation 3.3

Where εx(t) is the prediction error whose magnitude can be evaluated by its variance var(εx(t)) and simultaneously another stationary time series y(t).

The Granger causality performs a series of t-test and F-tests on lagged values. The ***t*-test** is any statistical hypothesis test where the test statistic follows a t-distribution under the null hypothesis. The F-test is a statistical test where the test statistic has an F-distribution, a continuous probability distribution arises commonly as the null hypothesis (Kothari, 2004). The F- test is often used when comparing statistical models that have been tailored to a data set so that a model that best fits the population from which the data were sampled can be identified. Also to note, is that the results of the Granger causality test are sensitive to the length of the lags (Hiemstra and Jones, 1994)

The Granger causality model was used as it was formulated for linear modules and in some cases to identify the appropriate patterns of interactions for multiple non-linear time series (Chen *et al.*, 2004).

3.6.4 **Simple Regression Analysis**

The Granger causality also included measurements of regression. Regression was the determination of a statistical relationship between two or more variables. In simple regression, there were only two variables. The one variable (defined as independent) was the cause of the behaviour of the other one (defined as dependent variable). Regression only interpreted what exists physically so there must be a physical way in which independent variable X can affect dependent variable Y. The basic relationship between X and Y was given by (Kothari, 2004);

$$\hat{Y} = a + bX$$

Equation 3.4

The symbol $\hat{Y}$ represents the estimated value of Y for a given value of X. This equation is known $\hat{Y}$ as the regression equation of Y on X which means that each unit change in X produces a change of b in $\hat{Y}$, and is positive for direct and negative for inverse relationships.

3.6.5 **Multiple Correlation and Regression**

When there exists two or more than two independent variables, the analysis concerning relationship is known as multiple correlation and the equation describing such relationship as the multiple regression equation. The equation below depicts multiple correlation and regression taking only two independent variables and one dependent variable (Kothari, 2004).

$$\hat{Y} = a + b_1 X_1 + b_2 X_2$$

Equation 3.5

3.6.6 **Reliability and Validity**

Reliability and validity are key concerns in the measurement of data and aid in establishing truthfulness and credibility of the data (Neuman, 2014). To address validity in the research it was important to ensure that the assessment of the data measured the concept being investigated. The sample size must also be appropriate and consist of participants best representative of the research subject (Morse et al., 2002). Guidance from knowledgeable people was solicited to validate the measurement tools (Neuman, 2014).

According to Kimberlin and Winterstein (2008) in classical test theory, any score gathered by a measuring instrument is composed of both the "true" score, which is unknown, and an "error" score in the measurement process. A true score is where the score a person would have received if the measurement were perfectly accurate. The process of developing and validating an instrument is in large part focused on reducing the error in the measurement process. (Kimberlin and Winterstein, 2008). The measuring instrument that was used were observation grids to collect the individual data for the number of projects from the project management office and marketing campaigns from the e-commerce department for the period under review. Observation grids were also used to collect data from the finance department the passenger numbers and revenue figures for the matching period of the other two variables.

Reliability

One of the functions of reliability estimates was to evaluate stability measures administered at different times using the same standards where the reliability coefficients ranged from 0.00 to 1.00 with the higher coefficients indicating higher levels of reliability (Kimberlin and Winterstein, 2008). Should measurement results not be reliable, it is more difficult and risky to test hypotheses or to make inferences about the relationships between variables in quantitative research (Ihantola and Kihn, 2011).

To test reliability, the measurement instrument needed to be standardised to facilitate consistency. Understanding, practice and verification of the measurement strategy was employed to maintain consistency of the data that will be recorded, compiled and analysed (Marczyk, DeMatteo and Festinger, 2005).

Validity

Kothari (2004) states that validity is the most critical criterion as it indicates the degree to which an instrument is able to measure what is intended to measure. Validity is the extent to which difference found in the measuring instrument reflect the true differences among those being tested. Validity evidence is built over time with the validations occurring in a variety of populations (Kimberlin and Winterstein, 2008). It was important that during data collection possible threats to internal validity were considered. These possible threats included instrumentation issues where scores yielded from a measure lacked the appropriate level of consistency or failed to generate valid scores. Some examples of possible threats during data analysis and interpretation included errors in statistical testing, misleading correlation and causal error. Another key criterion in quantitative research was external validity which determines whether general conclusions was drawn on the tenets of the model used and the data collected and if the results were generalised to other samples, time and period sceneries. External validity is also threatened if biases or limitations are present in the accessible population (Ihantola and Kihn, 2011).

For this research internal validity was employed to assess the conformity of the research findings with reality. Also assessed is the degree that what was observed and measured was what was supposed to measured (Zohrabi, 2013). Internal validity discusses the establishment of cause and

effect relationships. It emphasises constructing an internally valid research process in the case study research whilst establishing occurrences in a credible way. With internal validity it was considered how confident the outcomes of the study, based on avoiding certain threats that can make the results debatable (Riege, 2003). The employment of internal validity in this research was because it aims to justify that one variable causes another.

Through the informal conversation interview some input from the data collection process was gathered to check the process and meaning of the data. The participant interviewed was identified as a subject matter expert (SME) as they were the best resource to provide the research data required. The participant was also the best resource to explain the data and answer related questions. As a management accountant, the participant manages and explores the data collected as the part of their monthly functional responsibilities for reporting to the executive. The research data collected was reviewed by the researcher and questions were developed based on the data. An interview was conducted with the basic questions. Some questions were formulated during the interview process as guided by the discussion to provide clearer understanding of the data representation.

After statistical modelling and analysis of the data, the results and interpretations of the analysis of the research were submitted to the participant for review, validation and content veracity.

3.6.7 **Interpretation of Data**

The collection and disparity of the historical data, while very important, was merely a step to the highly important task of being able to interpret the significance. It was important for the interpretation of the data was objective and the process remains as such throughout the study. Deciphering the numerous facts that have been gathered about the data and how they relate to the hypotheses is an important first task (Singh, 2006).

Establishing causation in the study can be dangerous and requires a good understanding of the concepts in order to be able to make the right interpretation. Closing the gaps, the continuity and the perspective which super imposes on the data to make them meaningful to the researcher as they establish the claim to the scientific status (Singh, 2006).

3.7 Ethical Issues/Clearance

As the use of the internet for research increases, more writers need to attend to ethical issues and considerations involved with this medium of research and information. It is firstly important to obtain informed consent from the participants in the form of a signed statement (Merriam, 2009). If a researcher involves human sample participants in their research then they have a responsibility to the participants in that they must protect their identity and data collected on those participants (Singh, 2006). The research conducted in this study does not specifically involve human participants. The data collected is on an airline for which consent to use the data was obtained from the Chief Executive Officer (CEO) of the parent company (see Appendix A).

The data for the study was collected from the finance, e-Commerce and Project Management departments of Standard Air. No falsification of any data collected for use in this research was made to influence any outcomes of this study. No misrepresentation of the data was made and all research findings and results were presented without manipulation.

Ethics clearance was obtained though the School of Mechanical, Industrial and Aeronautical Engineering Ethics Committee. The Ethics clearance number is MIAEC 025/20. Refer to Appendix F.

3.8 Conclusion

In this chapter the methodology employed in this study is detailed including the sources of the data collected and how the data was sampled. Also discussed in the chapter are the data collection methods and instrumentation thereof. A brief description is provided about the statistical tools used and how the data analysis methods that would be used to interrogate the data. The results are discussed in the following chapter (4).

CHAPTER 4

4 Data Analysis and Results

4.1 Overview

The aim of the study was to evaluate the impact of customer focused innovative technologies on passenger growth for a domestic low-cost carrier airline.

The data in use was collected for the period starting from 1st January 2007 to 31st December 2017. This was an observational study.

The data was statistically modelled in RStudio using R which is a programming language for statistical computing and graphics. Appendix D shows all the programs that were used to model the data. In the results section below, the different statistical models were performed for exploratory analysis and descriptive statistics.

4.2 The Results

4.2.1 Exploratory Analysis

To be able to understand the quality of the observed data, an exploratory analysis was conducted to check for missing values, skewness of the data, and correlations between the observed variables and the data plots over time. This was done through the use of histograms and density plots as outlined in chapter 3 section 3.6.1.

4.2.1.1 Histograms

From the Figure 6 below it can be seen that the Campaigns frequency histogram shows right skewed distribution. This indicates that there is a natural limit that constrains outcomes to one side. In the dataset there are higher frequency of the zero value. The Pax frequency histogram has a bimodal distribution indicating that there are two distinct groupings of passenger numbers.

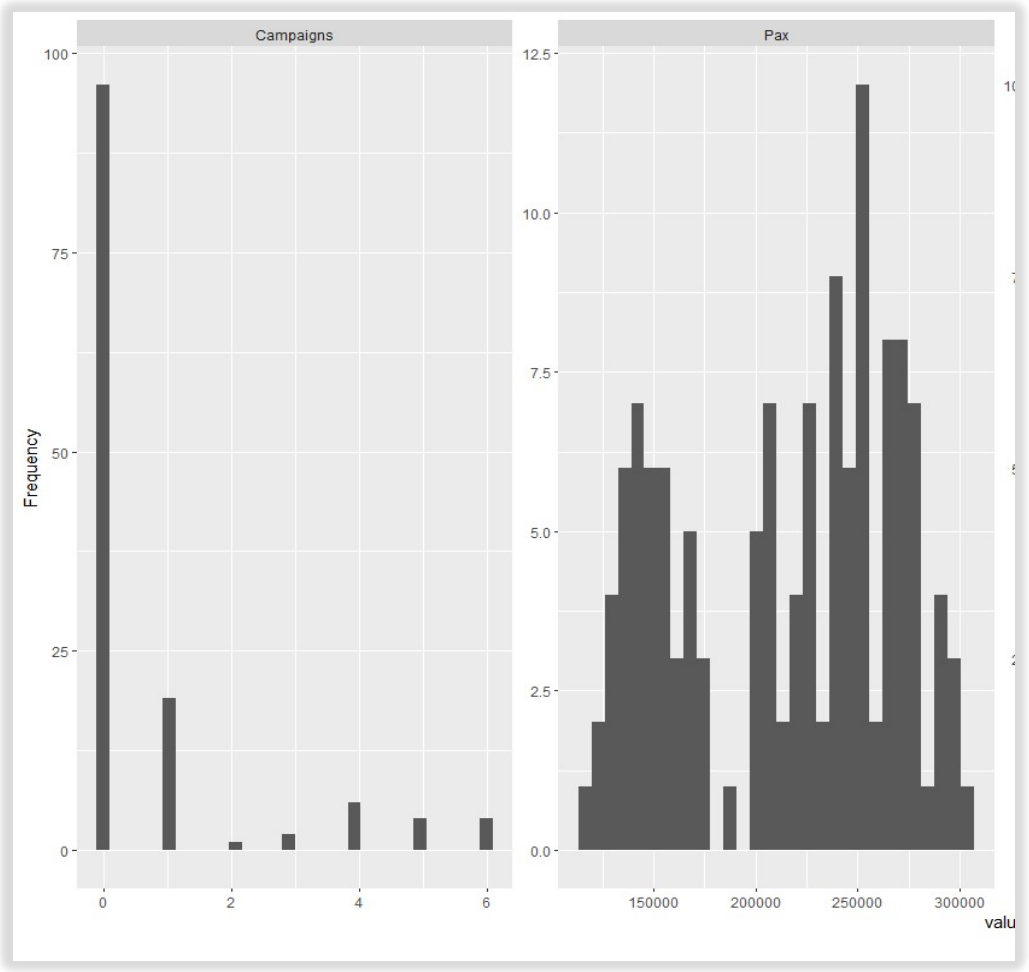


Figure 4: Histogram of Frequency and Value of the Campaigns and Pax (Passenger numbers) variables

From Figure 7 below it was seen that the Projects frequency histogram showed a right skewed distribution. This indicated that there was a natural limit that constrains outcomes to one side. In the dataset there were higher frequency of the zero value. The Revenue frequency histogram had a bimodal distribution indicating that there were two distinct groupings of passenger numbers.

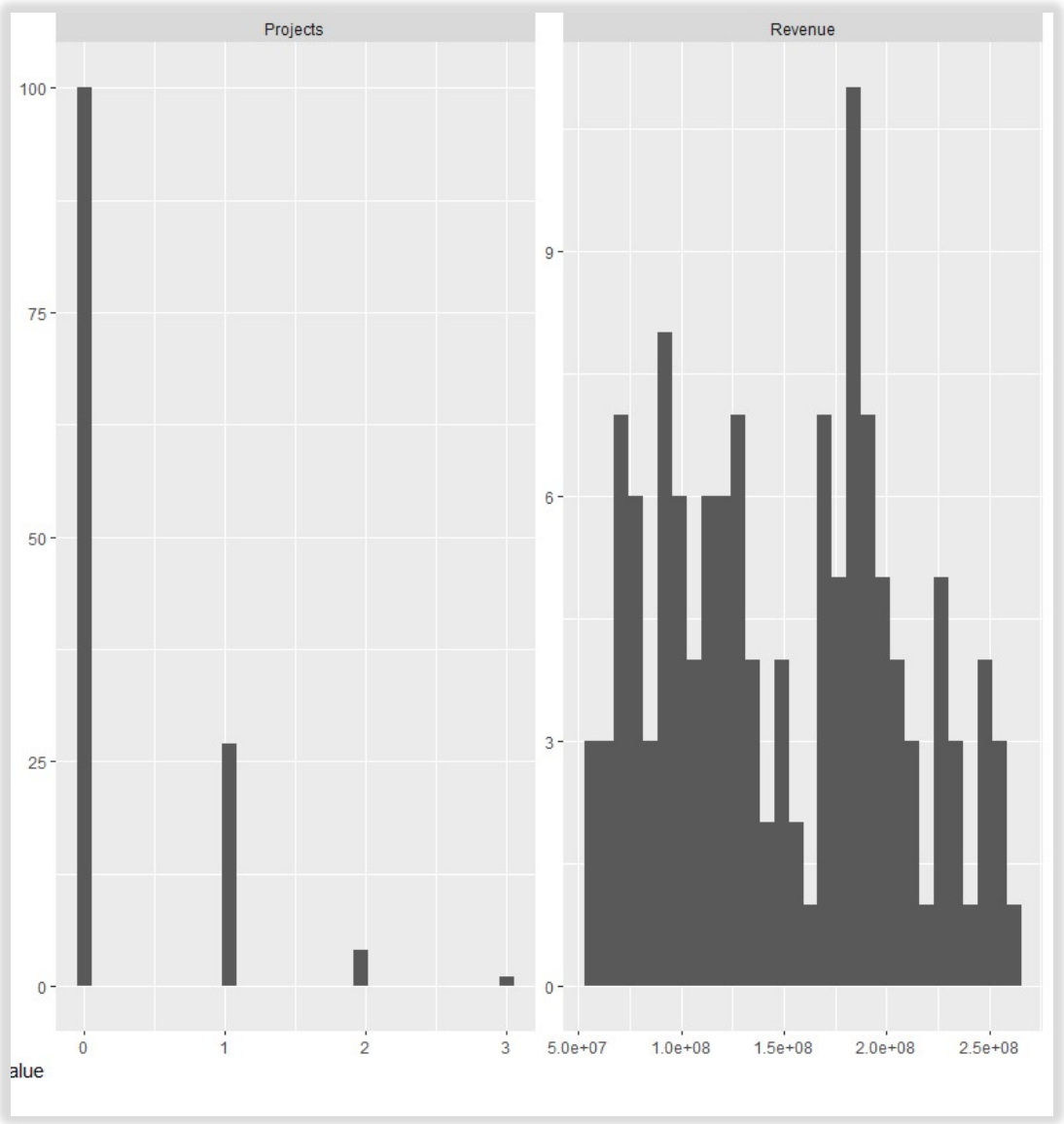


Figure 5: Histogram of Frequency and Value of the Projects and Revenue variables

4.2.1.2 Density Plots

The density plots for Campaigns and Pax shown in Figure 8 and 9 below matched the frequency histogram as they both showed the frequency distribution of the numeric values. The density plots better show the distribution shape of the data with the peaks in the plot showing where the values are more concentrated over the interval (Venables and Smith, 2019).

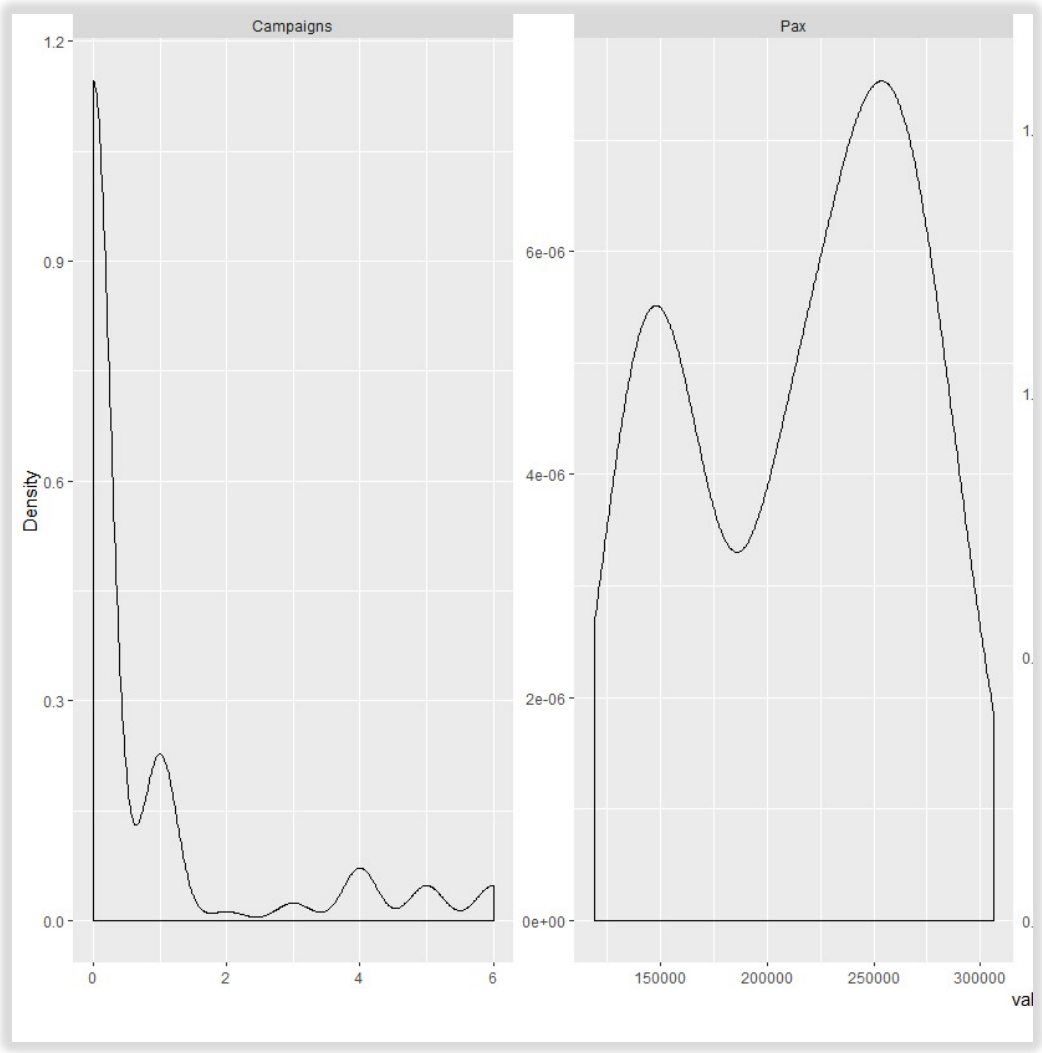


Figure 6 : Density plot showing Campaigns and Pax (Passenger numbers) distribution shapes

Likewise the density plots for Projects and Revenue match the frequency histogram.

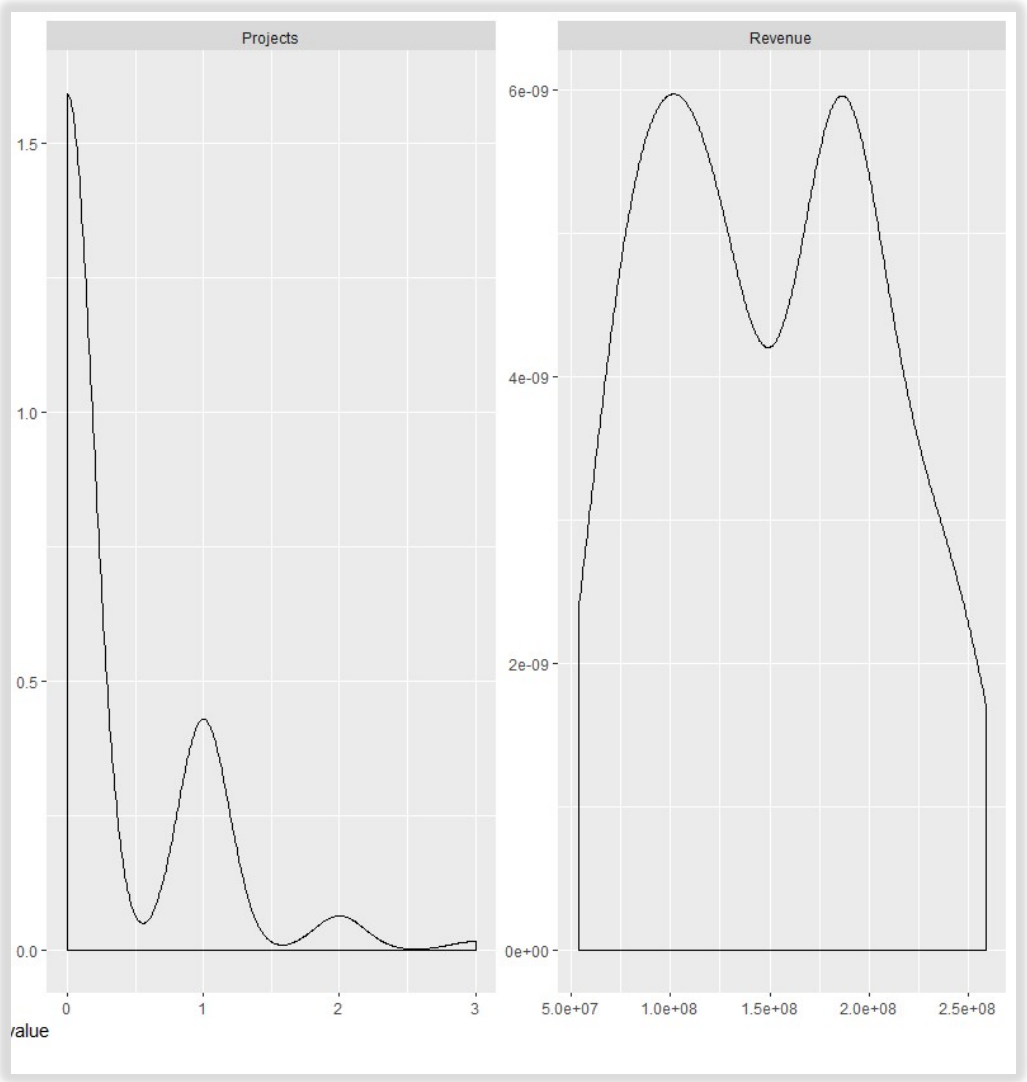


Figure 7: Density plot showing Projects and Revenue distribution shapes

4.2.1.3 Correlation Matrix

The correlation matrix in Figure 10 below shows how each of the variables relate to each other variable by measuring the strength of the linear relationship In the correlation matrix below we can see that at 0.94, Pax and revenue show a strong positive linear relationship.

The relationship between Pax and Campaigns (0.18), Pax and Projects (0.03) and Revenue and Projects showed a none to extremely weak positive linear relationship.

On the other hand, the relationship between Campaigns and Revenue (-0.03) and Campaigns and Projects (-0.03) both showed a none to extremely weak negative linear relationship.

The correlation coefficient formula is represented below (Lind et al., 2018);

$$r = \frac{1}{n-1}\left(\frac{\sum\left(X-\overline{X}\right)\left(y-\overline{y}\right)}{s_x s_y}\right)$$

Equation 4.1

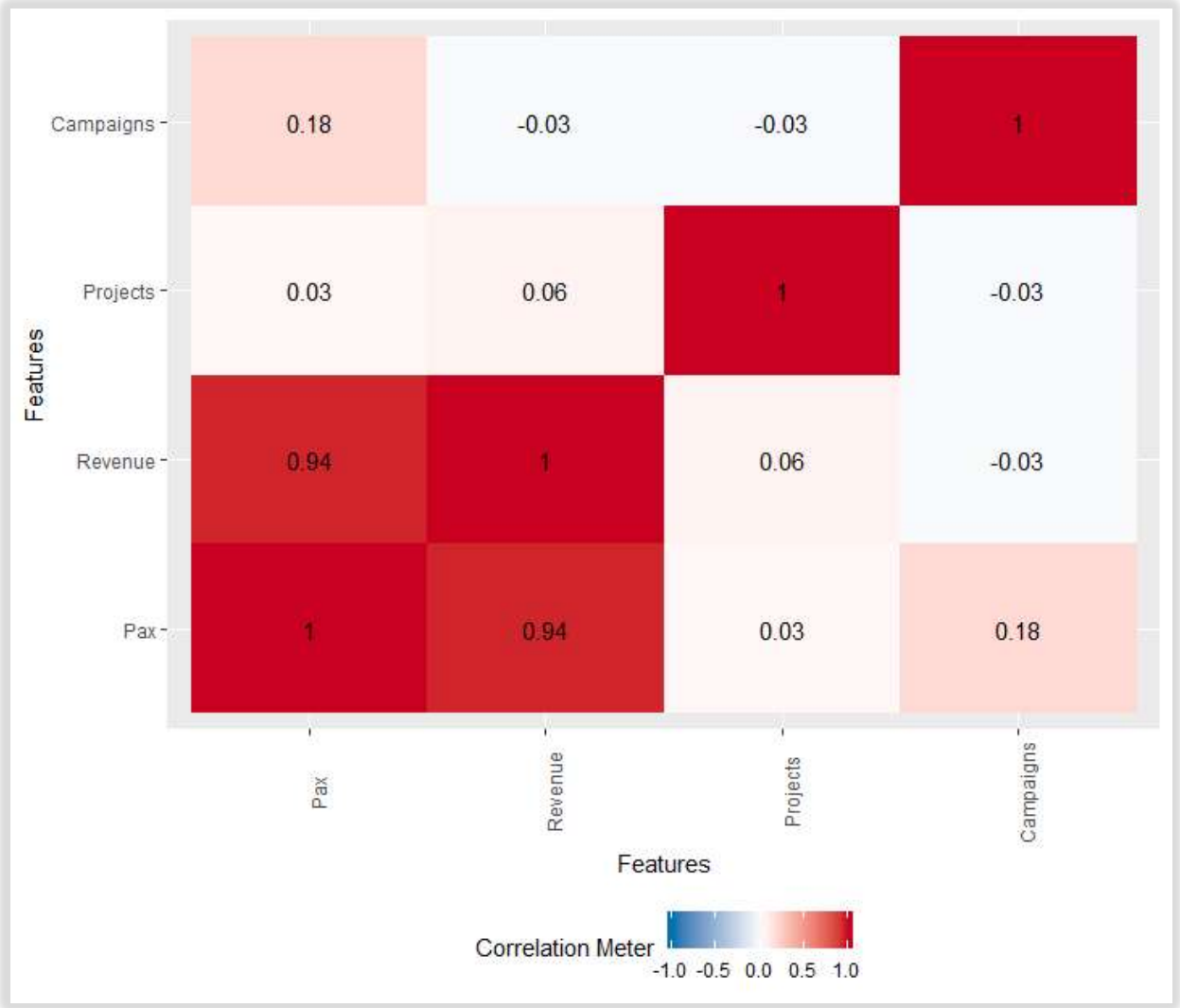


Figure 8 : Correlation Matrix of the multiple variables

4.2.1.4 Line plot for PAX

Figure 11 below illustrates the relationship between passenger numbers and time and shows a positive upward trend over time. This indicated that over time in the period of the study the number of passengers grew.

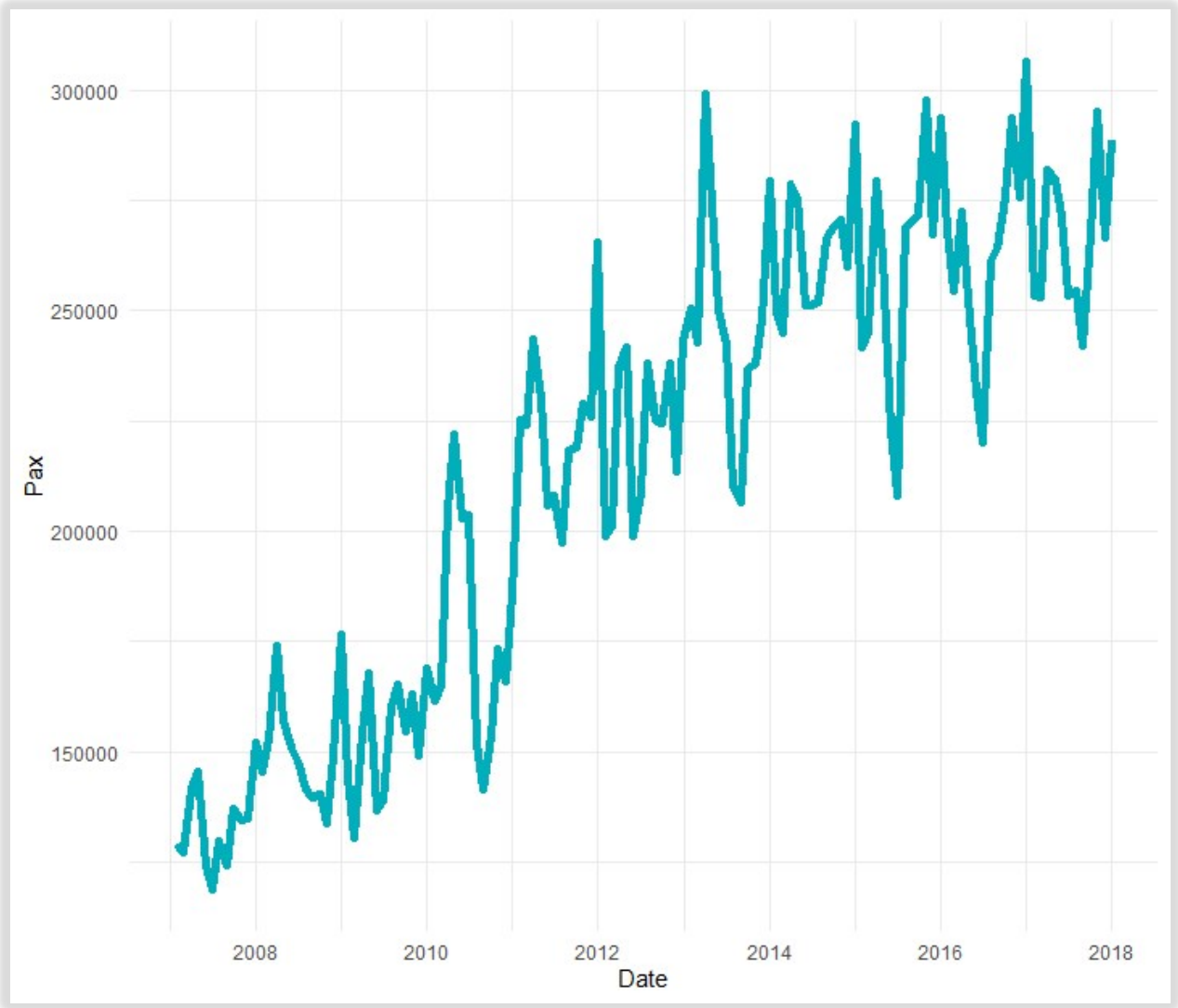


Figure 9 : Line Graph showing Pax (Passenger numbers) over time

4.2.1.5 Line Plot for Revenue

The revenue line plot in Figure 12 below indicates a positive upward trend over time showing that revenue was improving over time. This graph is similar to the Pax graph and aligned as expected to the strong positive linear relationship between Pax and Revenue as seen in the correlation matrix.

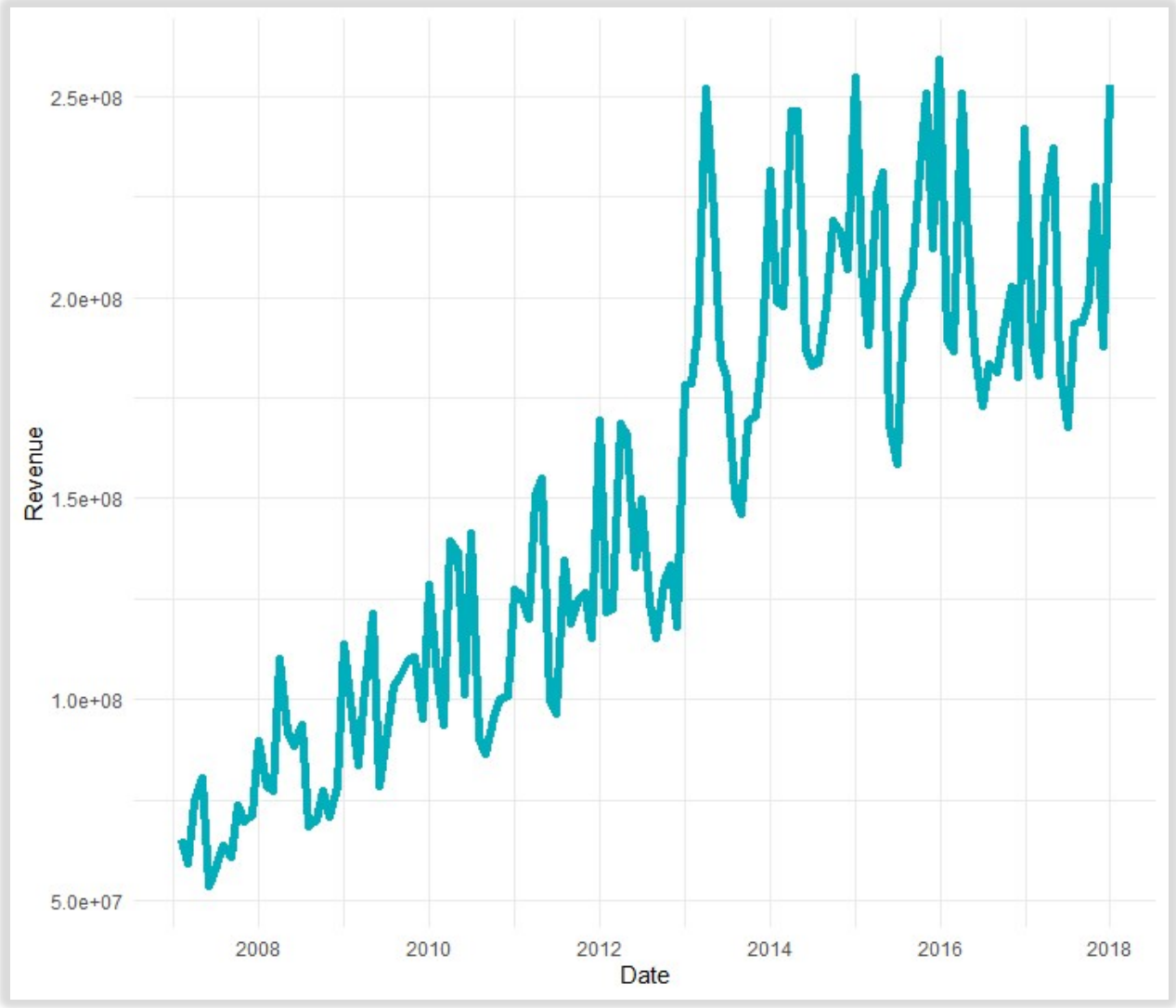


Figure 10 : Line Graph showing Revenue over time

4.2.1.6 Line plot for Projects

The line plot for projects in Figure 13 below, did not show any linear relationship through time. The values were concentrated in a straight line along 0 (zero) on the x-axis.

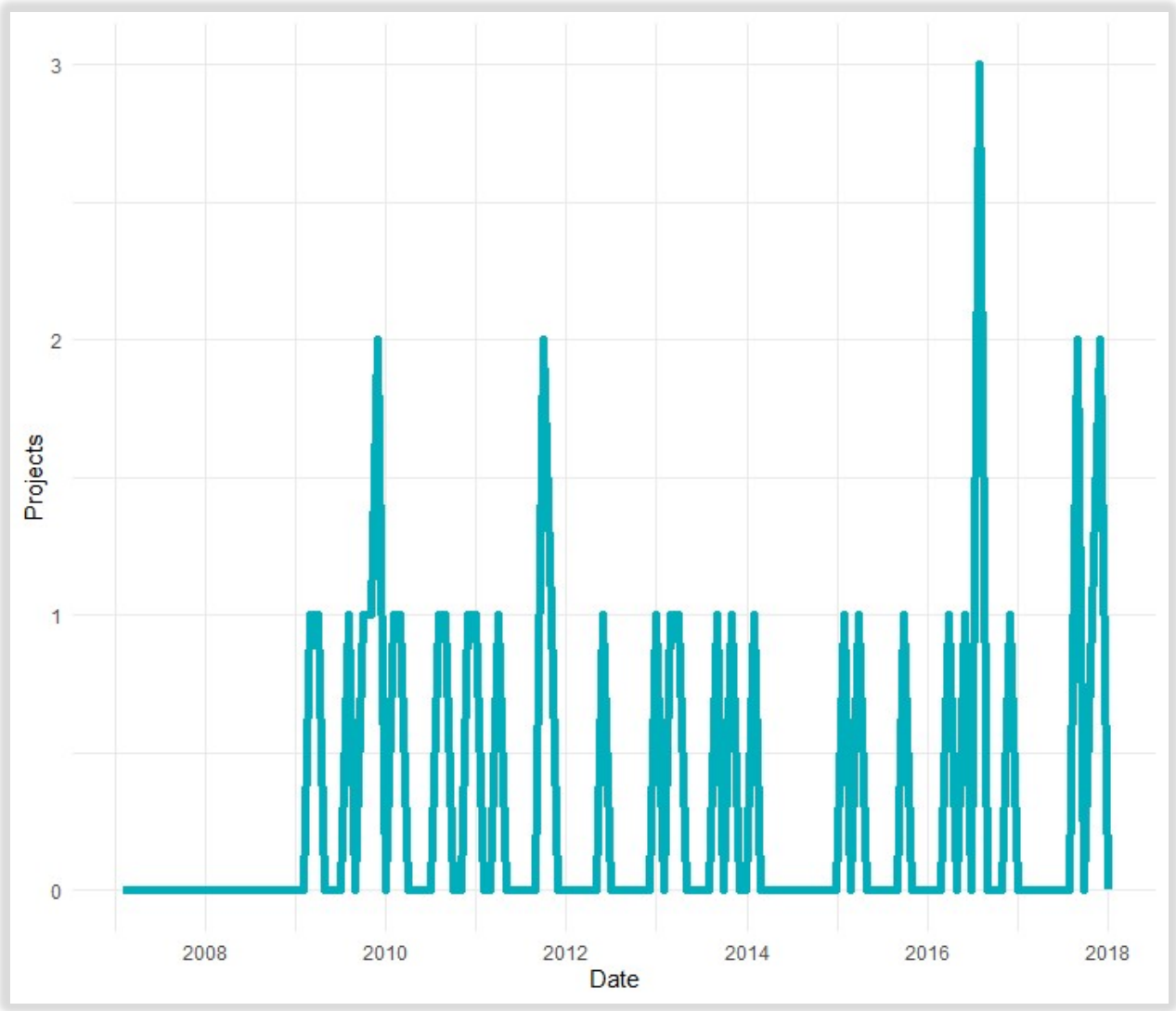


Figure 11 : Line Graph showing Implemented customer focused projects over time

4.2.1.7 Line plot for Campaigns

The line plot for campaigns, Fig 14 below, also did not show any linear relationship through time. Like the projects data, there were a lot of 0 (zero) values along the x-axis.

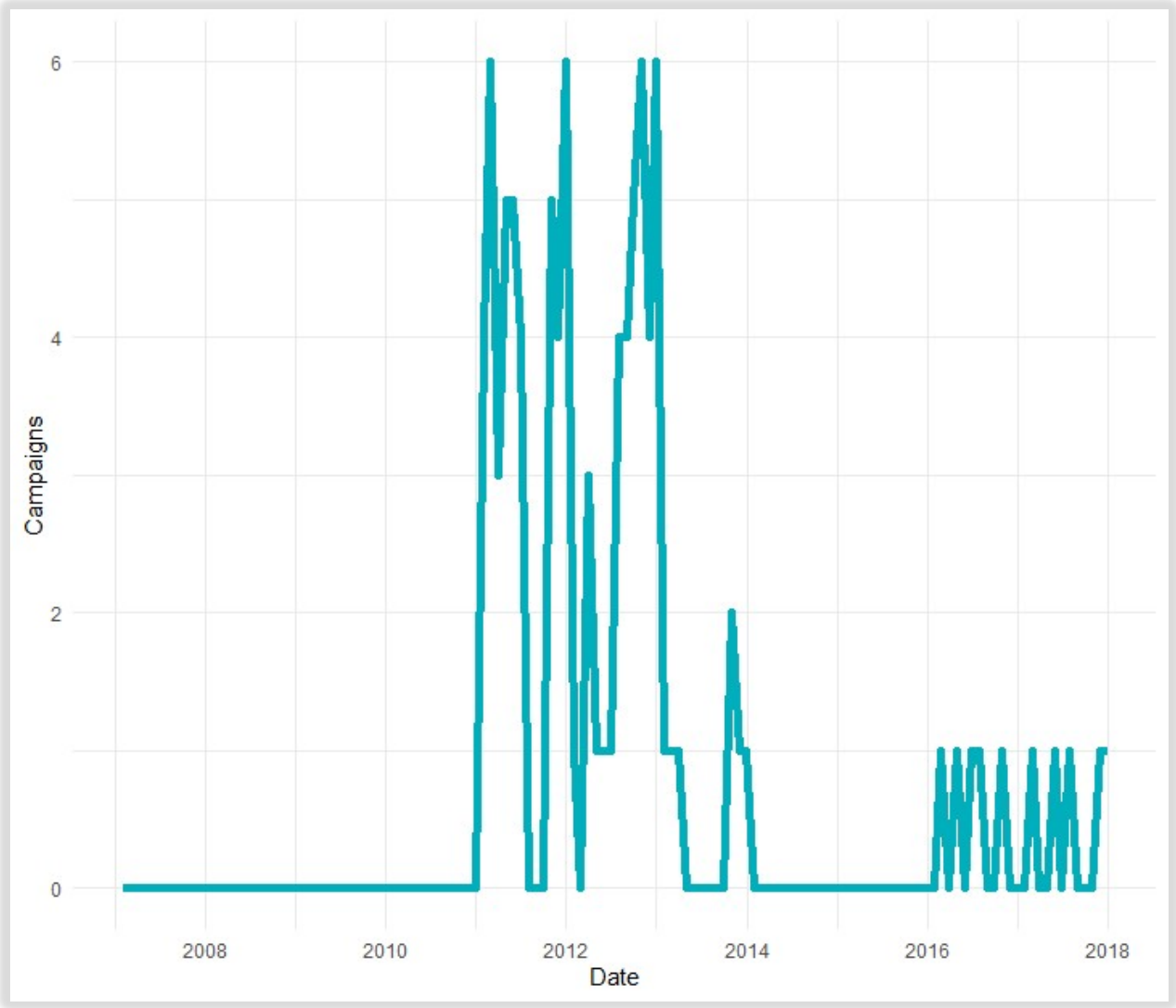


Figure 12 : Line Graph showing Customer Campaigns over time

4.2.2 **Granger Causality Test**

The Granger causality model was used as it was formulated for linear modules and in some cases to identify the appropriate patterns of interactions for multiple non-linear time series (Chen *et al.*, 2004).

In the following Granger causality calculations the Pax (passenger numbers) tested for, as the dependent variable and the Projects, Campaign and Revenue as the independent variables. A lag length, the shift of a time base by a given number of periods, of 1 was used as optimal. The Akaike information criterion (AIC) was used to determine the optimal lag for the model.

The AIC calculates an estimated measure of the quality of each of the available econometric models for a given set of the data variable. The model chosen is the one where AIC is the least, and is represented by the following formula (Webster and McBratney, 1989);

$$AIC = n \ln R + 2p$$

Equation 4.2

In the equation, n is the number of experimental points, ln is the natural logarithm, R is the residual sum of squares and p represents the number of parameters in the model (Webster and McBratney, 1989).

The syntax to calculate the granger causality tests are in appendix D. The results shown in Table 3 showed that projects had a p-value of 0.02134 which is below the desired significance level of 0.05.

The results for campaigns (Table 4) and revenue (Table 5) had a p-value of 0.6958 and 0.4339 respectively. These values are higher than the desired significance level.

Granger causality test (Projects Independent Variable)

Table 5: Granger Causality test Projects with a lag of 1

```
Model 1: Pax ~ Lags(Pax, 1:1) + Lags(Projects, 1:1)
Model 2: Pax ~ Lags(Pax, 1:1)
  Res.Df Df      F  Pr(>F)
1    128
2    129 -1 5.4313 0.02134 *
```

Granger causality test (Campaigns Independent Variable)

Table 6: Granger Causality test Campaigns with a lag of 1

```
Model 1: Pax ~ Lags(Pax, 1:1) + Lags(Campaigns, 1:1)
Model 2: Pax ~ Lags(Pax, 1:1)
  Res.Df Df      F Pr(>F)
1    128
2    129 -1 0.1535 0.6958
```

Granger causality test (Revenue Independent Variable)

Table 7: Granger Causality test Revenue with a lag of 1

```
Model 1: Pax ~ Lags(Pax, 1:1) + Lags(Revenue, 1:1)
Model 2: Pax ~ Lags(Pax, 1:1)
  Res.Df Df      F Pr(>F)
1    128
2    129 -1 0.6002 0.4399
```

4.2.3 Checking For Bi-directional Granger Causality

The bi-directional granger causality test was performed to asses if there was a two way causal relationship of the variables. To perform this test the independent variable became the dependant variable and vice-versa. The syntax to calculate the bi-directional granger causality are in appendix D.

The results in Table 6 and Table 7 respectively showed that the p-value of projects (0.7247), campaigns (0.9858) were above the desired significance level of 0.05. Table 8 shows the revenue result to be 0.004609 which was within the desired significance level. This meant that a passenger numbers (Pax) showed a causal relationship with revenue.

Granger causality test (Projects Dependable Variable)

Table 8: Granger Causality test Pax on Projects with a lag of 1

```
Model 1: Projects ~ Lags(Projects, 1:1) + Lags(Pax, 1:1)
Model 2: Projects ~ Lags(Projects, 1:1)
  Res.Df Df      F Pr(>F)
1    128
2    129 -1 0.1246 0.7247
```

Granger causality test (Campaigns Dependable Variable)

Table 9: Granger Causality test Pax on Campaigns with a lag of 1

```
Model 1: Campaigns ~ Lags(Campaigns, 1:1) + Lags(Pax, 1:1)
Model 2: Campaigns ~ Lags(Campaigns, 1:1)
  Res.Df Df      F Pr(>F)
1    128
2    129 -1 0.0003 0.9858
```

Granger causality test (Revenue Dependable Variable)

Table 10: Granger Causality test Pax on Revenue with a lag of 1

```
Model 1: Revenue ~ Lags(Revenue, 1:1) + Lags(Pax, 1:1)
Model 2: Revenue ~ Lags(Revenue, 1:1)
  Res.Df Df      F   Pr(>F)
1    128
2    129 -1 8.3173 0.004609 **
```

Table 9 is a summary of the outcomes of the granger causality tests outlined in the above text. There were two casual relationships that were identified between a dependent variable and an independent variable. These independent variables (Projects, Pax) influence the dependent variable (Pax, Revenue) respectively.

Table 11: Summary of Granger causality results

Dependent Variable	Independent Variable	p-value	Granger cause result
Pax	Revenue	0.4339	No causal relationship
Pax	Projects	0.02134	Causal relationship
Pax	Campaigns	0.6958	No causal relationship
Revenue	Pax	0.004609	Causal relationship
Projects	Pax	0.7247	No causal relationship
Campaigns	Pax	0.9858	No causal relationship

4.2.4 **Internal Validity Results**

Table 10 shows the list of informal conversation interview questions that were asked of the participant and their responses. From the table it is seen that the data collated was extracted from a system. Due to system changes the method of data extraction had to change but the values of the data over the sample period of the research did not require any manipulation therefore would remain the same values each time they were extracted.

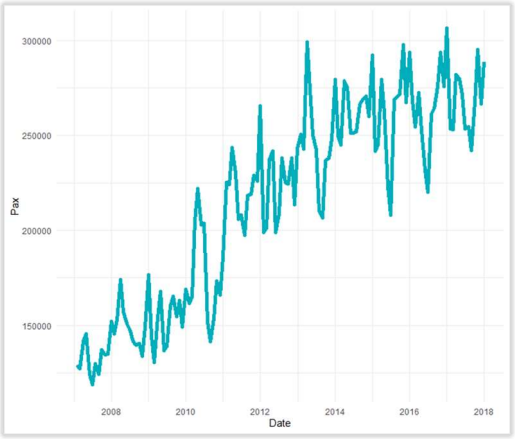
The participant was also asked to make commentary on their thoughts and experience of the independent variables (technology implementations and marketing campaigns) on the passenger number bookings and growth. The observation of the participant indicated that technology had a positive impact on customer growth. It also showed from participant observation that marketing stimulated demand but that did not necessarily translate to actual passenger growth.

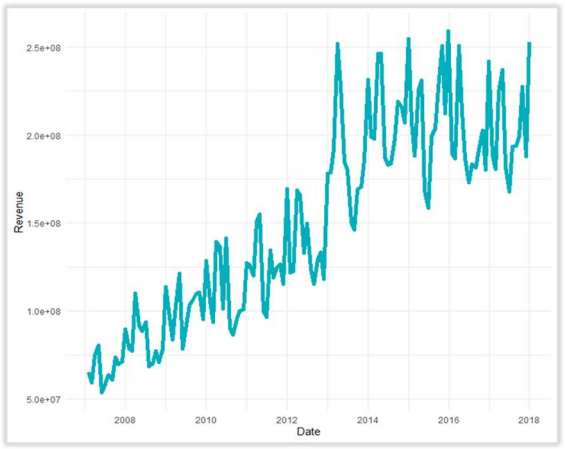
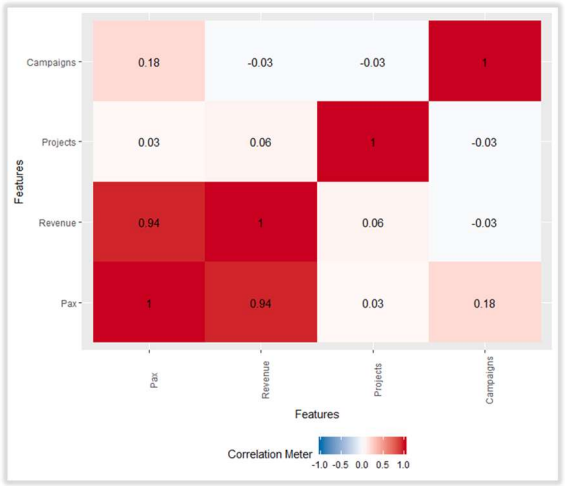
Table 12: Interview conversation questions and response

	Question	Response (Y/N)	Comments
1	Is the requested data collated from a system	Y	
2	Would you collate the requested data the same way each time	N	Due to changes in systems, methods had to differ
3	Do you have to manipulate the values of the data	N	Values were collected and supplied as found
4	Does the data collated reflect a positive linear trend	Y	
5	Would you expect that technology projects would impact passenger growth?	Y	The use of technology within our organisation revolutionalised bookings and customer growth tremendously
6	Would you expect that marketing campaigns would impact passenger growth?	N	In my experience, passengers look for experience and affordable prices. Marketing may stimulate demand but rarely translate to growth

The questions and responses asked of the participant after analysis are shown in table 11. The responses from the participant indicated agreement of the analytical results. The response in question 10 highlights that the introduction of better passenger booking methods and product offerings through the implementation of technology solution has increased passenger numbers. Also in agreement with the statistical analysis is the expectation that marketing campaigns do not have a causal effect on the growth of passenger numbers.

Table 13: Interview conversation questions and responses after analysis

	Question	Response (Y/N)	Comments
7	The graph shows the relationship of passenger numbers overtime. Does this represent your expectation? 	Y	This is in line with expectations

8	The graph shows the relationship of revenue overtime. Does this represent your expectation? 	Y	
9	There is a close positive relationship between passenger numbers and revenue at 0.94. This means that when passenger numbers change, the revenue also changes in the same direction. Does this represent your expectation 	Y	The more the passengers, at the right price, the higher the revenue.

10	The results show that there is a form of causal relationship between the projects implemented and the growth in passenger numbers. The impact is not immediate but is evident after 1 month of implementation. From your experience would you agree with this finding?	Y	Better methods of booking and offering products have resulted in higher pax numbers
11	The results show that there is no causal relationship between marketing campaigns and the growth of passenger numbers. From your experience would you agree with this result?	Y	
12	The findings show that there is no causal impact of revenue on passenger numbers but that there is a causal relationship on revenue by passenger numbers. From your experience is this in line with the reality?	Y	Revenue is as a results of passengers and not the other way round.

4.3 **Conclusion**

In this chapter the results from the statistical tool were collated and analysed. The first set of outputs were exploratory data analysis (EDA) results. EDA is well suited for a first review of understanding the data and accessibility of the results (Li Vigni, Durante and Cocchi, 2013). The granger causality test was the used. The granger causality model was formulated for linear modules and to identify appropriate interactions for multiple non-linear time series (Chen *et al.*, 2004). The key variables assessed where revenue, passenger numbers (pax), projects and campaigns. The main finding was that projects granger caused passenger numbers (pax).

CHAPTER 5

Discussion

5.1 Overview of the study and implications

The study was to explore the customer focused innovative technology projects that were implemented at Standard Air to understand the relationship between the projects themselves and the growth of the passenger booking numbers. Also, the study was to understand if there was any value from implementing these specific technologies for the airline in relation to the revenue growth as well. Through the research, the value acknowledged may not specifically be confined to direct financial gain. The implications of the study will be on how the low cost carrier airlines can review and align their technology innovation strategies. The study will also have implications on the perception of customer value in relation to product and service innovation and the role that plays in growing an airline in a highly competitive and dynamic market.

This study may highlight the role of customer focused innovative technology in the low cost carrier space and ultimately for full service carriers as well. The effort and cost of building innovative technology solutions can be high and prohibitive so it is important to understand if value is derived for initiatives that are explored. Showing the positive effect of innovative technology on the airline business can encourage its further development. In the competition for passenger numbers and bookings, there could also be a side effect that will be beneficial to the customers, improved, fast evolving technology that creates high levels of customer value

In this study, besides the innovative technology variable, other variables were also looked at to see how they perform in the same time period. These variables were campaigns and revenue. The campaigns represented the marketing campaigns that were sent out to the customers in efforts to drive more sales. The other variable is revenue which is the money generated from the ticket sales for Standard Air.

5.2 Objectives review

The objectives of the research outlined in chapter 1 and how they were achieved were briefly unpacked below;

Innovative customer-oriented technologies and the growth of passenger numbers.

Through the period of study form January 2007 to December 2017 monthly data was collected on the technology implementations and the passenger bookings. As the objective was being assessed over a time period a statistical analysis model that measured variables in a time series analysis. The granger causality test was used to determine if the technology implementation time series was useful in forecasting the passenger numbers time series. The passenger numbers was the dependent variable and hence each of the other variables were tested against it using this method. For this objective though, the key interest was testing for granger causality on the innovative technology implementations.

To quantify the passenger numbers before the month in which customer-oriented technology changes were implemented and in the month(s) after

This objective also assessed the data over a time series and required the exploration of when to check for the change in passenger numbers due to the impact of the technology implementation. Using the Akaike information criterion, the optimal lag length was determined to be 1 period. The data collected was monthly, a period, therefore the lag length was a month long. To be able to notice the impact of the technology implementation on the passenger growth, a period of a month must have passed.

To determine the impact of customer-focused technology implementations on revenue generated over the same time period

The results from the correlation matrix were used as an exploratory analysis of any relationship between technology implementations and revenue. There was a none to extremely weak position relationship, but this didn't necessarily mean that there would not be a causal relationship. The granger causality test was employed and revenue was made the dependent variable. At the significance level of 0.05 there was no causal effect of customer focused technology on revenue.

However, at the 0.10 significance level there was evidence of a causal relationship of innovative technology on revenue.

5.3 Research Finding

5.3.1 Null Hypothesis (H_0)

Customer focused innovative technology has no impact on the passenger growth of low-cost carrier airline

In this research the null hypothesis asserts that there is no effect of the customer focused innovative technology on the passenger booking numbers growth of the low cost carrier airline in the study. Testing the granger causality of passenger numbers (pax) with projects it was discovered that the probability value (p-value) was **0.02134**. The p-value was below the significance level and therefore translated to the rejection of the null hypothesis. The rejection of the null hypothesis meant that indeed customer focused innovative technology had no granger cause impact on the passenger number growth of the low cost carrier airline.

5.3.2 Alternative Hypothesis (H_1)

Customer focused innovative technology has an impact on the passenger growth of low-cost carrier airline

As the p-value from the granger causality test was **0.02134**, it occurred within the range for which the alternative hypothesis was accepted**.** This meant that indeed, there was a granger causal effect of technology projects implementation on the growth of passenger numbers. The granger causal relationship of projects take 1 period (month) to be effective on the growth of the passenger numbers. Information and technology have become the airlines front line communication tool with the passengers who want more autonomy with the solutions that airlines provide. The continued efforts of the implementation of these technologies is indicative that passengers expect airlines to develop solutions that are relevant to them(Taneja, 2011).

Technology has had an impact on the growth in passenger numbers in part because of the proliferation of mobile devices and the applications that can be used on these platforms. Airlines are also using innovative technology to enable ticket payments through customisation of bespoke

payment engines and more accessible mobile money transfer services (M-Pesa in East Africa) for the unbanked (Bowen, 2019).

The causal effect of technology on passenger or customer growth is in alignment with why many successful companies have been maximising how to drive their customers spending through technology and innovation and access a greater share of the customer's wallet (Van der Merwe, 2000).

Bieger et al (2007) posited that customer value was a factor that impacted the growth of demand micro level and influenced by the evolution of airline technological advances thus supporting the outcome that the impact on customer growth had a causal relationship with the innovative technologies implemented and the value they provided.

With pax as the dependent variable, it was discovered that the variables campaigns (0.9858) and revenue (0.4339) did not granger cause the growth of passenger numbers on Standard Air for the period under review. This meant that these two variable did not influence or cause the growth of passenger numbers.

While low cost carrier airlines such as EasyJet saw the potential of social media platforms to engage customers, Ryanair did not use a social media as a marketing strategy for their airline. This abstention from this marketing strategy did not diminish the rising passenger number, load factors nor profits of Ryanair (Poulsen et al., 2016). As indicated by the results of the granger causality test of this research for Standard Air, marketing did not have a causal effect on the growth of passenger numbers thereby echoing some of the reasons why Ryanair did not invest in marketing as a strategic imperative to grow their passenger numbers (Poulsen et al., 2016). According to Acha-anyi (2016), in South Africa, marketing remains one of the biggest weaknesses of the airlines regardless of the marketing strategies explored. The marketing is seen to be elitist and did not adequately filter to the majority of the population. This again was further indicative that passengers continue to fly with no particular influence by marketing which in itself in South Africa targets a small demographic of the population (Acha-anyi, 2016).

A granger cause bi-directional test was performed on each of the variables Projects, Campaigns and Revenue on the Pax variable. It was determined that there is no bi-directional granger cause on the Pax variable by the projects and campaigns variables of the data set of the tested variables

in the data set. However, the results do show that Pax has a granger cause effect on revenue. This result supported the reasonable logic that the greater the number of passengers booking seats, the more the revenue that is expected. Iberia Airlines showed increased market share of the customer segmentation propelled by new technologies had positive effects on revenue (Van der Merwe, 2000).

The relationship between innovation and technology and how airlines need to adapt is becoming more and more critical to understand by airline strategists. One such strategist is Fernando Estrada, chief strategy officer at Vueling which is part of the International Consolidated Airlines Group has suggested how mobile features have a positive and constructive effect on customers' travel experience. To quote Estrada, "Since then, we have added many handy features to smooth customers' travel experience, with the app receiving more than two million downloads to date, with a usage of 1.5 million every month" (Brewer, 2015).

As this market is very competitive, price is an important factor for customers but is not always the key determinant for them to make that purchase. Other factors also weigh in on their decision and these include products and services that the airline offers. With the advent of increasing mobile usage and technology advancement airlines are introducing products and services that are being facilitated by these tools to improve the customer's access to them (Kim and Lee, 2011). There is a constant need to re-think and design new innovative products and services with increased functionality. Being innovative is essential for many reasons, amongst which is to better serve customers and to meet the demands of mobile devices and smartphones users more easily and faster further building customer value (Brewer, 2015).

5.4 Conclusion

The research findings found that the p-value was below the significance value and therefore the null hypothesis was rejected. This means that indeed there there was a granger causal effect of technology projects implementation on the growth of passenger numbers. In summary, technology has had a positive impact on the growth of passenger numbers. Some of these technologies were discussed in chapter 2 and are indicative of how airlines are using technology and innovation to drive customer spend (Van der Merwe, 2000).

CHAPTER 6

6 Conclusions and Recommendations

The main objective of the research was to determine if there was an impact of the customer focused technology projects on the growth of passenger numbers on Standard Air over the period under consideration (January 2007 to December 2017). The passenger growth of Standard Air may be determined by various factors in the operational lifecycle of the airline. The research study took into account another variable which airlines use to deliberately target their customers, which are marketing campaigns.

The marketing campaigns did not seem to have a positive impact on the growth of passenger numbers nor did they have a positive impact on the revenue growth. This suggested that from an operational perspective the efforts of the campaigns did not have an impact on improving the passenger booking numbers. It would have seemed that marketing campaigns would assist in improving passenger numbers.

Overtime there was a notable positive linear relationship of passenger growth and revenue. This stands to reason as the assumption is the more passengers that are booked on Standard Air the more the expected revenue. This assumption is also highlighted in the correlation matrix that shows that there was a very strong correlation between the passenger numbers and revenue.

The granger causality test of the relationship between passenger numbers and customer innovation technology shows that there was a granger cause that the projects did have an impact on the growth of passenger number. This meant that providing customers with innovative technology that provides more information and improved access to products and services does grow the passenger numbers on a low cost carrier airline. The technology projects that have been implemented have added customer value to the passengers giving them information, ability and autonomy to make purchases of the airlines inventory. An analysis of the collected marketing campaigns data does not support that there is any impact on the growth of passenger numbers by any marking campaign efforts.

It is therefore recommended that low cost carriers need to adapt to implementing customer innovations that can deliver relevant solutions to their customers to enhance their ticketing

booking experience as well as their travel journey from the first “click” to the arrival of their destination.

Limitations

The limitations of the research are that only the customer focused innovative technology was in the realm of the study. The study did not include other innovative technologies of a low cost carrier airline that are operational, that improve processes and that are used by the flight operations team, ground staff or cabin crew. This limitation meant that the total effect of innovative technology implementation could not be assessed and had to be omitted. Another limitation is that a survey was not conducted with the passengers to collect their actual feedback and perspective on the technology implementation and the effect of the implementations on their purchasing choices and other drivers for their decisions.

Also on the list of limitations was the catergorisation of the marketing campaigns and the identification of public and school holidays, major sporting and social events that necessitate travel throughout the year.

Recommendations

The study has highlighted some gaps in the knowledge of innovative technologies and how they impact the low cost carrier airlines and furthermore the airline industry at large. Further areas of research must look more in-depth into the type and catergorisation of innovative products that are being implemented. This can more specifically help identify which are the more value adding innovative products. Innovative technologies on the business operation of a low cost carrier airline and wider ranging aspects of the implementation of technology should be evaluated across the value chain of the business.

There were innovative technology implementations that encompassed ground staff operations, cabin crew (pilots and cabin attendants), operations control centre and other functions that are also instrumental and aid in the smooth running of the low cost carrier airline. Each of the different user groups mentioned will need to participate in the research to give their input and help catalogue the nuances and effect of the technology they use. Ancillary offerings are becoming how low cost airlines differentiate themselves and are a big driver of revenue for these airlines. Technology is also pivotal in making ancillary products available and dynamic so to the

airlines passengers. This could also be a great area of research to conduct to determine an airlines profitability and chance for success.

These areas of research would allow better understanding of the different views of the technology implementations, the usage impact on the system users and customers, the efficiency of the low cost airline operations and the commercial impact on passenger numbers and airline revenue.

There has been almost no research done on low cost carrier airline industry in South Africa, let alone Africa. Another area of research would be to analyse the technologies low cost carrier airlines use on the African continent and how the technologies are derived (off the shelf or bespoke to the airlines business strategy). These research areas may shed some light on the rate of success of low cost carriers in Africa.

Another recommendation for future research must look at analysing feedback from the customers on the innovative technology and products and services specifically delivered by such technologies and the value derived by the customers.

Further research on the recommendations above will provide a greater understanding of the impact that technology has on the low cost carrier consumer on the African continent.

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Appendices

Appendix A

i. Research Approval letter

17/07/2018

Dear Mr. Erik Venter,

Re: Participation in Research on **Innovative technologies in a domestic low-cost carrier airline**

I am a part-time MSc student in the School of Mechanical, Industrial and Aeronautical Engineering at the University of the Witwatersrand, under the supervision of Ms Bernadette Sunjka. My MSc title is: **The impact of customer focused innovative technologies on passenger growth for a domestic low-cost carrier airline (kulula.com)**

My belief is that the innovative technologies that are being implemented on kulula.com are enhancing passenger growth. I would specifically like to understand the role that the technologies focused on the customers use. has played in the survival of the company.

I would like to formally request data on kulula.com that relates to passenger numbers, revenue generated and technology implementation chronology between January 2007 and December 2017 from Comair Limited.

I would like to collect the relevant data to my research between August and December 2018. The research will not require any formal face to face interviews nor surveys. Assistance from different resources in the organisations may be needed from time to time to give better context to the data being collected and understand any key industry definitions that would assist in the research as a whole.

Participation in the study is voluntary, and you may be withdrawn at any time. Anonymity (regarding any owner/manager/employee names) and confidentiality of information provided will be assured and respected.

The results of the study will form part of my MSc dissertation report and may also be reported in academic papers and at conferences. A summary of the results of the research will be made available to you on request.

Please contact me if you have any questions regarding the research and participation in the study.

I look forward to hearing from you.

Yours faithfully

Modisha Maribe

approved.

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ii. PDF version of Research Approval

Adobe Acrobat Document

Appendix B

i. Customer oriented projects identified

These are the customer oriented technology projects that were identified between January 2007 and December 2017. These projects do not include any project that is not specifically geared to customer use. Projects that improve customer experience but do not directly engage with the customer have also not been included in the list of projects identified below.

Item #	Project Name	Description	Customer/Backend	Go-live Date
1	Departure Control System	Testing at Durban and Lanseria have been very successful, with only some minor issues to be sorted out. Lanseria was given the green light and is now live for check-in and departure gates. The delay allowed the team to work on home printed boarding passes. This will go live for Lanseria in Early Feb.	Customer	July, 2009
2	Sabre Airmax	A Team from Sabre came to investigate the work done and to assist Comair in preparation for the implementation. Further development work is required to accommodate Serial Nesting and will be completed in March 2010 Thereafter Sabre will take approximately 4 to 5 months to set up the system and gather historic data for Comair. The system should be ready for User Acceptance Testing in August 2010	Customer	September 1, 2009
3	SLOW Lounge	The SLOW Lounge project was delivered on time and is proving to be very successful. Additional functionality is under development to allow for centralized reporting.	Customer	December 9, 2010
4	Directory Module	The development work on the DM project for MT Beds was completed and the system is in User Acceptance Testing phase. It should be released in Feb 2010	Customer	February 1, 2010
5	Travel Portal (OJ) Phase 1	- The team are currently building Application Programming Interfaces to and from the OJ platform as well as assisting with hardware & deployment support - IT are also investigating the opportunity to deploy a suitable Content Management System on K3 to be able to support changing requirements going forward	Customer	August 1, 2010

6	Travel Portal (OJ) Phase 2	- The team are currently building Application Programming Interfaces to and from the OJ platform as well as assisting with hardware & deployment support - IT are also investigating the opportunity to deploy a suitable Content Management System on K3 to be able to support changing requirements going forward	Customer	November 1, 2010
7	Travel Portal (OJ) Phase 3	- The team are currently building Application Programming Interfaces to and from the OJ platform as well as assisting with hardware & deployment support - IT are also investigating the opportunity to deploy a suitable Content Management System on K3 to be able to support changing requirements going forward	Customer	September 1, 2011
8	Ancillary Products		Customer	May 9, 2012
9	Group Booking tool	OJ Platform	Customer	October 1, 2011
10	Mobi Standard Air Check-in		Customer	September 1, 2011
11	Vitality SID			August 20, 2013
12	Travelbank R6			October 13, 2013
13	Vitality Hotels			January , 2014
14	Hotel search Input	Improve the search facility for hotels	Customer	August 31, 2017
15	Caravello Cross Sell	Upselling of seats from economy to club class or across the airline brands		November 2, 2017
16	Group Optimiser	Group traveler booking tool to manage traveler groups and manage their rates and benefits		October 30, 2017
17	Lounge Access	Allow ancillary payment for access to the SLOW lounges	Customer	November 7, 2017
18	Europcar	Book flight plus car		November 1, 2009
19	Refund Reason	Ability to get start refund claim		October 1, 2009
20	Add Infant	Ability to add an infant to a booking		November 1, 2009
21	SID security Info Update	Improving payment process of the SID		March 1, 2009
22	Vitality Log-in Enhancement	Improve seamlessness		February 1, 2009
23	Project Moolah	money transfer options		July 1, 2010
24	Online check-in	online check-in ability		January 1, 2010

25	eBucks as a form of payment	Ability to use eBucks to make payments		December 1, 2012
26	Avios transfer	Ability to transfer AVIOS points to make payment		August 1, 2017
27	Etihad IET	IET and Codeshare with the airline		November 1, 2016
28	Tempest car hire	the airline & vitality car hire offer		July 1, 2016
29	Variable Booking Fee	Vitality Variable booking for encourage booking products earlier than travel time		July 1, 2016
30	Branded Fares	Structure the seat fares into different structures for customer differentiation		March 1, 2016
31	Kiosk Upgrade	Enhancements to the Sabre Kiosk		May 1, 2016
32	Groups Travel	Groups traveler booking enhancements		July 1, 2016
33	Vitality Stream Function	Streamline vitality booking functions		September 1, 2015
34	Seating by Attribute	Selecting seating based on seat position in the cabin		March 1, 2015
35	KQ IET	IET and Codeshare with the airline		March 1, 2013
36	Flexi Fares	Flexible fare structures to accommodate customer differentiation		February 1, 2013
37	Travel Insurance	Offering travel insurance		March 1, 2011

Appendix C

i. Observation grid for the collection of project implementation data

Year /Month	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
2007												
2008												
2009	1		1	1	2			1	1			
2010	1	1			1	1	1	1				
2011			2	1					1			
2012						1					1	
2013		1		1				1	1			
2014							1					
2015			1				1		1			
2016	3				1				1		1	
2017		2		1	2							

ii. Observation grid the collection of marketing and campaign data

Year /Month	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
2007												
2008												
2009												
2010												
2011	4	6	3	5	5	4				5	4	6
2012	1		3	1	1	1	4	4	5	6	4	6
2013	1	1	1							2	1	1
2014												
2015												
2016		1		1		1	1			1		
2017		1			1		1				1	1

iii. The observation grid to combine all variable data

This is the observation grid of the research. It includes the year and month of the passengers (Pax) and the revenue, as well as the projects (technology implementations) and the marketing/advertising campaigns that were carried out in the corresponding month and year.

Year	Month	Pax	Revenue	Projects	Campaigns
2007	July	129,988	63,556,192	0	0
2007	August	124,254	60,819,267	0	0
2007	September	137,076	73,861,465	0	0
2007	October	134,700	69,581,166	0	0
2007	November	134,993	71,373,546	0	0
2007	December	152,016	89,769,275	0	0
2007	January	129,153	65,109,246	0	0
2007	February	127,088	59,169,720	0	0
2007	March	141,402	74,335,948	0	0
2007	April	145,657	80,387,044	0	0
2007	May	124,213	53,531,876	0	0
2007	June	118,719	58,905,367	0	0
2008	July	141,340	68,531,633	0	0
2008	August	139,730	70,156,668	0	0
2008	September	140,537	77,381,329	0	0
2008	October	133,887	70,685,040	0	0
2008	November	149,126	78,377,046	0	0
2008	December	176,447	113,909,020	0	0
2008	January	145,460	78,500,772	0	0
2008	February	152,754	77,158,608	0	0
2008	March	174,182	109,967,477	0	0
2008	April	157,173	92,098,238	0	0
2008	May	150,932	88,436,851	0	0
2008	June	148,183	93,539,235	0	0
2009	July	160,240	103,210,930	1	0
2009	August	165,277	105,681,552	0	0
2009	September	154,638	109,850,994	1	0
2009	October	163,003	110,580,467	1	0
2009	November	149,323	95,303,240	2	0
2009	December	168,993	128,512,595	0	0
2009	January	144,019	96,712,845	0	0
2009	February	130,659	83,793,527	1	0
2009	March	154,193	103,069,070	1	0
2009	April	167,873	121,171,588	0	0
2009	May	136,792	78,396,251	0	0
2009	June	138,866	89,170,731	0	0
2010	July	151,945	90,566,859	1	0
2010	August	141,486	86,464,865	1	0
2010	September	153,443	95,512,658	0	0
2010	October	173,264	100,033,796	0	0
2010	November	166,183	100,821,903	1	0

2010	December	185,918	127,551,052	1	0
2010	January	161,445	105,871,669	1	0
2010	February	165,271	93,860,860	1	0
2010	March	204,974	139,203,114	0	0
2010	April	222,024	136,539,169	0	0
2010	May	203,067	101,479,241	0	0
2010	June	203,790	141,428,971	0	0
2011	July	197,458	134,581,995	0	0
2011	August	218,144	118,883,692	0	0
2011	September	219,069	125,121,155	2	0
2011	October	229,092	126,545,038	1	5
2011	November	225,936	115,387,955	0	4
2011	December	265,446	169,429,946	0	6
2011	January	225,225	126,193,126	0	4
2011	February	224,350	119,947,943	0	6
2011	March	243,518	150,785,040	1	3
2011	April	229,886	155,037,007	0	5
2011	May	205,991	100,137,434	0	5
2011	June	207,898	96,644,269	0	4
2012	July	238,057	124,129,707	0	4
2012	August	225,247	115,423,311	0	4
2012	September	224,416	128,897,964	0	5
2012	October	238,030	133,274,800	0	6
2012	November	213,698	118,122,221	0	4
2012	December	243,231	178,080,376	1	6
2012	January	199,082	121,590,422	0	1
2012	February	201,256	122,389,748	0	0
2012	March	237,036	168,747,006	0	3
2012	April	241,819	165,649,395	0	1
2012	May	198,929	132,987,157	1	1
2012	June	208,756	149,853,013	0	1
2013	July	210,280	150,520,560	0	0
2013	August	206,506	146,160,622	1	0
2013	September	236,658	168,978,527	0	0
2013	October	238,148	170,538,358	1	2
2013	November	247,959	185,722,184	0	1
2013	December	279,409	231,471,798	0	1
2013	January	250,619	178,723,575	0	1
2013	February	242,929	191,774,416	1	1
2013	March	299,188	251,722,588	1	1
2013	April	274,133	227,783,644	0	0
2013	May	250,050	184,845,049	0	0

2013	June	242,355	179,827,179	0	0
2014	July	252,136	183,872,460	0	0
2014	August	266,104	198,367,311	0	0
2014	September	268,942	219,246,342	0	0
2014	October	270,779	215,957,932	0	0
2014	November	259,855	207,201,083	0	0
2014	December	292,364	254,785,801	0	0
2014	January	249,703	199,233,050	1	0
2014	February	245,031	198,016,365	0	0
2014	March	278,675	246,500,331	0	0
2014	April	275,693	246,272,812	0	0
2014	May	251,077	187,504,570	0	0
2014	June	251,341	183,084,958	0	0
2015	July	268,659	198,906,988	0	0
2015	August	270,181	204,031,119	0	0
2015	September	271,863	227,226,701	1	0
2015	October	297,682	250,723,728	0	0
2015	November	267,421	212,104,870	0	0
2015	December	293,810	258,945,750	0	0
2015	January	241,767	207,396,334	1	0
2015	February	245,399	188,162,610	0	0
2015	March	279,438	225,614,154	1	0
2015	April	262,321	231,199,728	0	0
2015	May	223,159	168,376,734	0	0
2015	June	208,198	158,666,230	0	0
2016	July	261,253	183,413,168	3	1
2016	August	264,107	181,617,441	0	0
2016	September	275,700	191,314,264	0	0
2016	October	293,676	202,851,913	0	1
2016	November	275,732	180,321,619	1	0
2016	December	306,293	241,722,176	0	0
2016	January	267,969	189,536,036	0	0
2016	February	254,426	186,447,127	0	1
2016	March	272,531	250,663,535	1	0
2016	April	252,673	213,508,222	0	1
2016	May	231,990	186,445,599	1	0
2016	June	220,019	173,132,009	0	1
2017	July	254,438	193,523,909	0	1
2017	August	242,006	193,882,685	2	0
2017	September	267,416	199,276,106	0	0
2017	October	295,092	227,368,707	1	0
2017	November	266,586	187,664,384	2	1

2017	December	288,492	252,672,573	0	1
2017	January	253,396	188,159,929	0	0
2017	February	252,943	180,565,846	0	1
2017	March	282,045	224,094,160	0	0
2017	April	279,911	237,032,928	0	0
2017	May	271,403	182,041,940	0	1
2017	June	253,537	167,993,628	0	0

Appendix D

The R programmes for the different statistical analyses are captured below. Each group of programmes are explained and the functionality they perform.

i. Installing Statistical Packages

```
#installing packages

install.packages("readr")#to read the data, in this case to read our csv format

install.packages("readxl")#to read the data, in this case to read our csv format

install.packages("DataExplorer")#to conduct our exploratory data analysis

install.packages("ggplot2")#to plot or graph

install.packages("tidyr")# Creating custom views of data

install.packages("dplyr")

install.packages("lmtest")#to conduct granger causality test

library(DataExplorer)

library(readxl)

library(ggplot2)

library(tidyr)

library(dplyr)

library(lmtest)

theme_set(theme_minimal())#works with the ggplot, for aesthetics
```

ii. Fetching the dataset

```
passenger <- read.csv(file.choose(),header=TRUE) #Fetching the data

passenger
```

iii. Statistical Model: Exploratory Data Analysis

```
###Univariate

head(passenger)

#Data cleaning

passenger$Date = as.Date.character(passenger$Date)

#checking the dimension of the input dataset and the time of variables.

plot_str(passenger)

#search for Missing Values

plot_missing(passenger)

#Histogram is analyst's best friend to analyse/represent Continuous Variables.

plot_histogram(passenger)

plot_density(passenger)

###Multivariate

plot_correlation(passenger, type = 'continuous')
```

iv. EDA Part 2, looking at time series plots

```
# Basic line plot for Pax

# "#00AFBB" - Blue

#"#FC4E07" - Orange

ggplot(data = passenger, aes(x = Date, y = Pax))+

  geom_line(color = "#00AFBB", size = 2)

# Basic line plot for Revenue

ggplot(data = passenger, aes(x = Date, y = Revenue))+

  geom_line(color = "#00AFBB", size = 2)
```

v. Comparing two variables Revenue & Pax over date and value

```
dataframe1 <- passenger %>%

  select(Date, Pax, Revenue) %>%

  gather(key = "variable", value = "value", -Date)

head(dataframe1, 3)
```

vi. Multiple line plot

```
ggplot(dataframe1, aes(x = Date, y = value)) +
 geom_line(aes(color = variable), size = 1) +
 scale_color_manual(values = c("#00AFBB", "#E7B800")) +
 theme_minimal()
```

vii. Optimal lag selection (Akaike's Information Criterion)

VARselect(passenger$Projects)

$selection

AIC(n) HQ(n) SC(n) FPE(n)

1 1 1 1

$criteria

1 2 3 4 5 6 7 8 9 10

AIC(n) -1.0782814 -1.0670653 -1.0515191 -1.0406050 -1.0380419 -1.0218470 -1.0058233 -0.9940868 -0.9796241 -0.9699780

HQ(n) -1.0596108 -1.0390594 -1.0141779 -0.9939285 -0.9820301 -0.9564999 -0.9311409 -0.9100692 -0.8862711 -0.8672897

SC(n) -1.0323138 -0.9981139 -0.9595840 -0.9256861 -0.9001392 -0.8609605 -0.8219531 -0.7872328 -0.7497863 -0.7171564

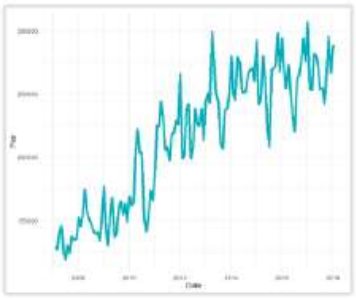
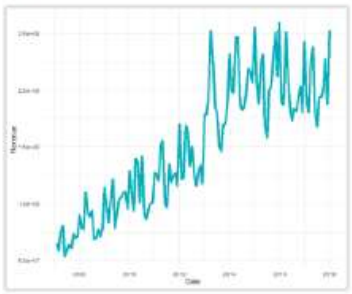
FPE(n) 0.3401807 0.3440200 0.3494148 0.3532571 0.3541756 0.3599750 0.3658123 0.3701606 0.3755907 0.3792776

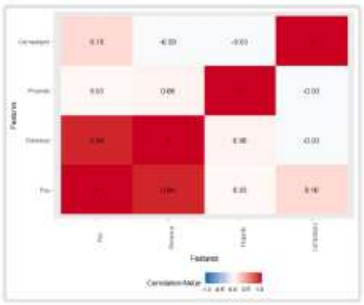
viii. Granger Test

```
plot(passenger)

grangertest(Pax ~ Projects, order = 1, data = passenger)

grangertest(Pax ~ Projects, order = 4, data = passenger)

grangertest(Pax ~ Campaigns, order = 4, data = passenger)

grangertest(Pax ~ Revenue, order = 4, data = passenger)

##Check for Bi-directional##############

grangertest(Projects ~ Pax, order = 4, data = passenger)

grangertest(Campaigns ~ Pax , order = 4, data = passenger)

grangertest(Revenue ~ Pax, order = 4, data = passenger)
```

Appendix E

i. Informal conversation interview

	Question	Response (Y/N)	Comments
1	Is the requested data collated from a system	Y	
2	Would you collate the requested data the same way each time	N	Due to changes in systems, methods had to differ
3	Do you have to manipulate the values of the data	N	Values were collected and supplied as found
4	Does the data collated reflect a positive linear trend	Y	
5	Would you expect that technology projects would impact passenger growth?	Y	The use of technology within our organisation revolutionalised bookings and customer growth tremendously
6	Would you expect that marketing campaigns would impact passenger growth?	N	In my experience, passengers look for experience and affordable prices. Marketing may stimulate demand but rarely translate to growth
7	The graph shows the relationship of passenger numbers overtime. Does this represent your expectpectation? 	Y	This is in line with expectations
8	The graph shows the relationship of revenue overtime. Does this represent your expectpectation? 	Y	

9	There is a close positive relationship between passenger numbers and revenue at 0.94. This means that when passenger numbers change, the revenue also changes in the same direction. Does this represent your expectation 	Y	The more the passengers, at the right price, the higher the revenue.
10	The results show that there is a form of causal relationship between the projects implemented and the growth in passenger numbers. The impact is not immediate but is evident after 1 month of implementation. From your experience would you agree with this finding?	Y	Better methods of booking and offering products have resulted in higher pax numbers
11	The results show that there is no causal relationship between marketing campaigns and the growth of passenger numbers. From your experience would you agree with this result?	Y	

12	The findings show that there is no causal impact of revenue on passenger numbers but that there is a causal relationship on revenue by passenger numbers. From your experience is this in line with the reality?	Y	Revenue is as a results of passengers and not the other eay round.

Adobe Acrobat Document

Appendix F

i. Ethical Clearance Approval letter

Ethics Clearance Number for Modisha Maribe Inbox ×

Bruno Emwanu <Bruno.Emwanu@wits.ac.za> 22 Jun 2020, 11:56 (1 day ago)
to 1894632@students.wits.ac.za, me, Bernadette

Dear Maribe,

I am pleased to inform you that your ethics application for MSc 50/50 has been successful. The Ethics number is MIAEC 025/20. Please use this number for future reference on the same matter.

By copy of this email your supervisor is also informed.

Regards,

Dr. Emwanu