AIRLINE REVENUE MANAGEMENT

PERFORMANCE MEASUREMENT OF SOUTH AFRICAN AIRWAYS

ORIGIN-DESTINATION REVENUE MANAGEMENT

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ABSTRACT

Revenue Management (RM) in the airline industry is the practise of selling fixed capacity as a service over a finite time horizon. The market is characterised by the customers' willingness to pay different prices for the service. This creates the opportunity to target different customer segments and use price differential to attain the optimal passenger fare mix to maximise revenue. The aim is to maximise revenue and an airline can expect revenue increase of between 3 to 7 percent with the successful implementation of a Revenue Management system. The question of whether the revenue increase can be attributed to the RMS is crucial in determining its level of success and validating the optimisation strategy applied (Rannou and Melli, 2003). South African Airways (SAA) migration from Leg-based optimisation to Origin-Destination (O&D) network based revenue management optimisation created the opportunity for this study to measure and evaluate the RMS performance. Revenue performance measuring tools using inventory systems data to measure RMS performance, ASK (Available Seat Kilometre), RASK (Revenue per Available Seat Kilometre), CASK (Cost per Available Seat Kilometre), RPK (Revenue Passenger Kilometre) and cabin factor yield. The limitations relating to the performance measuring tools utilising inventory system data, is the inability for continuous measurement and the isolation of the impact to revenue due to the RMS on its own. In seeking to gauge the performance of the O&D optimisation, the Revenue Opportunity Model (ROM) is applied. ROM is a post departure measuring tool utilised to continuously measure and isolate the contribution of the RMS on SAA's O&D network. The revenue opportunity achieved versus the potential revenue was assessed. A revenue comparison of the airlines 2014 and 2015 financial year is performed. The results of the analysis showed the O&D optimisation yielded positive revenue capture on routes that applied the correct optimisation strategy. Recommendations on the optimisation strategy to be applied on routes having average or low revenues captured are presented.

The aim is to provide the SAA revenue management department with tangible solutions that would result in increased revenue for the SAA network.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADR average daily rate.

ARO achieved revenue opportunity.

APCD available passenger cruise day.

ASK available seat kilometre.

CASK cost per available seat kilometre.

DWM decision window model.

DINAMO dynamic inventory allocation and maintenance optimizer system.

EMSRa expected marginal seat revenue (a).

EMSRb expected marginal seat revenue (b).

MIT Massachusetts institute of technology.

O&D origin and destination.

PARO percentage achieved revenue opportunity.

PM performance measurement.

PODS passenger origin-destination simulator.

RASK revenue per available seat kilometre.

RevPASH revenue per available seat-hour.

RM revenue management.

RMS revenue management system.

RO revenue opportunity.

ROM revenue opportunity model.

RPK revenue passenger kilometre.

SLF seat load factor.

DECLARATION

I, Duncan Githiri, hereby declare that this thesis is my own original work, that all references and sources have been accurately reported and acknowledged, and that this document has not previously, in its entirety or part, been submitted to any University to obtain an academic qualification.

Duncan Githiri

9 December 2016

CHAPTER 1: INTRODUCTION

1.1 Introduction

This chapter starts by providing the context of revenue management in the airline industry and the need for RM in SAA. The scope of the research is explained and the research question guiding this research is introduced. The objectives, aims to be fulfilled are explained and the theoretical framework of RM is explained. It concludes with the structure of the thesis.

1.2 Revenue Management Context

Revenue management (RM) is a pricing technique utilised in capacity constrained service industries to maximise revenue. Industry conditions that are conducive to RM are characterised as having perishable inventory, limited supply or capacity, varying demand with time, the ability to segment the market, product or service can be sold in advance, low cost competition, high fixed cost, low sales margins and fluctuation in balancing supply and demand. The airline industry is fundamentally service orientated with no physical exchange of goods in return for money paid. RM in this context is about increasing the airlines revenue by forecasting and responding to passenger demand by either accepting or rejecting different priced tickets on sale to the customer. Originating in the airline industry following the deregulation of the USA airline market in 1979, other industries that have applied RM are hotels, car rental, railways and cruise lines (Talluri and Van Ryzin, 2008).

The specific application of RM varies from industry to industry but the underlying theme and goal is to increase revenue. Per Belobaba (2011), an airline can expect revenue growth of between 4 to 6 percent with the successful implementation of RM. Quantifiable success at American Airlines following the successful implementation of revenue management systems resulted in a 4.5 percent increase in revenue in 1985 (Smith et al, 1992). National Car Rental emerged from liquidation with the implementation of RM that resulted in revenue increase of $ 56 million, (Geraghty and Johnson, 1997), Hertz car rental reported a 5 percent increase in revenue (Carroll and Grimes, 1995) and

Mexican restaurant chain Chevy's Mexican Restaurants reported 5% revenue increase after adopting revenue management systems (Kimes, 2004).

Facing increased competition from low cost carriers on the domestic market, Gulf airlines in the long-haul market and the high oil price resulted in SAA incurring losses of R843 million in 2011/12, R1.1 billion in 2012/2013, R1.6 billion in 2013/2014, R5.6bn in 2014/15 and R1.5bn in 2015/16 financial year (SAA, 2016). A long-term turnaround strategy identified the inability of SAA to effectively optimise revenues as a major factor in the loss-making of the airline. A migration from leg based revenue optimization to Origin–Destination (O&D) revenue optimization was implemented in 2014 aimed at controlling seat availability based on origin-destination passenger requests. The aim of O&D is to determine accurate fare and class levels; control passenger spill due to overbooking and optimising the departure times to increase revenue. The main objective for SAA is to better utilise the airlines ''perishable inventory'' (seats on a flight) by effectively optimising the inventory on the airlines whole network resulting in the allocation of a fare to a passenger on an itinerary that would generate the highest revenue for the airline. O&D optimization offer the airline the ability to priorities long-haul connecting passengers over domestic passengers when the long-haul passengers generate higher revenue over the network or when it is advantageous to prioritise domestic passengers (Pak and Piersma, 2002).

1.3 Research Scope

The deregulation of prices and flight schedules following the enactment of the 1978 Airline Deregulation Act in the USA was the catalyst for the growth of discounted fares. The simplified business model of the new airlines offering less restricted fares structures developed into the Low-Cost Carriers that have captured substantial market share today. The growth of LCC provided the impetus for fundamentally changing the pricing models of airlines. Internet distribution channels created transparency and offered more information on the fare structure enabling the customer to easily compare different airfares. Legacy carriers like SAA were forced to respond by offering comparable fares to protect their market share. By simplifying the fare structures, the legacy carriers were losing the most effective tool to segment business and leisure passengers. Higher productivity and better utilisation of aeroplanes coupled with aggressive cost cutting enabled the legacy carriers to bridge the pricing gap offered by the LCC. Having achieved substantial cost cutting and higher productivity, RM became the competitive advantage the airlines could utilise to increase revenue (Belobaba, 2011).

Early RM systems developed in the 1980s utilised data from computer reservation systems to compare actual bookings to a predetermined booking threshold that would be profitable to the airline. By the 1990s RM systems were developed to calculate booking limits for each fare class using mathematical models to forecast and optimise flights. The RM systems were designed for restricted fares and assumed independent demand for each fare class. The demand assumption that a passenger is only willing to purchase the fare class only with no possibility of selecting another airline, itinerary or lower fare was flawed. Legacy carries adapted to the changing market conditions and started offering less restricted tickets. The less restricted fare structures resulted in a higher load factor as more passengers purchased tickets. This was due to the passengers purchasing the lower value fare resulting in reduced revenue for the airline. The RM systems were required that would optimise and forecast demand for restricted and unrestricted fares assuming dependent demand. By the year 2000, LCCs had increased the number of itinerary and fare options. To remain competitive airlines invested in new RM systems that could forecast and optimise flights with few restricted fare structures assuming dependent demand over the entire network. Current RM systems utilising Origin Destination network controls can model the passenger's willingness to pay therefore forecasting demand and optimise inventory over the entire network with no restricted fares assuming dependent demand. This offers the airline the ability to match the LCCs unrestricted fares and protect the revenue from high paying business passengers by restricting and closing the low fares early, encouraging buy-up (Fiig et al, 2010).

SAA's migration from leg-based to origin destination network controls (O&D) and the advancement in the airlines' ability to accurately forecast dependent demand resulted in the requirement for a method to continuously evaluate and track the revenue management performance. Previously SAA utilised leg-based revenue management controls to manage each flight independently assuming single demand of each flight sector with no interdependencies between different flights. Origin Destination revenue management controls which SAA has migrated to, consider the passenger itinerary and the interdependencies between each flight sector to evaluate a connection booking request as one Origin & Destination itinerary. The result is optimal seat availability determined from the whole network that would result in the highest revenue gain at the time the booking is requested (Chiang et al, 2007). With O&D control, a passenger connecting on SAA for a long-haul flight from a feeder airline in a low booking class will be accepted as the higher revenue gain from the long-haul flight maximising the revenue which is optimal for the whole network. With single leg based controls used by SAA previously, each flight sector is evaluated separately and the passenger connecting to SAA with a lower booking class from the feeder airline will be considered poor revenue management control and not accepted. The scope of this study is to quantify and validate the results achieved by Origin Destination revenue management control.

1.4 Research Problem

For SAA, the desired result of O&D revenue optimisation is an increase in revenue. This increase is attributed to the RM system excluding external factors that would contribute to revenue increase due to market forces. The research design is to evaluate whether the switch from leg based revenue optimisation to O&D revenue optimisation has resulted in revenue increase for the airline. The following research question guides this study:

Has the migration from leg based revenue optimisation to O&D revenue optimisation provided overall network optimisation resulting in increased revenue for SAA?

1.5 Research objectives

The objective of the research in measuring the performance of SAA's O&D revenue management system is to:

- Evaluate the performance of revenue management controls applied,
- With perfect hindsight identify the optimal RM controls to produce maximum revenue,
- Gauge the merits of the RM approach as either profitable or poor,
- Provide options and insight into alternatives on what could have been done differently to improve revenue performance.

1.6 Theoretical Framework

Fundamentally the theory and practice of RM is concerned with demand management decisions and the methodology and systems required to make the decisions resulting in the efficient use of perishable capacity. Drawing from microeconomics, RM is an airlines' attempt to balance the market forces of supply and demand resulting in price differential and market segmentation. The demand management decisions in airline RM can be classified as: Price decisions on how to price categorised booking classes, the ability to mark down or discount an airfare over time and how to price individual or group packages and reserve prices. Inventory or Quantity decisions relating to the allocation of seat capacity to different market segments, managing capacity by accepting or rejecting offers to purchase tickets or when to withhold and sell tickets later as demand increases. Structural decisions relating to the method of market segmentation and price differential. Refund and cancellation options and the format used for the sale of tickets either by fixed prices or auction bidding (Birbil et al., 2013).

By addressing supply and process decisions, RM can be viewed as being complementary to supply chain management (Talluri and Ryzin, 2005). Pricing is critical in RM and the management of advance pricing determines the success of the RM strategy. An airline must be able to dynamically control differential pricing throughout the selling period before the flight departs. Optimisation controls inventory when market conditions dictate, allowing for the highest paying mix of passengers to be selected. This is achieved by closing low fare tickets when demand is high to sell the higher fare tickets.RM can therefore be summed up as the science of maximising revenue by forecasting demand and using mathematical optimisation to model future pricing and control inventory (Belobaba, 2009).

Having implemented an RMS, the justification for the significant investment in the system must be made. The performance measure of RM is aimed at gauging the success of the RMS and quantifying the potential revenue being achieved. Of critical importance is the continuous tracking of the RM performance to identify and eliminate weaknesses that may hinder the RMS from maximising revenue. Performance measure used in the airline industry are: ASK (Available Seat Kilometre), RASK (Revenue per Available Seat Kilometre), CASK (Cost per Available Seat Kilometre), RPK (Revenue Passenger Kilometre) and cabin factor yield. The limitation related to these performance measuring metrics in RM is the inability for continuous measurement and the inability to isolate the revenue impact due RMS on its own (Polt, 2001). Revenue Opportunity Model (ROM) is a post departure measuring tool utilised to continuously measure and isolate the contribution of the RMS. Using perfect hindsight, the estimated upper limit of achievable revenue is compared with the actual revenue revealing the potential revenue gains that can be attributed to the RMS. The performance measures provide useful information aiding in capacity management decisions and improving the pricing strategy (Rannou and Melli, 2003).

The impact on revenue resulting from the O&D network optimisation on its own have not been studied or quantified within SAA. The question, "Is SAA making as much money as it should be?" is therefore relevant due to the lack of clear directives or guidelines on the performance measure of RM in the airline. This research aims to provide useful empirical feedback to SAA on the merit of O&D and its impact on revenue thereby influencing the optimisation strategy utilised and aid in the decision-making process of the airline’s revenue management department.

1.7 Structure of Thesis

This thesis consists of six chapters and is structured as follows. Chapter 1 is an introduction providing the scope, problem statement and research objectives. An introduction to Revenue Management, the theoretical framework grounding RM and the context of the research from an SAA perspective. Chapter 2 is the literature review presenting a comprehensive account of revenue management which is the foundation of the research. Studies done on airline revenue management and the use of revenue management in other industries are addressed. Chapter 3 explains the research methodology in the context of measuring the performance effects of revenue management, the research goal, paradigm and a detailed description of ROM with its main facets. Revenue management performance measures in other industries are explained. Chapter 4 analyses and illustrates the results by means of ROM calculation tables and comparison tables of the passengers carried, total network revenue and average revenue per passenger from financial year 2014 to 2015. The results of each O&D route selected for the study are discussed. Chapter 5 discusses the results of the ROM calculations and the PARO effect on revenue. Chapter 6 is a summary of the research, recommendations on future RM research and the conclusion

1.8 Conclusion

In this chapter, an introduction of airline revenue managements' main components, the need for the research and discussed the structure of the thesis. The second chapter will focus on the literature review of revenue management; other industry use of RM and the performances measures used in other industry.

CHAPTER 2: REVENUE MANAGEMENT AND PERFORMANCE MEASURE LITERATURE REVIEW

2.1 Introduction

This chapter introduces the literature that grounds the research. A brief history on RM, its definition, the evolution and history of airline RM are provided. The theories highlighting the major components of RM are explained. The methods and techniques of performance measures in airline RM and a thorough over view of ROM is presented. A detailed analysis of performance measure limitations in the SAA context concludes this chapter.

2.2 History of Airline Revenue Management

The introduction of wide-body aeroplanes in the early 1970s significantly increased airline capacity resulting in increased competition. Following the Middle East oil embargo of 1973, the dramatic increase in fuel prices was the catalyst for the airline industry deregulation. The United States of America was the first country to deregulate its airline industry with the enactment of the Airline Deregulation Act of 1978 (US Government Accounting Office, 2006). The result of the deregulation was a rapid expansion of the hub-and-spoke networks servicing smaller secondary markets which most airlines had not been serving. Airlines increased load factor which lowered operating cost resulting in lower ticket prices for the passengers. The increased competition forced airlines to adapt business models which lead to the development of strategies that accurately estimate demand and allocate resources efficiently therefore increasing revenue (Belobaba, 2009). People-Express formed in 1981 exemplified the new revenue management approach with low airfares and a cost-efficient operation (Cross, 1997). Innovations in marketing that reward repeat airline customers like frequent flyer programs were developed by the airlines to build brand loyalty whiles offering customers added benefits.

The first revenue management model for a single leg flight with two distinct fare classes and two different prices was published by Ken Littlewood (Littlewood 2005). The term Yield Management was used to describe this model in the early

1980s. American Airlines developed the first on-line reservation system that centralized and controlled reservation activity with the launch of American Super Saver Fares (Smith et al., 1992). Expected Margin Seat Revenue (EMSR) developed by Belobaba (1987) introduced multiple nested fare classes which offered airlines the ability to generate expected bookings from historic data and compare this with actual bookings. The airlines were therefore able to manage demand on the expected bookings by recognising the willingness of different passengers to pay different prices for the same seat on the aeroplane. Airlines can therefore service the highest paying passengers by exploiting their differences to derive higher revenue.

2.3 Defining Revenue Management

Revenue Management is a pricing and demand management technique used to identify and target customers a company intends serving. By establishing the correct product or service offering and setting the optimal price models for the customer, higher profits can be achieved. The prime objective of revenue management is determining optimal inventory allocation by managing demand over time. This is achieved by using variable pricing and market segmentation to target customers based on their unique characteristics, dynamically balancing supply and demand. The airline industry is fundamentally a service industry with perishable capacity transporting passengers and cargo from one destination to another at an agreed price (Baker and Murthy, 2005). The characteristics of the airline industry of fixed capacity with perishable inventory, a reservation system, variable pricing strategy and market segmentation have created the need for revenue management. The components underpinning revenue management principals are inventory control which is the allocation of fixed capacity, pricing which relates to variable pricing of a product or service and demand forecasting (Zeni, 2001). American Airlines pioneered the definition of Revenue Management which is premised on selling the correct seat to the right customer at the appropriate time. By maximising capacity through demand management, American Airlines could systematically increase revenue (Belobaba, 1987). RM has evolved over the years, Weatherford and Polt (2002) present evidence of revenue increase of between 2% and 12% on specific routes serviced by U.S Airlines by upgrade RM. The airline industry revenue management is primarily focused on inventory control using demand forecast, customer segmentation, price differential and overbooking (Kimes, 2004).

2.4 Evolution of Airline Revenue Management

In 1971, Rothstein investigated yield management in airlines premised on overbooking policies either by considering the cost of denied boarding (overbooking) or considering the proportion of booked passengers denied boarding and the probability of denied boarding to minimize revenue loss through overbooking therefore increasing revenue (Rothstein,1971). Rothstein's theory assumed the price was fixed and not a critical factor (Bitran and Caldentey, 2003). Ken Littlewood working for British Overseas Airways Corporation later renamed British Airways, proposed the first revenue management model for a single leg flight incorporating two distinct fare classes and prices as the first publication on airline yield management. He described passenger forecasting and revenue models aimed at maximizing revenue instead of only increasing passenger bookings as was then the norm at the time (Littlewood, 2005).

Following the deregulation of the United States of America airline industry with the enactment of the 1978 Airline Deregulation Act, airlines had the freedom to amend prices and increase schedules resulting in innovation and increased investment in technology that enhanced the value to the airlines. New entrants into the airline industry with lower costs structures and diverse ticket prices resulted in price sensitive customers who embraced the mixed fare offering. Formed in 1981 People-Express were quick to explore revenue management techniques and models that offered a new revenue management approach with discounted fares that were up to 70% cheaper than traditional airlines as part of their product offering. By offering point to point operations and simplifying their service, they could lower cost and by 1984 revenue reported was $1 billion and profit $60 million (Cross, 1997). To counter the increased competition American Airlines developed the first on-line reservation system and launched American Super Fares (Smith et al., 1992). By 1988 American Airlines had developed Dynamic Inventory Allocation and Maintenance Optimizer system (DINAMO) which was the first large scale revenue management system that offered the airline booking comparison of forecasted bookings and actual bookings by generating expected booking data (Sun et al., 2011).

The use of complex mathematical algorithms in operations research, coupled with technology advancement ushered in sophisticated revenue management systems with different views on the expanded scope of revenue management. The advancement did not change RM as a demand management decision making strategy, but rather the methodology of the decision-making process in airline revenue management (Boyd, 2004). The introduction of Expected Margin Seat Revenue (EMSRa) by Belobaba, (2008) incorporating multiple nested fare classes advanced the Littlewood rule. The model forecasts demand to a seat allocation optimisation model. This model determines the number of seats, or booking limits, to be allocated to each booking class. Expected Margin Seat Revenue (EMSRb) evolved following developments in RM systems from simple single leg control to segment control, to the current origin– destination control. O&D with computation ability to interpret, compute and formulate solutions using data from over 800 flights and over 165 aircrafts by way of complex algorithms improved the accuracy of the RM. Due to the complexity and volume of data used in the decision-making task of an RM system, the task of computation is beyond the human ability. Without the technological advances, the computation task would have to be simplified to such an extent that the opportunity for revenue growth would be lost. Scientific advances in operational research, statistics and information technology have resulted in RM systems with the capabilities of modelling demand, simulating economic conditions and accurately forecasting market response leading to better management of demand decisions and pricing strategies (Barnhart et al., 2003).

2.5 The Theory of Airline Revenue Management

Revenue Management utilises economic principles of supply and demand as an optimisation tool by combining price with statistical analysis. The aim is to increase revenue from the available capacity resulting in higher profits. Demand management in Airline Revenue Management is the concept of selling the right product to the appropriate consumer at the correct time. Effective demand management requires the airline to respond to changes dynamically. During peak times, discounted tickets should be reduced to take advantage of the excess demand by selling higher booking class tickets. The perishable nature of airline seats dictates that during off peak times, more discounted tickets should be made available to ensure that the aircraft does not depart with empty seats (Kimes and Wirtz, 2003). By varying the price of an airline ticket based on the ticket class, the value the customer places on the purchase and their willingness to pay, inventory levels can be controlled and sold at a price that maximises revenue (Cullen and Helsel, 2006). The interdependency of the basic airline revenue management principle's market segmentation, product definition, pricing, demand forecasting, inventory management and optimization form the foundation of effective revenue management hinges on accurately forecasting demand and an understanding of price elasticity (Cleophas and Frank, 2011). The primary objective and goal of airline revenue management is to achieve an optimal load factor with mixed fare class seat allocations, to accurately forecast cancellations and no shows resulting in realistic overbooking limits being set to maximize revenue (Jacobs, 2012).

The principles of airline revenue management are:

2.5.1 Pricing

The fundamental principles of economics supply and demand and the market theory underpin the allocation of resources. Price is a representation of supply and demand. Therefore, pricing in airline revenue management is used to manage and influence consumer demand with the pricing structure underpinning the different fare class used to determine the allocation of passengers. Price elasticity, which is the change in demand with the change in price, is a measure of the customer's willingness to pay and is dependent on the consumer fare class (business or economy) and seasonal peak or off-peak times. Dynamic pricing which is the continuous changing of ticket prices daily to control ticket sales is used to ensure the correct mix of ticket sales is achieved (Fiig et al., 2010). Pricing is fundamentally the most crucial aspect of airline revenue management as the airline aims for optimal pricing of each seat, maximize revenue each seat can generate and the best seat fare mix that can produce the highest revenue for the airline.

Figure 1.0 illustrates the movement on the demand curve from one point to the next signifies a change in price and quantity demanded implying that the demand relationship is consistent. Therefore, only a change in price will result in a change in the quantity demanded (Poelt, 2011).

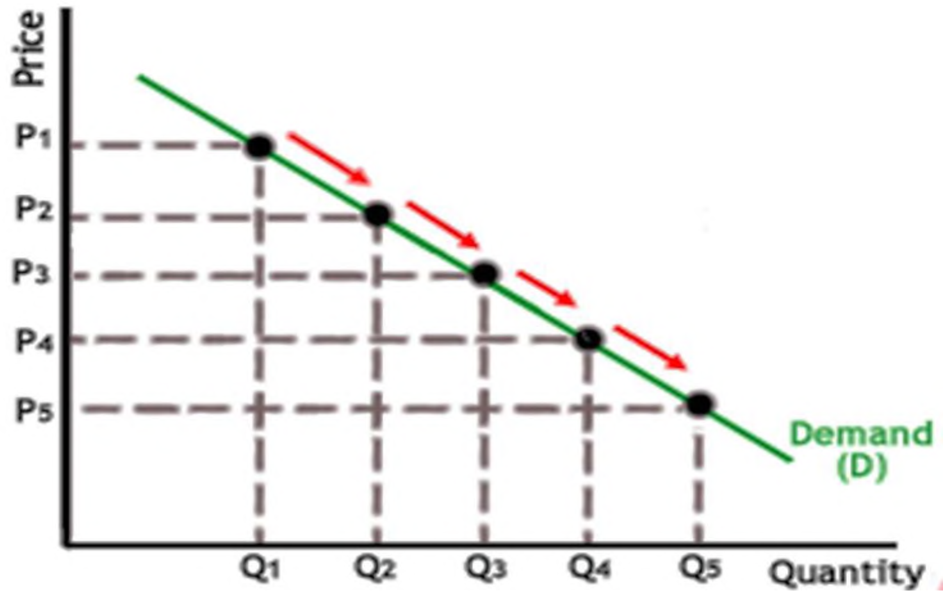

Figure 1.0 Demand Curve Price - Quantity. Source IATA, 2012.

Price Differential: The objective for any airline is to attain the highest revenue which is accomplished by identifying the most profitable passenger mix based on price. Differential pricing is therefore a demand control strategy used to sell an airline ticket at different prices to different customers in the same class based on the booking method, delivery time and method, payment terms and type of consumer. Optimal ticket price setting is dependent on competition pricing, customer preference and market segmentation. Product differential is the setting of ticket price based on the quality of service associated with the ticket price. Business travelers require more options to enable them to change travel dates at short notice, travel at peak times, add on (business class lounge) and would therefore be willing to pay a premium. Price sensitive leisure travelers in contrast are less inclined to pay a premium based on add ons to travel (Belobaba, 2009).

Price Discrimination**:** Price discrimination relates to setting different ticket price for the same service for different customers based on the customers' ability or willingness to pay, quantity sold (frequent flyers qualify for discounted fares) and the customers' market segment profile. Unique purchase conditions and service amenities for each identical seat allow for pricing and marketing as distinct service options. The main goal of any airline is to attract the highest fare customers and capture as much revenue from the available capacity as possible (Boyd and Kallesen, 2004).

Market Segmentation**:** Revenue management is premised on the airline managing customer travel preference rather than how the airline operates its routes. Therefore, market segmentation is the aggregation of customers into different fare categories distinguished by their similarities in needs, preferences and the perception of the airfares offered by the airline differently from each other (Jerath et al., 2010). Flight and network analysis enables the airline to offer price differential fares aimed at distinct segments of the market on a fixed capacity aeroplane (Cutshall and Weisbrodt, 2006). Future flight departures are identified and treated as independent allowing the airline to segment each flights' origin and destination market. The airline can therefore offer a combination of different air fares to potential customers with varying affordability and willingness to pay with the goal to increase revenue (Belobaba and Botimer, 1999). By placing travel restrictions on lower fares, the airline prevents customers with a willingness to pay higher priced tickets from buying the discounted airfares. The inferences of this demand segmentation are therefore that customers who value flexibility are willing to pay more and the price sensitive customer who values price above flexibility is not willing to pay more (Gorin and Belobaba, 2004).

Figure 2 illustrates the demand curve representing the demand – price relationship on fare basis. As price increases, demand decreases. The restrictions placed on each booking fare class are intended to prevent high paying business customers from paying lower prices. With high demand the availability of restricted discounted seats is reduced increasing revenue as more of the higher value tickets are sold. As demand decreases, the percentage of the lower value tickets allocated is increased, resulting in revenue for the airline as the seats would have remained unsold at the higher price (d'Huart and Belobaba, 2012).

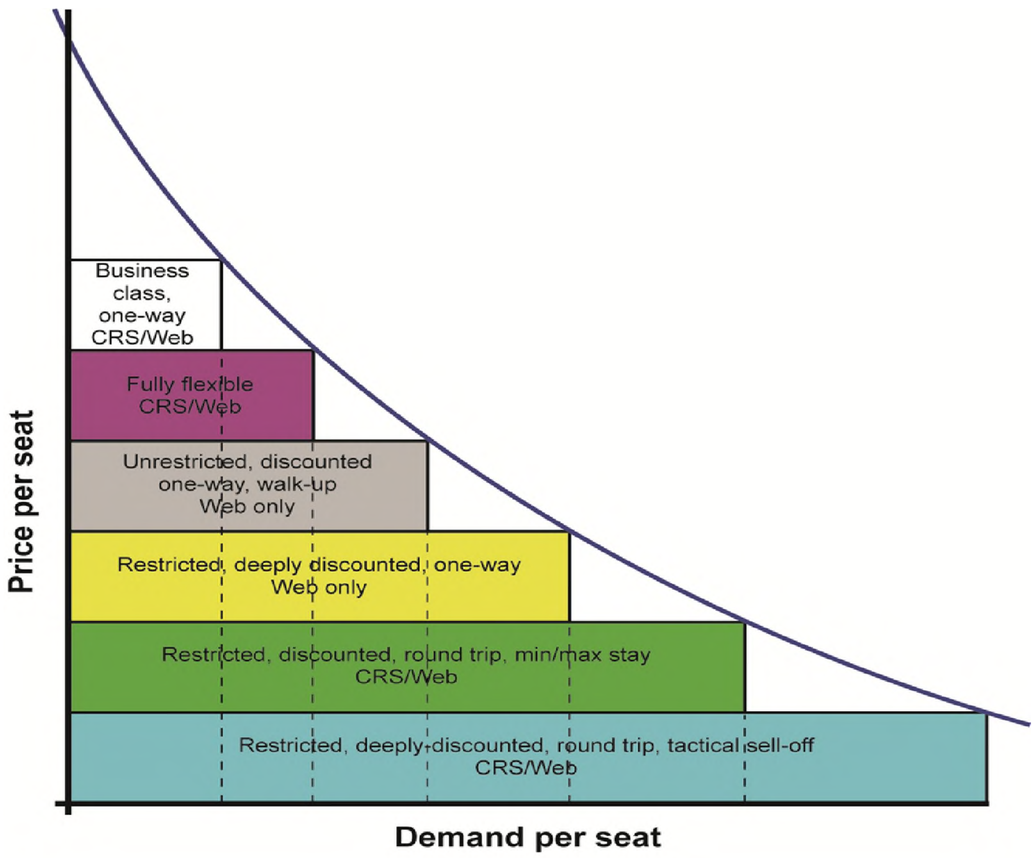

Figure 2 Demand – Price. Source IATA, 2012.

2.5.2 Demand Management

The airlines' ability to forecast demand is one of the key principles of revenue management. Demand represents the maximum potential passengers available to make a reservation for a flight independent of capacity available (Weatherford et al., 2010). Demand forecasting is achieved by applying statistical calculations to historic booking data, no show data and actual bookings to provide inputs for overbooking systems, pricing and capacity control allocation (Anderson and Carroll, 2007). Accurate demand forecasting is crucial to capacity control and therefore should the forecast demand for high-fare customers be overestimated, capacity will be constrained resulting in the aircraft departing with empty seats which could have be sold to low-fare customers. Demand management can create value and avoid the increasing commoditisation of services (Fiig et al., 2014).

Factors affecting demand forecasting are:

Seasonal travel: Based on the time of year e.g. higher demand in summer and school holidays and lower demand in winter. The day and time of week with weekday early morning and evening flights being in demand with business passengers and weekend travel demanded by leisure passengers. Special sporting events and conferences temporarily increase demand to a specific destination managed by the airline by increasing capacity to cater for the higher demand during that period.

Price sensitivity: Affects demand through price differential to achieve market segmentation.

Demand censure: The use of accepted booking observed for forecasting instead of total requested bookings resulting in the upward demand potential remaining unknow.

Group bookings: Cancellations in large numbers because of group booking may skew the booking behaviour data of passengers used for demand forecasting with booking limits constraining the demand seen in the historical data.

Delayed flights causing the passenger to elect not to travel and no-shows reflecting as cancellation in the demand data used for forecasting (Boyer, 2010).

Variable Demand: Figure 3 illustrates seasonal variation of demand during the peak, off-peak and shoulder seasons. During peak season, demand exceeds available capacity therefore demand is wasted. To maximise revenue the discounted lower value seats allocation is reduced therefore increase demand for the value fare class. Conversely, during off-peak season available capacity exceeds demand resulting is wasted demand. By increasing the lower discounted fares, demand is stimulated resulting in increased revenue. During the shoulder period, a mixture of high and low value fares allocation is used to maximise revenue. Optimal capacity utilisation which the airlines aim for, occurs when demand and capacity are in equilibrium. This is achieved by varying demand based on the booking class (Zhang and Cooper, 2005).

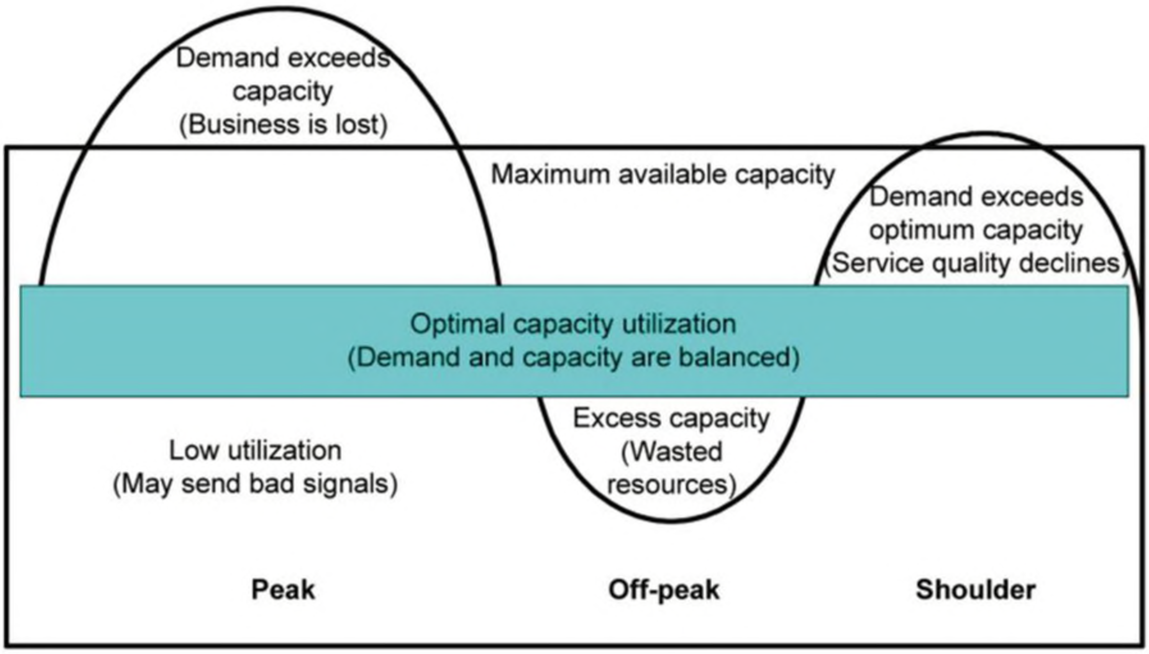

Figure 3 Seasonality Effects on Demand. Source: IATA, 2012.

2.5.3 Seat Inventory Control

Inventory relates to capacity allocation with airlines' capacity being essentially fixed due to the set number of seats on an airplane. This allocation considers the consumer perceived value to formulate a strategy that increases revenue. Capacity allocation plays an important role within revenue management and the concept is based on the protection of seats for high- fare passengers allowing only the seats that would ultimately remain empty to be made available to discount passengers. Optimization is the optimal allocation of seat capacity to demand by controlling availability through price. (Gregory, 2010). Seat inventory control used as a control mechanism, is a system and control procedure that limit capacity of each fare or booking class with the end objective to attain the most optimum passenger mix therefore maximising revenue. The requirement for control is due to the perishable nature of airline seats (finite seat inventory) and the different booking patterns between business and leisure passengers. An airline may want to increase capacity on a route, but the capacity constraints limit its ability to do so. Seat inventory control therefore becomes critical to attaining the correct fare mix that will give the most revenue. The seat allocation and control is achieved by the following control measures (Van Ryzin and McGill, 2000).

Single Leg Inventory Controls: Is the use of different policies for each flight legs formulated independently to maximise revenue. The policies are based on optimal booking limit which is predicting demand by accepting a discounted ticket only if the revenue it generates exceeds the expected revenue from a full fare (Littlewood, 2005). There are two categories used in single leg control the first being static solution method which assumes sequential booking request (low fare before high fare) allowing for bookings to be allocated during periods when all booking request are of the same fare class. The second category being the dynamic solution method which monitors the booking process over time and decides on booking acceptance based on the current booking trends (Belobaba and Hopperstad, 2004).

Network Controls: Network seat inventory control is the optimization of the complete airline network simultaneously by distributing revenue from an itinerary over its sectors - termed prorating (Pak and Piersma, 2002). Origin Destination control allow the airline to respond to different fare requests with different seat availability on a given itinerary based on the revenue value of each request irrespective of the fare restrictions. The network control problem can be solved by grouping domestic and connecting fares together to then apply leg based booking limitations know as virtual nesting (Belobaba, 2002).

Overbooking: An inventory control practice of accepting additional reservations on a flight beyond available seating capacity to fill seats that are forecasted to be empty due to no-show customers (Luo et al., 2009). The negative public relations perception from passengers is the risk for the airline but compared to the cost of an empty seat due to denied boarding this is an acceptable risk. The cost to the airline for denied boarding per Popescu et al., (2006) include, passenger goodwill, monetary compensation for involuntary denied boarding, hotel and meal cost for passengers displaced from a flight and travel vouchers awarded to voluntary denied boarding passengers. To mitigate this risk, overbooking models determine the maximum bookings to accept based of historic and forecast data (Amaruchkul et al., 2011).

Booking Limits: The practice of placing partition or protection for higher fare customers to ensure that the airline will always accommodate them when capacity is available and despite the overbooking. Limiting the number of bookings accepted for the higher fare passengers if no change to demand distribution is foreseen, results in an optimal fare mix for the airline (Perakis and Roels, 2010).

Nested booking limits: Nested booking limit protects seat availability in a hierarchical manner. Once the booking limit has been reached for a fare, the next lower valued fare is made available from the seat inventory reserve. The hierarchy order is based on the highest fare class being set equal to the full capacity of the plane with the second highest fare class set to the full capacity minus the initial booking limit for the highest fare class. Nesting techniques for network models use fare class, fare level and the opportunity costs approximation derived from mathematical models of the seats used as variables in determine the booking limits to use. A drawback of nesting control is that it can lead to overprotection of the higher fare class to the detriment of total revenue (Talluri et al., 2008).

Bid Price: This is the price control directly linked to the opportunity costs of each seat. The bid price is dependent on demand expectations, remaining time and the capacity set for each flight to a threshold value. Only once a booking fare request exceeds the bid price can a booking be accepted. Continuous updating of the bid price is required to ensure booking requests that exceed the bid price marginally are reduced. Optimal bid pricing occurs when opportunity costs of a combination of flights are equal to the sum of the opportunity costs of the individual flights (Talluri and Van Ryzin, 2004).

2.6 Performance Measurement of Revenue Management

Performance measures in revenue management aim at describing whether the revenue management system coupled with the revenue managers' efforts has achieved the goal of RM, which is to maximize overall revenues (McGill and van Ryzin, 1999). Talluri and van Ryzin (2005) identify the distinction between "revenue-opportunity assessment" which is performed before the implementation stage and "revenue benefits measurement" which is performed continuously after implementation. A prerequisite for measuring the revenue benefits of an operational revenue management system, is the use of actual data. They classify the measuring categories as Comparison of pre-and post RM system implementation performance, the use of classical performance measures and assessment of the achieved revenue potential. The importance of measuring the performance of the RM system includes the justification of the considerable financial investment by the airline on the revenue management system and the potential revenue that has been gained must be quantified. Continues assessment provides performance tracking over time to identify and correct short comings that the system may have and by collecting actual data from the operational revenue management system over a long period, there is a high probability of the data being free from major outside factors (Talluri and Van Ryzin, 2005).

Revenue performances measuring tools that use inventory systems data in the airline industry are ASK (Available Seat Kilometre), RASK (Revenue per Available Seat Kilometre), CASK (Cost per Available Seat Kilometre), RPK (Revenue Passenger Kilometre) and cabin factor yield. However, the data derived from these tools and competition comparison do not allow for the isolation of the revenue impact due to the revenue management system on its own. The indicators may increase or decrease independently due to market conditions or specific anomalies to a market. The market condition events may indicate a reduction in revenue whereas additional revenue generated may have increased due to the revenue management system (Polt, 2001). The impact of the outbreak of the Ebola virus on the revenue from SAA's West African market in 2014/2015 is a prime example. The intention for SAA is to measure the degree of revenue increase attributed to the revenue management efforts and identify potential revenue improvements.

2.7 Methods of Measuring RM Performance

The importance of continuously measuring the performance of RM is critical in justifying the investment made and highlighting any deficiencies within the system. It is therefore a basic premise that the measuring method used should be able to isolate the RM contribution to revenue on its own (Talluri and van Ryzin, 2004).

In airline RM, the methods utilised in measuring performances are:

2.7.1 Pre- and Post – implementation:

The comparison of two time periods one before and after the implementation of the revenue management system with parallel tests of flights with and without revenue management controls. The major challenge is selecting two comparable time periods regarding overall market structure. This method is ideal for justification in implementing the revenue management system but not well suited for continuous revenue management performance.

2.7.2 Classical performance measures

Revenue per Available Seat Kilometre (RASK) and Seat Load Factor (SLF). Often used in financial reports indicating the performance of either the overall success or parts of the revenue management system. Isolating the effects on revenue by the revenue management system is quite difficult and often the classical indictors offer a view on the overall success of the airline. An example of this is the aggressive pricing of low cost carriers which has caused decreases in the RASK and SLF for the airline although the RM controls have improved dramatically.

2.7.3 Simulation

Using models to mimic passenger demand behaviour and investigating the most probable performance of the revenue management system.

2.7.4 Experimental Design

Experiment to test the cause and effect relationships between revenue variables.

2.7.5 Revenue Opportunity Model

Measures the revenue performances of the inventory control system as a percent of "Revenue Opportunity". The achieved revenue during a booking period is compared with the upper limit of potential achievable revenue using perfect hindsight information.

2.8 Revenue Opportunity Model Concept

During a booking cycle, the reference point used as the main revenue opportunity model measuring in isolating the RM performances and represented as Percentage achieved Revenue Opportunity (PARO) as illustrated by Fig 3.1 are (Chiang et. al., 2007).

Potential Revenue: Represents the revenue that would be achieved estimated with unconstrained demand being deterministic at the close of the booking cycle. The maximum revenue achievable with perfect hind sight. Unconstrained demand is the process of extrapolating true demand from censored booking data before the resulting demand can be applied to the forecasting models.

No RM revenue: Indicates the revenue that would have been earned with no RM controls and accepting all booking requests assuming a first come first served basis limited only by the aeroplane capacity with no overbooking performed.

Actual revenue: The result of decisions by the revenue manager and the controls of the revenue management system.

Revenue Opportunity: Represents the possible revenue gains that would be achievable by utilizing revenue management techniques.

Achieved Revenue Opportunity (ARO): The actual revenue earned by the airline from the potential revenue available.

Percentage Achieved Revenue Opportunity (PARO): The percentage representation of the success of the revenue management controls.

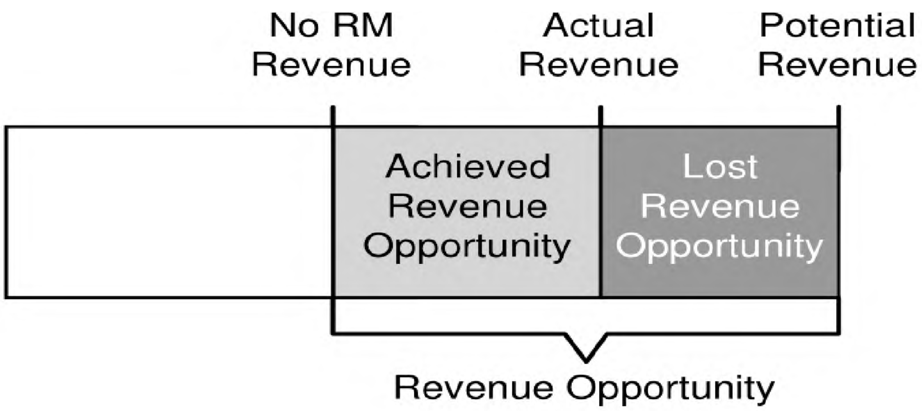

Figure 4 ROM Concept. Source: Temath et al., 2012.

Revenue opportunity model formula used in determining the Potential Achieved Revenue Opportunity (PARO) is:

- Revenue opportunity (RO) = Potential revenue - No RM revenue
- Achieved revenue opportunity (ARO) = Actual revenue - No RM revenue
- Percentage Achieved Revenue Opportunity (PARO) = Achieved revenue opportunity / Revenue opportunity.

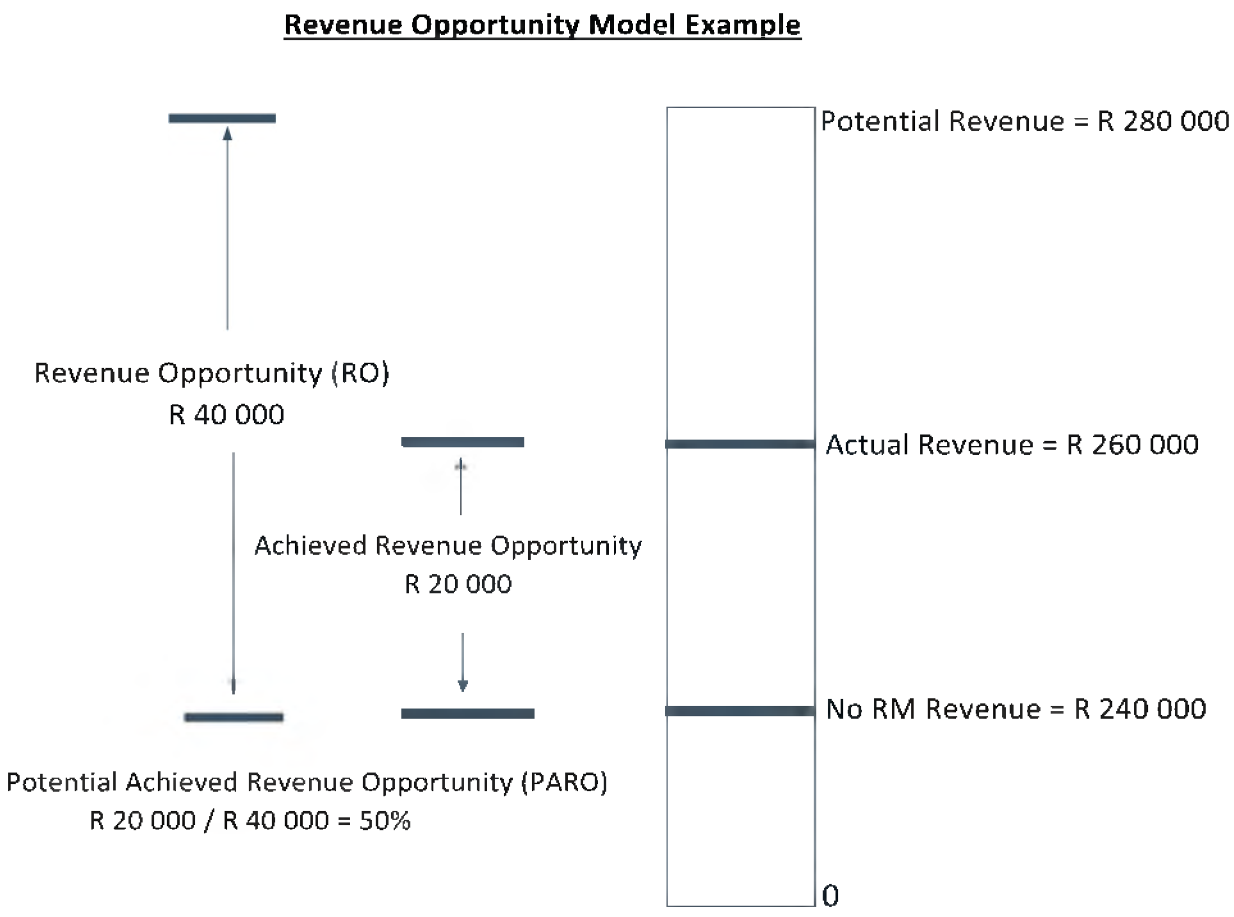

Figure 5 ROM Example. Source: Adapted from Temath et al., 2012.

The product of ROM the PARO is a representation of better revenue management performance with a high PARO (80%) indicating better performances than lower values (50%).

In the example figure 5, the PARO indicates that only 50% of the total revenue opportunity has been achieved. With adjustments to the RM controls and strategy, revenue can significantly be increased. It therefore can be concluded that PARO is an indication of:

1. The specific percentage revenue improvement gained from RM efforts and strategies.
2. An indication of the remaining revenue potential that can be achieved.

2.9 Practical Application of ROM

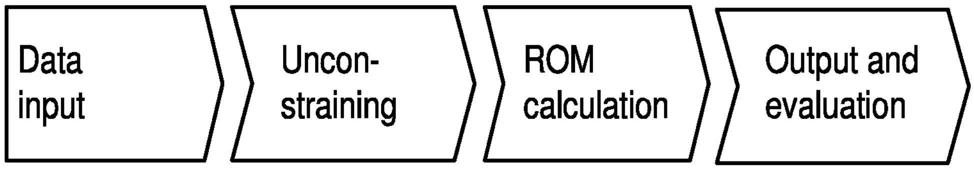

Figure 6 ROM Process

The data used in the estimation of the underlying demand is derived from historic data sales and actual bookings. The historic data does not include lost demand due to capacity constrain (airplane has a set number of seats) so to estimate the true underlying demand, an extrapolation of the actual sales is performed. Recapture which is the redirected demand due to the customers' first choice not being available is identified and all the input data is then assessed. The second stage is the generation of the ROM input data which the estimated unconstrained demand data is generated. This is achieved by extrapolating true demand from censored booking data before the resulting demand can be applied to the forecasting module. The third stage is the ROM calculation which is calculated using the estimated unconstrained demand data. In the final stage the output which is Percentage Achieved Revenue Opportunity (PARO) is analysed and split further (Chandler and Ja, 2007). The Revenue Opportunity Model considers the following factors when determining the optimal overbooking levels, fare class split, flight availability and point of sale across multiple periods during the booking period (Vinod, 2006).

- Same-flight up-sell and cross-flight recapture: When the customer's first choice flight is not available and the booking is accepted on an alternative flight with the same airline. Using historical sales data and statistical models results in accurately estimating recapture.
- Competition by market: The estimated proportion of total traffic in the market derived from passenger booking data and market information data.
- Planned cabin upgrades: The RM control method of making empty seats in the higher valued class available for passengers willing to

book at the lower valued class. This is usually done when the lower valued class seat forecast is high and when the higher value class indicates empty seats at the end of the booking period.

- O&D network demands: Represents the total demand including connecting flights passengers.

Revenue Opportunity Model Performance Process

1. Demand is estimated from network sales, historic data and the most recent departure dates

↓

2. The Revenue Opportunity Model is run with upselling and recapture to determine the best revenue management controls with perfect hindsight

↓

3. The current actual controls being utilised are compared to the optimal controls from the ROM to determine what could have been done differently to increase or maximise revenue.

↓

4. Adjustments and manual overrides are made to the revenue management system for future flights that will result in higher revenue (Anderson and Blair, 2004).

2.10 Revenue Opportunity Model Limitation

The validation of the ROM measures and its robustness are the main prerequisite in presenting valid performances measures. ROM relies on demand data and demand cannot be measured precisely with the only information available being class availability and observed bookings to forecast demand. The data is extrapolated to estimate true demand in a process called un-constraining demand. The estimated unconstrained demand is used as the input to calculate ROM measures. Due to demand variance, the estimated unconstrained demand is not perfect and contain two sources of errors namely data related errors and model related errors. Due to the estimated unconstrained demand containing errors, the ROM measures calculated will also contain errors. Testing against input data errors is the main determinant for the ROM validity and the airline should ask the following question in seeking to answer the question of the ROM robustness (Temath et al., 2010).

> *Does the input data error distort the ROM results to such an extent that the results are not reliable leading to the wrong conclusion on the performances of the RM strategy?*

Model errors: Caused by the aggregation of demand data and the practical limitations of ROM not reflecting reality accurately in the estimation of the potential revenue and the no RM revenue. The demand data aggregation is performed at the data collection point level and deriving the correct booking order is not possible. A demand order between two data collection points should be selected with the RM strategy influencing the results (Temath et. al., 2009). The errors based on the selected strategy are:

- First Come First Served booking order used to estimate the No RM revenue will result in the accuracy of the No RM revenue strongly dependent on the actual bookings.
- Low before High booking order, will result in low fare purchasing passengers showing up first ahead of the high paying passengers which therefore leads to lower accuracy of the No RM revenue estimate.

Data related errors: ROM demand data relies on the estimated unconstrained demand which does not reflect the reality accurately due to unconstrained errors. This results in the incorrect input data leading to incorrect estimation of the No RM revenue and Potential Revenue. The calculated Potential Achieved Revenue Opportunity (PARO) would therefore be different for real demand and estimated unconstrained demand leading to the misinterpretation of the results and RM controls (Polt, 2001).

The severity of the unconstrained error is not known and due to its effect on the quality and validation of the ROM, an approach to quantify the error is required. Simulation developed for Lufthansa Airlines and presented by Frank et al., (2008) quantifies the degree of error between real and the unconstrained demand. Figure 3.3 below is an illustration of the simulation. Input to the simulation of actual booking data which translates to the unconstrained demand and the real demand data and measuring the degree of similarity between the results based on the estimated unconstrained demand and real demand allows for the checking of the ROM robustness. Two thresholds are defined as minimum level of similarity between ROM measured considered as appropriate for real application in the ROM and the maximum error level of the unconstrained demand expected in a worst case real scenario. The ROM is robust if all the error levels are above the required level to the defined maximum worst case scenario level (Temath, 2011).

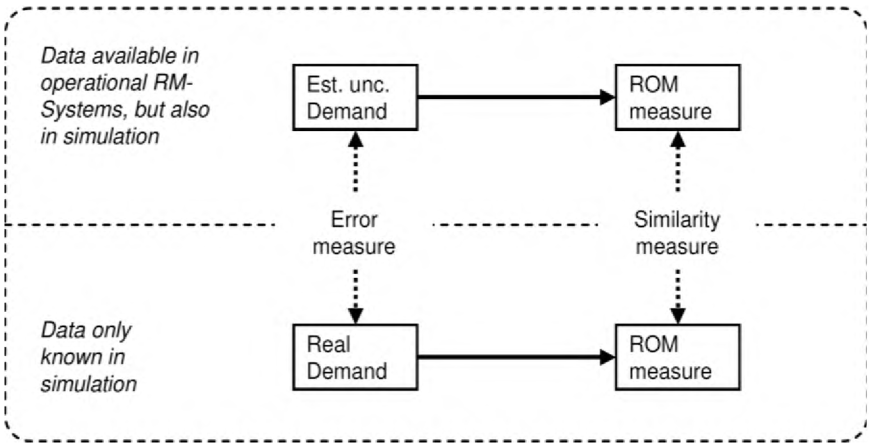

Figure 7 Simulation of error measure. Source: Temath,2011.

2.11 Performances Measures Analysis

This section introduces and explains the other RM performance measuring tools used in airline RM. An explanation of the limitation on each measuring tool is explained in the context of SAA requirement for a measuring tool for O&D optimisation.

2.11.1 Pre-and Post-implementation performance comparison

The pre-implementation study is normally based on perfect hindsight to estimate the revenue potential. By firstly analysing historical data and correction to estimate demand, optimum price controls are then identified based on observed price response and an upper limit of the potential revenue is calculated. This maximum revenue is then compared to historical revenue to determine the potential revenue of the revenue management system. The comparison is then used to determine and justify the investment for the revenue management system.

The three time periods used for the comparison are before, after and parallel test of flights or markets with and without revenue management system controls. The challenge for this type of comparison is the selection of two comparable market situations and the period for the data retrieval that would offer comparisons of the overall market structure. The impact of the revenue management system can be isolated and quantified but the comparison is not suitable for continued assessment of the overall market. The pre-implementation comparisons are used to justify the need or requirement of having the revenue management system. The post implementation and parallel test approach are then used for comparison with any positive gains to revenue attributed to the revenue management system. The shortcomings of the pre-and post-comparison is that once all flights and markets are controlled by the revenue management system, continued assessment is not possible and no meaningful information is derived from the data (Talluri and van Ryzin, 2004).

2.11.2 Classical performance measures

Classical airline performance measure indicators frequently used are:
Average Ticket Value (ATV), Revenue per Available Seat Kilometres (RASK), Cost per Available Seat Kilometres (CASK), Revenue Passenger Kilometres (RPK), Yield (Revenue per Passenger Kilometre), Load Factor (RPK divided by Available Seat-Kilometres) and Seat Load Factor (Number of passengers divided by Number of Seats) (Feng and Wang, 2000).

Revenue per Available Seat Kilometre (RASK) incorporates the revenue gained and considers the supply on offer which is the seat kilometres that have been offered to passenger. Seat Load Factor (SLF) and Load Factor are the percentage representation of the utilization of the aeroplane. This measure is known to measure forecast accuracy and are frequently used for financial reporting in the airline financial reporting. It is however very difficult to isolate the contribution of the revenue management system to the overall increase of revenue as both RASK and SLK will decrease with the entrance of a new competitor in the market. The requirement for the airline to change its network either by adding or reducing flight frequencies, destinations and capacity as the market dictates, will influence the RM system which affects the classical performances measures suitability to assess and measure RM performance accurately (Phillips, 2005). The airline schedule is generated one year before date of departure and therefore adding a single long haul destination on an Origin Destination inventory will dramatically change the expected demand and fare class mix for connecting flights which will impact classical performance indicators comparison metrics. The network load factor will increase; average ticket value will increase, but Revenue per Average Seat Kilometre (RASK) and Yield factor will reduce. As the metrics become more variable, assessing the impact of RM decisions becomes difficult as the results achieved cannot be attributed to RM decisions alone or whether the impact is due to the change in airline network. To gain a true representation of the RM performance an analysis of a combination of classical measure coupled with simulation would increase probability of isolating the RM performance. It however requires a large work force and specialist which increase costs to perform both classical measures and simulation (Weatherford and Ratliff, 2010).

2.11.3 Simulation

By using models to mimic the customer demand process and the response from the RM system of the replicated forecasting and optimization methods accurate potential revenue gains can be gauged and studied in a realistic environment. The simulation model should accurately conform or replicate the current control process, the business environment and the planned process to provide meaningful results. Uncertainty and “what if” scenarios that the airline has not experienced in the past can also be modelled and simulated contributing to the RM strategy that best suits the airline (Gorin and Belobaba, 2004). The simulation process is governed by a simulation clock with a pseudo-random number generator using the airlines historical booking patterns to generate customer bookings. Multiple events are inputted into the simulation at time intervals during the simulation to evaluate the response from the RM system. The input events include cancellations, no-shows, booking requests, price changes, delayed or late purchase, passenger arrivals, forecasting runs and optimization (Talluri and van Ryzin, 2004). The Passenger Origin Destination Simulation (PODS) developed at the Boeing Company by Hopperstad, Berge and Filipowski in 1997 is the best state-of-the-art airline revenue management simulation. PODS evolved from the Decision Window Model (DWM) developed by Boeing to analyse passenger path preference and spill and has advanced to having a research alliance with Massachusetts Institute of Technology (MIT) and nine international airlines Air Canada, Air New Zealand, Delta Airlines, Air France/KLM, Lufthansa, Swiss, SAS and United Airlines. The PODS model simulates passenger decision behaviour based on their airfare and airline choice, in a simulated network environment with two or more competitors offering multiple airfares with restrictions, aircraft capacity, different departure schedules and route networks. This approach allows the different airlines within the PODS consortium to have different to have different RM system capabilities resulting in different flight schedules, prices and product offering (Hopperstad, 2005).

Simulation offers the most accurate results but the main disadvantage is that a series of modelling assumptions are made that may not reflect the real conditions the airline will experience in the real world. Arbitrariness flaws may occur in the assumptions and modelling due to the developer having total control over the environment which may cause bias. Lack of knowledge of the model utilised by competitors and its objective make the simulation of competitors' reactions very difficult (Talluri et al., 2010). Talluri and van Ryzin (2004) and Frank et al., (2008) describe the implementation principals of setting a simulation model that can assist airlines to improve revenue.

The limitation of using simulation form SAA's perspective is the significant time, effort and expertise required to calibrate and run the simulation. Continued model inputs to adjust for changes in the real world requires dedicated resources to be allocated to maintain a model that will be effective with creditable results from the simulation. This requires significant financial investment and specialised skills development which is not attainable for the airline.

2.11.4 Empirical Analysis

Empirical analysis is the use of evidence based results to measure revenue management performances. A hypothesis is developed and is tested using empirical data produced from observation and experiments. The use of regression models can explain the RM performance as a function of Revenue per Seat Kilometre using historical data as a base line for comparison (Zeni, 2003). The metrics used in the model are capacity changes, load factor, fuel price, macroeconomic indicators and seasonality effects in passenger demand behaviour. Regression analysis is used as a multivariate analysis in cross sectional data to measure the impact of a random probability distribution with time series analysis used to study the dynamic aspect of the changing variable. Panel data regression models utilise both regression and time series analysis to produce an effective and efficient forecast of load factor which are the metrics used to measure capacity and demand management efforts of the airline (Stefanescu et al., 2004). A regression model developed by Ja et al., (2001), using American Airlines historical data and treating unconstrained and observed booking from a single class as known values produced credible results. Using data from both the airline and entertainment industry, Stefanescu, (2009) developed a multivariate regression model that considered the product and time dimensions of historical data in demand estimation which produced accurate results.

By using correlation analysis and utilising the Pearson Product Moment Correlation Coefficient to determine the strength and direction of a linear correlation between two key performance variables, Shrinivasan, et al., (2012) determine the degree of influence on revenue. In 2013, Arhall and Cox, (2013) performed a study for Scandinavian Airlines System to examine the correlation between key performance indicators used by the airlines revenue management department to evaluate different flights profitability. Using data from Sweden's domestic market, correlation analysis was conducted and the results, the destination based analysis and the data based analysis were cross referenced with the main correlation analysis using all the data. Revenue per Kilometre (RPK), Cabin Factor (CF) and Revenue per Available Seat Kilometre were identified as the pivotal KPIs that would best illustrate the airlines profitability (Arhall and Cox, 2013).

Empirical analysis using models for testing is limited as the performances test is only testing within the model but does not address the appropriateness or validity of the model itself. Regression models for performances measures are limited as most of the imputation methods are based on statistics theory with complex algorithms and model assumptions that must be validated to produce credible results. This require dedicated specialised skilled teams to develop the regression model and run the simulation at great expense to the airline (Queen et al., 2007).

2.11.5 Experimental Design

Experimental design is used for testing the cause and effect relationship between variable where the experimental group and control group are specified. By administering the independent variable to the experimental group and measuring both the control group and experimental group on the same dependent variable, tests for revenue performances can be obtained

(Cox and Reid, 2000). The live test experiment (Sandbox test) is the best design for testing revenue performances over a long period that offers useful and meaningful results. The proposed or new algorithms are used to control flights during specific periods with the results and behaviour observed. Simultaneously, the incumbent revenue performances measures of manual interface and algorithms are used in parallel and the results are compared. The advantage of using Sandbox testing in the design is that the revenue performance can be isolated with no assumptions or models used as the data is based on actual flights and market conditions with the results being tangible and a credible understanding of the revenue management strategy that offers maximum revenue for the airline. The live test using actual flight and demand data offers the advantage of the RM system confronting real world complexity that cannot not be replicated in simulation. However, once off economic trends or events may taint the results and therefore may not offer credible results on the new RM system being tested (Talluri et al., 2010).

An RM methodology prototype developed for Iberia Airlines modelling passenger purchasing behaviour, potential demand on a flight date level, flight ticket characteristics and competing product offering was reviewed over two years. In aiming to convince the airline management to implement the prototype on an operational level, an experimental design was developed to justify that the introduction of the prototype RM system would increase revenue. The experimental design test included ten different markets chosen randomly with a set of twenty-two flights in each market controlled by the test method to show the cause that the prototype model or algorithm would be the cause of revenue management process improvement compared to the current system the airline was utilising. The experiment utilised Sandbox testing on live flights with the current revenue management system running a group of controlled flights in parallel. The results of the experiment indicated that the flights out of the test experienced significant improvement and these flights captured all the unidentified changes in demand (Talluri et al., 2010).

2.12 Conclusion

This chapter provided the state of art of RM and ROM. The methodology adopted for the research is explained in detail and its limitation presented. An analysis of other revenue management performance measures and the limitation of each in the context of SAA performance measure requirement is explained. The next chapter will present and highlight the findings from the collected data.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

In this chapter the manner the research was conducted will be explained. The research problem, the research goals and the objectives of the study will be specified. The research paradigm and the research design will be discussed.

3.2 Methodology

This research is analytical by design with a quantitative approach. Analysing financial information from SAA 2014 and 2015 revenue, and evaluating SAA's O&D optimisation using the Revenue Opportunity Model. The performances measure methodology that would offer the most accurate representation of the revenue performance for SAA at acceptable cost is the Revenue Opportunity Model. ROM is a post departure performance evaluation model that simulates the total demand (passengers that want to fly with the airline) thereafter determining revenue achieved from the potential passengers. Using inventory controls to optimise availability that would result in maximum revenue, the revenue performance is measured as a percentage of the Revenue Opportunity. The maximum possible revenue with perfect information for the flight is calculated from Expected Marginal Seat Revenue a (EMSRa) and Expected Marginal Seat Revenue b (EMSRb) simulation. Then subtract the revenue with no inventory control. The performance of the inventory control is measured as a percentage of the revenue opportunity earned divided by the total revenue opportunity represented as the Potential Achieved Revenue Opportunity (PARO). PARO, is therefore the theoretical improvement of revenue which is the ROM measure for isolated RM performance (Vinod, 2006).

3.2 Research Paradigm

Positive facts or verified data derived from rational interpretation and mathematics presented as empirical evidence is the philosophy of positivism which is the paradigm for this thesis (Saunders et. al., 2009). Quantitative descriptive statistics are used to present the results of the study.

3.3 Population and Sample

The primary data source for the research is from SAA's Origin-Destination revenue optimisation statistics for financial year 2014 and 2015 with a population size of 700 weekly flights and stratified random selection of long haul, regional and domestic flights. The dataset contains the following information: Ticket price, point of sale, origin and destination, passenger service class, available seat capacity for that itinerary and passenger numbers (SAA, 2015).

3.4 Research Question

The research design is to evaluate whether the switch from leg based revenue optimization to O&D optimization has resulted in revenue gain for SAA. The main goal of this research is to provide useful empirical feedback to SAA on the merit and the significant impact of Origin-Destination revenue optimization thereby influencing and aiding the decision-making process of the airline's revenue department. The following research question guides this thesis:

Has the migration from leg based segment revenue optimization to the origin destination revenue optimization at SAA provided network optimization resulting in increased revenue?

3.5 Data Analysis

The Revenue Opportunity Model calculation to derive the Percentage Achieved Revenue Opportunity is applied to all the routes and presented in table format. The whole network passengers carried and revenue received are used to derive the average revenue per passenger and is presented in table format.

3.6 Research Limitation

The lack of clear guidelines or key performances indicators for isolating and measuring the RM contribution on its own means that the validation of the results from ROM is difficult. Revenue Opportunity Model relies on demand data and demand cannot be measured precisely with the only information available being class availability and observed bookings to forecast demand. Due to the estimated unconstrained demand containing errors, the ROM measures calculated will also contain errors.

3.7 Conclusion

In summation, this chapter sets out how the data was collected and the analysed. The methodology adopted for the research is explained and the research question and paradigm are addressed. The data analysis is discussed followed by the limitation of the research. The following chapter is a presentation of the ROM results from the data collected.

CHAPTER 4: RESULTS

4.1 Introduction

This chapter presents the results from the Origin Destination network based revenue management optimisation. The results are based on the Revenue Opportunity Model demonstrating the effects of O&D on revenue. The data collected from the markets/routes selected are discussed and the descriptive statistics derived from the results are addressed.

4.2 Route Information

The total O&D network that SAA received revenue during financial year 2014 and 2015 was 14 486 flights per year. Only the O&D routes that SAA services with direct flights are considered for the research. The selected routes are Frankfurt in Germany, Perth Australia, New York USA, Hong Kong, Lagos in Nigeria, Luanda in Angola and Maputo in Mozambique.The O&D flights itineraries contained the following information used for the study: class fares for each point of sale country and the rest of the world fares, the flight capacity, available seating and available seats at each point of sale country.

4.3 Results Presentation

The data is presented in table format for the routes selected for the study. The passengers carried and revenue for each route is presented with the Percentage Achieved Revenue Opportunity calculated for each route. The total passengers carried on the SAA network is used to derive the average revenue per passenger and is presented in table format.

4.3.1 Network Analysis

Table 1: The annual total passengers, total revenue, average revenue per passenger and percentage change from financial year 2014 to 2015 of each O&D route selected for the research.

Table 1 O&D Routes

O&D Route	Financial year 2015	Financial year 2014	Change %
Frankfurt			
Passengers	108 325	106 596	2%
Revenue	R 626 267 893	R 567 303 801	10%
Average revenue per passenger	R 6 858	R 6 554	5%
Hong Kong			
Passengers	42 867	38 752	11%
Revenue	R 293 987 522	R 253 976 451	16%
Average revenue per passenger	R 6 858	R 6 554	5%
Perth			
Passengers	48 536	59 646	-19%
Revenue	R 462 343 027	R 516 647 268	-11%
Average revenue per passenger	R 9 526	R 8 662	10%
New York			
Passengers	93 297	93 693	-0.4%
Revenue	R 390 492 172	R 292 192 477	34%
Average revenue per passenger	R 4 186	R 3 119	34%
Lagos			
Passengers	108 325	106 596	2%
Revenue	R 626 267 893	R 567 303 801	10%
Average revenue per passenger	R 5 781	R 5 322	9%
Luanda			
Passengers	159 262	163 267	-2%
Revenue	R 450 830 558	R 388 805 401	16%
Average revenue per passenger	R 2 830	R 2 381	19%
Maputo			
Passengers	127 353	121 961	4%
Revenue	R 260 118 904	R 220 008 903	18%
Average revenue per passenger	R 2 043	R 1 804	13%

Table 2: The total SAA O&D network which is all the flights that generate revenue from financial year 2014 to 2015 and the percentage change.

SAA Total O&D Network	Financial year 2015	Financial year 2014	Change %
Total Passengers	6 118 719	6 308 759	-3%
Total Revenue	R 24 057 715 732	R 24 132 257 644	-0.3%
Average revenue per passenger	R 3 931	R 3 825	2.8%

Table 2 Total Network Comparison

Table 1, represents the total passengers, total revenue, average revenue per passenger and percentage change from financial year 2014 to 2015 of each O&D route used for the study. Table 2 Is the total of SAA O&D network representing 14 486 flights that generated revenue from financial year 2014, 2015 and the percentage change. The total passengers carried in 2015 decreases by 3%. This is however from reduced capacity after the withdrawal from Mumbai, Abu Dhabi and Beijing. The average revenue per passenger increases by 2.5%. The significance of the nominal change in revenue and passengers carried is that the load factor increases.

These results reflected in an overall analysis of the revenue change due to the network based O&D revenue management. The Revenue Opportunity Model calculation of each O&D route is highlighted in the preceding discussion.

4.3.2 Frankfurt

Table 3 ROM Calculation

FRANKFURT	
Capacity	C 420
Available Demand	C 400
Available seats for Point-of-Sale DE	C 290
Available seats for Point-of-Sale ZA	C 110
Potential Revenue	R 15 788 880
Fares	
ROW Rest-of-World	R 35 055
POS DE (Germany)	R 40 976
POS ZA (South Africa)	R 29 134
No RM revenue	R 11 653 600
POS DE (R40 976) x 290 Pax	R 11 883 040
POS ZA (R29 134) x 110 Pax	R 3 204 740
Actual Revenue	R 15 087 780
Calculation of Revenue Opportunity	R 15 788 880 - R 11 653 600
O & D II Revenue Opportunity	R 4 135 280
Calculation of Achieved Revenue Opportunity	R 15 087 780 - R 11 653 600
O & D II Achieved Revenue Opportunity	R 3 434 180
Percentage Achieved Revenue Opportunity	R 3 434 180 ÷ R 4 135 280
O&D PARO	**83%**

Table 4 Yearly comparison

Frankfurt	**Financial year 2015**	**Financial year 2014**	**Change %**
Total Passengers	108 325	106 596	2%
Total Revenue	R 626 267 893	R 567 303 801	10%
Average revenue per passenger	R 6 858	R 6 554	5%

The ROM calculation results in a Percentage Achieved Revenue Opportunity (PARO) of 83%. The total revenue achieved increase from the financial year 2014 to 2015 by 10% with a 2% increase in passengers. The average revenue per passenger increased by 5%. This is an indication that the O&D optimisation is yielding good results.

4.3.3 Hong Kong

Table 5 ROM calculation

HONG KONG	
Capacity	C 420
Available Demand	C 400
Available seats for Point-of-Sale HK	C 250
Available seats for Point-of-Sale ZA	C 150
Potential Revenue	R 22 075 740
Fares	
ROW Rest-of-World	R 43 847
POS HK (Hong Kong)	R 67 271
POS ZA (South Africa)	R 29 207
No RM revenue	R 17 538 800
POS HK (R67 271) x 250 Pax	R 16 817 750
POS ZA (R29 207) x 150 Pax	R 4 381 050
Actual Revenue	R 21 198 800
Calculation of Revenue Opportunity	R 22 075 740 - R 17 538 800
O&D II Revenue Opportunity	R 4 536 940
Calculation of Achieved Revenue Opportunity	R 21 198 800 - R 17 538 800
O&D II Achieved Revenue Opportunity	R 3 660 000
Percentage Achieved Revenue Opportunity	R 3 660 000 ÷ R 4 536 940
O&D PARO	**81%**

Table 6 Yearly Comparison

Hong Kong	Financial year 2015	Financial year 2014	Change %
Passengers	42 867	38 752	11%
Revenue	R 293 987 522	R 253 976 451	16%
Average revenue per passenger	R 6 858	R 6 554	5%

The ROM calculation results in a Percentage Achieved Revenue Opportunity (PARO) of 81%. The total revenue achieved increased from the financial year 2014 to 2015 by 16% with a 11% increase in passengers. The average revenue per passenger increased by 5%. These results indicate that O&D revenue management optimisation is yielding good results given the level of demand and the capacity offered.

4.3.4 Perth

Table 7 ROM Calculation

PERTH	
Capacity	C 380
Available Demand	C 220
Available seats for Point-of-Sale AU	C 150
Available seats for Point-of-Sale ZA	C 70
Potential Revenue	R 12 231 110
Fares	
ROW Rest-of-World	R 30 868
POS AU (Australia)	R 37 133
POS ZA (South Africa)	R 24 604
No RM revenue	R 5 412 880
POS AU (R37 133) x 150 Pax	R 5 569 950
POS ZA (R24 604) x 70 Pax	R 1 722 280
Actual Revenue	R 7 292 230
Calculation of Revenue Opportunity	R 12 231 110 - R 5 412 880
O&D II Revenue Opportunity	R 6 818 230
Calculation of Achieved Revenue Opportunity	R 7 292 230- R 5 412 880
O&D II Achieved Revenue Opportunity	R 1 879 350
Percentage Achieved Revenue Opportunity	R 1 879 350 ÷ R 6 818 230
O&D II PARO	**28%**

Table 8 Yearly Comparison

Perth	**Financial year 2015**	**Financial year 2014**	**Change %**
Passengers	48 536	59 646	-19%
Revenue	R 462 343 027	R 516 647 268	-11%
Average revenue per passenger	R 9 526	R 8 662	10%

The ROM calculation results in a Percentage Achieved Revenue Opportunity (PARO) of 28%. The total revenue achieved decreased from the financial year 2014 to 2015 by -11% with a decrease of 19% in the total passengers carried. The average revenue per passenger increased by 10%. These results indicate that O&D revenue management optimisation not yielding the desired results. Capacity is not utilised optimally resulting in low load factor. A PARO of 28% indicates that the potential to increase revenue is not being utilised sufficiently leading to the conclusion that the optimisation is overly restrictive and should be assessed and corrections made to the seat availability at each point of sale.

4.3.5 New York

Table 9 ROM Calculation

NEW YORK	
Capacity	C 400
Available Demand	C 330
Available seats for Point-of-Sale US	C 300
Available seats for Point-of-Sale ZA	C 30
Potential Revenue	R 36 671 720
Fares ROW Rest-of-World	R 71 912
POS US (United States of America)	R 101 197
POS ZA (South Africa)	R 42 626
No RM revenue	R 23 730 960
POS US (R 101 197) x 300 Pax	R 30 359 100
POS ZA (R 42 626) x 30 Pax	R 1 278 780
Actual Revenue	R 31 637 880
Calculation of Revenue Opportunity	R 36 671 720 - R 23 730 960
O&D II Revenue Opportunity	R 12 940 760
Calculation of Achieved Revenue Opportunity	R 31 637 880 - R 23 73 0 960
O&D II Achieved Revenue Opportunity	R 7 906 920
Percentage Achieved Revenue Opportunity	R 7 906 920 ÷ R 12 940 760
O&D II PARO	**61%**

Table 10 Yearly Comparison

New York	Financial year 2015	Financial year 2014	Change %
Total Passengers	93 297	93 693	-0.4%
Total Revenue	R 390 492 172	R 292 192 477	34%
Average revenue per passenger	R 4 186	R 3 119	34%

The ROM calculation results in a Percentage achieved Revenue Opportunity (PARO) of 61%. The total revenue achieved increased from the financial year 2014 to 2015 by 34% with the total passengers carried static at .04%. The average revenue per passenger increased by 34%. These results indicate that O&D revenue management optimisation not yielding the desired results. A PARO of 61% indicates that the potential to increase revenue is not being utilised sufficiently leading to the conclusion that the optimisation is restrictive and should be assessed and corrections made to the seat availability at each point of sale. Availability should be increased for the New York and the rest of world point of sale. Restrictions should be placed on SA point of sale with only high priced tickets being available. Although total revenue has increased the capacity utilisation is poor as the potential to sell more tickets is present should be optimised to ensure the higher priced ticket passenger are carried resulting in overall revenue increase. The exchange rate currency conversion from US Dollar ($) to SA Rand (R) can explain the large increase in revenue as a progressive weaker Rand from 2014 to 2015. This study does not take the currency fluctuation into account. The currency effect on revenue is an opportunity for future research.

4.3.6 Lagos

Table 11 ROM Calculation

LAGOS	
Capacity	C 420
Available Demand	C 350
Available seats for Point-of-Sale NG	C 350
Available seats for Point-of-Sale ZA	C 350
Potential Revenue	R 8 425 200
Fares	
ROW Rest-of-World	R 22 766
POS NG (Nigeria)	R 24 072
POS ZA (South Africa)	R 21 460
No RM revenue	R 7 511 000
POS NG (R 24 072) x 290 Pax	R 6 980 880
POS ZA (R 21 460) x 60 Pax	R 1 287 600
Actual Revenue	R 8 268 480
Calculation of Revenue Opportunity	R 8 425 200 - R 7 511 000
O&D II Revenue Opportunity	R 914 200
Calculation of Achieved Revenue Opportunity	R 8 268480 - R 7 511 000
O&D II Achieved Revenue Opportunity	R 757 480
Percentage Achieved Revenue Opportunity	R 757 480 ÷ R 914 200
O&D II PARO	**83%**

Table 12 Yearly Comparison

Lagos	Financial year 2015	Financial year 2014	Change %
Total Passengers	108 325	106 596	2%
Total Revenue	R 626 267 893	R 567 303 801	10%
Average revenue per passenger	R 5 781	R 5 322	9%

The ROM calculation results in a Percentage Achieved Revenue Opportunity (PARO) of 83%. The total revenue achieved increased from the financial year 2014 to 2015 by 10% with only a slight increase of 2% in the total passengers carried. The average revenue per passenger increased by 9%. These results indicate that O&D revenue management optimisation not yielding positive results. Historically Lagos has been SAA'S high revenue route with average load factor of over 95%. It is therefore reasonable to expected that with O&D the trend would continue therefore leading to higher revenue. A PARO of 83% indicates that the potential revenue captured has increased leading to the conclusion that the optimisation is utilised correctly. The seat availability at each point of sale is equal therefore a first come first served strategy is being implement. Although total revenue has increased by 10% and the PARO is 83%, the potential to capture more revenue exists. A change in the strategy to increase seat availability to the rest of world and Lagos point of sale with restrictions on point of sale SA. The change in strategy would result in higher revenue.

4.3.7 Luanda

Table 13 ROM Calculation

LUANDA	
Capacity	C 360
Available demand	C 260
Available seats for Point-of-Sale AO	C 150
Available seats for Point-of-Sale ZA	C 110
Potential Revenue	R 4 024 560
Fares	
ROW Rest-of-World	R 10 904
POS AO (Angola)	R 13 382
POS ZA (South Africa)	R 8 426
No RM revenue	R 2 835 040
POS AO (R13 383) x 150 Pax	R 2 007 300
POS ZA (R8 426) x 110 Pax	R 926 860
Actual Revenue	R 2 934 160
Calculation of Revenue Opportunity	R 4 024 560 - R 2 835 040
O&D II Revenue Opportunity	R 1 189 520
Calculation of Achieved Revenue Opportunity	R 2 934 160 - R 1 189 520
O&D II Achieved Revenue Opportunity	R 1 744 640
Percentage Achieved Revenue Opportunity	R 1 744 640 ÷ R 1 982 480
O&D II PARO	**88%**

Table 14 Yearly Comparison

Luanda	Financial year 2015	Financial year 2014	Change %
Total Passengers	159 262	163 267	-2%
Total Revenue	R 450 830 558	R 388 805 401	16%
Average revenue per passenger	R 2 830	R 2 381	19%

The ROM calculation results in a Percentage Achieved Revenue Opportunity (PARO) of 88%. The total revenue achieved increased from the financial year 2014 to 2015 by 16% but a decrease of -2% in the total passengers carried. The average revenue per passenger increased by 19%. These results indicate that O&D revenue management optimisation is producing positive results. A PARO of 88% indicates that the potential revenue captured has increased leading to the conclusion that the optimisation is utilised correctly. The capacity utilisation should be improved as the load factor should be higher as the PARO increases. At 74% seat load factor indicates the potential to increase revenue captured in high. A change in strategy to increase the number of high value tickets and reduce the discounted tickets from point of sale SA and increase the seat availability at point of sale Luanda would result in higher revenue.

4.3.8 Maputo

Table 15 ROM Calculation

MAPUTO	
Capacity	C 250
Available Demand	C 190
Available seats for Point-of-Sale MZ	C 190
Available seats for Point-of-Sale ZA	C 190
Potential Revenue	R 496 500
Fares	
ROW Rest-of-World	R 2 170
POS MZ (Mozambique)	R 2 353
POS ZA (South Africa)	R 1 986
No RM revenue	R 377 340
POS MZ (R2 353) x 170 Pax	R 400 010
POS ZA (R1 986) x 20 Pax	R 39 720
Actual Revenue	R 439 730
Calculation of Revenue Opportunity	R 496 500 - R 377 340
O & D II Revenue Opportunity	R 119 160
Calculation of Achieved Revenue Opportunity	R 439 730 - R 377 340
O&D II Achieved Revenue Opportunity	R 62 390
Percentage Achieved Revenue Opportunity	R 62 390 ÷ R 119 160
O&D II PARO	**52%**

Table 16 Yearly Comparison

Maputo	Financial year 2015	Financial year 2014	Change %
Passengers	127 353	121 961	4%
Revenue	R 260 118 904	R 220 008 903	18%
Average revenue per passenger	R 2 043	R 1 804	13%

The ROM calculation results in a Percentage Achieved Revenue Opportunity (PARO) of 52%. The total revenue achieved increased from the financial year 2014 to 2015 by 18% with a slight increase of 4% in the total passengers carried. The average revenue per passenger increased by 13%. These results indicate that O&D revenue management optimisation is not producing results as expected. A PARO of 53% indicates that the potential revenue captured is too low. The seat availability at each point of sale is equal and therefore the strategy used to optimise the flights of first come first serve is not producing the revenue required. Although the passenger carried increased by only 4% the potential to increase revenue is very high. A different optimisation strategy is required. An increase in the seat availability from point of sale Maputo, a decrease in the discounted tickets and an increase in high value tickets from point of sale SA would result in higher revenue.

4.3 Conclusion

A total of eight markets were selected and flights from these routes were used for the study. The calculation of the Revenue Opportunity Model was calculated and the results discussed. A comparison of the 2014 and 2015 financial year revenue, total passengers and average revenue per passenger was discussed. The next chapter will discuss the results.

CHAPTER 5: DISCUSSION

5.1 Introduction

In chapter 4, the results were presented with the Revenue Opportunity Model (ROM) calculation resulting in a Percentage Achieved Revenue Opportunity (PARO). The following chapter is a discussion of the results and the effects of the PARO on revenue.

5.2 Results Analysis

An analysis of the data will be discussed in this section. All the results were quantitative in nature with the aim of isolating the effects of the Revenue Management System to measure its effectiveness on revenue.

5.2.1 Network Calculation

Table 1 illustrates the total revenue, passengers carried and average revenue per passenger of the O&D routes selected. New York produced the highest percentage increase in revenue from 2014 to 2015. But the passenger carried was stagnant with a slight decrease by -0.4%. Due to the high availability of seats to point of sale USA, the effects of the weak South African Rand which has continually depreciated in the past two years cannot be discounted. Although the aim of O&D optimisation is to make seats available to the point of sale that will provide the highest revenue, the 34% increase cannot solely be attributed to O&D revenue management. This study could not isolate the currency effect and this is an avenue for future research. The lowest revenue was registered on the Perth route with a -19% decrease in revenue. The passenger carried decreased by -11%. The effect of SAA terminating its code share agreement with Qantas Airlines could help explain the drop in both revenue and passengers. Without a connecting airline to transport passengers from Perth to the rest of Australia, SAA has lost passengers who prefer the convenience of one airline connection. Luanda was the only other route to experience a decline in passenger carried by -2%. The effects of the outbreak of the Ebola virus in West African could explain the decrease in passengers which affect all carriers to the region.

Table 2 is a summary of the total network that SAA generate income from. The passengers carried decreased by at -3%, revenue by -0.3% and average revenue per passenger increased by 2.8%. During the period of 2014 and 2015, the airline stopped operating to Mumbai (India), Beijing (China) and Abu Dhabi. The airlines total capacity offered decreased. The effects of the South African government requiring unabridged birth certificates had an effect of the passengers traveling to SA. Passengers traveling to SA with O.R Tambo airport as the first port of entry decreased by -7.1%. With 45% of all passengers entering SA through this airport being transported by SAA, the airline was affected by the down turn in passengers willing to travel to SA.

5.2.2 ROM Calculation

The ROM calculation represents the impact of the revenue management on revenue by isolating other factors that would distort the revenue. The PARO therefore represents the empirical evidences of the revenue management performance. A high PARO indicates that the flights are optimised per the correct strategy and hence the higher revenue captured. A low PARO indicates poor optimisation and over restrictive controls leading to spill and low load factor.

The routes that performed with a PARO of over 80% were: Frankfurt PARO 83%, Hong Kong PARO 81%, Lagos PARO 83% and Luanda PARO 88%. The revenue management strategies vary with point of sale, Lagos and Luanda having a first come first serve strategy. The capacity on the two routes is however not exhausted and the potential to increase revenue exists without changing the strategy. More seats could be made available at point of sale in Lagos and Luanda which have higher demand than point of sale South Africa. New York with a PARO of 61% presents an interesting dilemma as the seat available at this point of sale is high. To increase revenue an upgrading strategy should be implemented with the passengers willing to pay more offered the excess seating. Point of sale Maputo with a PARO of 52% indicates there is potential to increase revenue. The current strategy utilised is first come first served. An overbooking strategy at both Maputo and South African point of sale could result in increased revenue. Perth with a PARO of 28% is the worst performer. This is an indication of overly restrictive revenue management controls being utilised which creates spill and low load factor. To increase revenue more seats should be made available at point of sale SA while keeping the same availability for point of sale Perth. An upgrade strategy should be utilised to increase revenue. The ROM calculations do indicate that there has been revenue growth due to the implementation of the O&D Network RM.

5.3 Conclusion

The results derived from the data are discussed in this chapter. The Network calculation and the financial year comparison are discussed. The ROM calculations are discussed and the meaning of the PARO in relation to revenue is discussed. In the context of this research the conclusion derived from the results discussion is as follows: With the aim of the research is to ascertain if there have been any revenue gains due to the implementation of O&D. The results presented show that the flights are being optimised to increase revenue resulting in an average of PARO 68% for the network. With overall capacity, reduced due to route closures, an increase in PARO above 75% is required to compensate for the loss in revenue. The network based revenue controls have resulted in an overall increase in revenue for the airline with higher load factor in financial year 2015 then 2014. There however needs to be an alignment of a common network strategy to gain the revenue improvements required. The final chapter will summarise the research.

CHAPTER 6: SUMMARY AND CONCLUSION

6.1 Research overview

The performance measures in airline revenue management are addressed in this thesis as an evaluation of SAA O&D revenue management. The importance of continuously assessing and providing feedback of the RM will lead to improved revenue. The migration from Leg based to Network RM controls created the need to quantify the effects on revenue of the new RM within the airline.

Chapter 1 introduced the RM context, SAA requirement to move from Leg-based to O&D Network RM control and provides the research scope. The problem statement is formulated and the objectives identified. The theoretical framework of airline RM is presented and concluded by outlining the structure of the thesis. In chapter 2 a literature review of airline revenue management and the performance measures are presented. The history of airline RM and its evolution is explained. An introduction of the main concept of airline revenue management on Pricing, Demand and Inventory provide a comprehensive account of RM performance measures used. An extensive description of ROM with the limitations is presented and the RM performance measure are described in detail including the limitation from an SAA perspective.

The research methodology in chapter 3 provides an overview of airline RM performance measures and the data is explained. The research question guiding the research is outline and the post positive research paradigm of the thesis and population was explained.

The results and data analysis are presented in Chapter 4 with the network calculation indicating the passengers carried, total revenue and average revenue per passage from SAA revenue of the financial year 2014 to 2015. The results indicate that overall revenue has been stagnant during this period and insight on the mitigating circumstances for the lack of revenue growth is presented. The ROM calculation on the routes selected is performed and the PARO with a description of the results is presented. The results discussion in chapter 5 details the relevance of the PARO and its significance to revenue.

Measures that would aid in the increase of revenue based on the PARO achieved on each route are proposed and chapter 6 concludes with a summary and opportunities for future research are explored.

6.2 Future Research Recommendations

The recommendation for future research is to investigate the effects of combining ROM measure with other key performances measure that are traditionally utilised in the airline industry.

The effects of exchange rate currency conversion to local currency to the performances measurement of ROM could be investigated.

6.3 Conclusion of the research

Based on the data collected and the results from the research, does this thesis fulfil its goal in answering the following: Has the migration from leg based segment revenue optimization to the origin destination revenue optimization at SAA provided network optimization resulting in increased revenue? The results confirm that the flights are being optimised at a network level and the Percentage Achieved Revenue Opportunity is on average above 68% for the whole network. An evaluation of the performance of revenue management controls applied on the SAA network is performed and with perfect hindsight, identifies the optimal RM controls to produce maximum revenue by incorporating different control strategy. The merits of the RM approach have been gauged per the performance analysis as either poor or profitable and options of controls that could be used to increase revenue are provided. The merits of network based revenue optimisation can be quantified and the airline can achieve increased revenue.

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