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"A Study on the Software Development Life Cycle–Waterfall Model" at a Aviation Management Consultant

Pranav S Kayande, Sidharth Phadnis

Abstract: ***We have selected the study of software development life cycle- waterfall model, herein after is referred to as SDLC for brevity purpose. We have been allowed to study in the software firm - Aviation Management Consultants. The researchers studied the software named –"Routonomics" developed by the firm. The software enables the airlines to prepare the business plan with 5 years perspective. The purpose of selection of this subject is that SDLC- Waterfall Model is the reference model of any software related work. Many SDLC models evolved from this basic concept. Further, the firm introduced a small change in one of the reports to enable us to understand the practical perception of the SDLC. The researchers were involved in the simulated development of small change in the report.***

Keywords: SDLC, Aviation Management System, Project Management.

I. INTRODUCTION

Aviation Management system (AMS) is a fundamental component of a modern airliner's avionics. An AMS is a specialized computer system that automates a wide variety of in-flight tasks, reducing the workload on the flight crew to the point that modern civilian aircraft no longer carry flight engineers or navigators. A primary function is in-flight management of the flight plan. Using various sensors (such as GPS and INS often backed up by radio navigation) to determine the aircraft's position, the AMS can guide the aircraft along the flight plan. From the cockpit, the FMS is normally controlled through a Control Display Unit (CDU) which incorporates a small screen and keyboard or touchscreen. The FMS sends the flight plan for display to the Electronic Flight Instrument System (EFIS), Navigation Display (ND), or Multifunction Display (MFD). The FMS can be summarised as being a dual system consisting of the Flight Management Computer (FMC), CDU and a cross talk bus. Aviation Management Consultants (AMC), a firm registered under the Software Technology Park of India, in the year 2009.

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It is engaged in the design, development and implementation of Aviation Domain specific application software. The firm also offers consultancy in the functional areas of Airline budgeting, financial systems implementation. (www.sabre.com [6]).

II. LITERATURE REVIEW

The article (Kasturi E, Prasanna Devi S, Vinu Kiran S, Manivannan S (2016) [1][7][8]) has brought in the analysis of airline Route profitability and its optimization using BIG DATA analytics on aviation data sets under heuristic Techniques. Applying vital decisions for new airline routes and aircraft utilization are important factors for airline decision making. For data driven analysis key points such as airliners route distance, availability on seats/freight/mails and fuel are considered. The airline route profitability optimization model is proposed based on performing Big data analytics over large scale aviation data under multiple heuristic methods, based on which practical problems are analysed. Analysis should be done based on key criteria, identified by operational needs and load revenues from operational systems e.g. passenger, cargo, freights, airport, country, aircraft, seat class etc., The result shows that the analysis is simple and convenient with concrete decision. The article (Srećko Krile, Marina Krile (2015) [2][11]) has brought in the analysis of new approach in definition of multi-stop flight routes. Optimization and profitability approaches play a crucial and central role in airline industry today. The main problem is how to overcome complexity by providing effective route schedule with minimal empty seats. So we need capable tools to re-optimize existing flight routes or to offer new one instead. This research deals about the efficient heuristic algorithm for optimal transportation of *N* different passenger contingents between ending points. We want to find out better transport plan with minimal transport cost for the route with more charging/discharging points (airports). Such optimization tool can help in sizing of appropriate airplane for definite direction, too. The article (Teoh, Lay Eng, Khoo, Hooi Ling (2016) [3][9]) provides the insight into the fleet Planning Decision-Making: Two-Stage Optimization with Slot Purchase. Essentially, strategic fleet planning is vital for airlines to yield a higher profit margin while providing a desired service frequency to meet stochastic demand.

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In contrast to most studies that did not consider slot purchase which would affect the service frequency determination of airlines, this paper proposes a novel approach to solve the fleet planning problem subject to various operational constraints. A two-stage fleet planning model is formulated in which the first stage selects the individual operating route that requires slot purchase for network expansions while the second stage, in the form of probabilistic dynamic programming model, determines the quantity and type of aircraft (with the corresponding service frequency) to meet the demand profitably. By analyzing an illustrative case study (with 38 international routes), the results show that the incorporation of slot purchase in fleet planning is beneficial to airlines in achieving economic and social sustainability. The developed model is practically viable for airlines not only to provide a better service quality (via a higher service frequency) to meet more demand but also to obtain a higher revenue and profit margin, by making an optimal slot purchase and fleet planning decision throughout the long-term planning horizon. The research paper (Aleksandra Fedosova (2016) [4]) examines the relationship between the financial performance of six European airlines, internal factors that characterize these airlines and the external factors surrounding and influencing the airline industry in general, and in Europe specifically. The number of passengers worldwide increased from 2.1 billion in 2004 to 3 billion in 2013, but airlines have only been able to generate a positive net profit margin in six of the last ten years. In 2013, airlines generated an average net profit margin of 1.5%. However, some airlines have performed better than others during this period. Furthermore, the airline industry is characterized by great competition and unpredictable events making it a complex industry to understand. This thesis is written in a pragmatic manner and based on inductive research approach and with a case study research design. This is reflected by the many sources of secondary data I have utilized and the framework that has been applied throughout the thesis. Ultimately, the main focus of this paper was to identify factors that contribute to the good performance of some airlines, and the poor performance of others between 2004 and 2013. The relationship between financial performance and its influencing factors has been explored in three steps. First, the financial performance of the relevant airlines was compared to each other by applying various financial ratios, such as EBT margin, operating expense ratio, current ratio and debt to equity ratio. The next step was to identify internal factors that characterize full scale carriers and low cost carriers, factors that can be used to explain the difference in performance. The research paper (Karim, Md,Choudhury, Musfiq, Bin Latif, Wasib (2019), [5][10]) purpose to make an analysis of the financial results of traditional and low cost airlines and compare them. The comparison is done through analysis of the representatives of traditional and low cost airlines – British Airways and easyJet. In addition, the investigation provides an overview of the airline industry. Researcher applies fundamental analysis, which includes four components: business strategy analysis, accounting analysis, financial analysis, and prospective analysis. However, the research is not covering the prospective analysis. Data for this thesis is collected by reviewing literature related to the topic and by analyzing the data from annual reports of chosen airlines. To answer research questions, the collection of numerical data, its evaluation and analysis of existing financial theories is done. Consequently, quantitative research method is applied throughout the investigation. The research concludes that the competition between airlines is vast nowadays and it continues to grow with the fast-developing airline industry. Eventually, the study proves that low cost airlines do have better financial results and they are the consequence of the strategy of low-cost carriers, the main aspect of which is the reduction of costs at the possible higher degree.

III. RESEARCH METHODOLOGY

The objectives of market research was to study the development of the software in the field of airline route profitability planning area–

- How SDLC process takes place?
- What tasks are done at each phase of SDLC?
- What are the key factors to make project successful?
- How the project is managed and controlled?
- How requirements are gathered?
- How the requirements are analysed?
- How the systems requirement document is prepared?
- How to communicate your question to the user to get right answer?
- How to communicate the requirements to the development team members?
- How to ensure that they have understood the requirements with clarity?
- What are the considerations for design?
- What is the process to identify the affected code areas due to changes in the requirements?
- How to prepare the test case, test data, execution of tests?
- What is the process of defects analysis?
- Understand the objective of airline route profitability plan software serves to the airline management.
- Understand the functionality of Routonomics – the airline route profitability plan software
- Observe the technology used, compare it with the current technology
- Observe the SDLC management processes followed
- Observe IT infrastructure required for software development
- Study the IT companies engaged in developing the airline route profitability software
- Study the market for such software
- Study what is the new trend in this field
- Study how the current software can be scaled to mitigate the new approaches like heuristic modelling.

Research is a logical and systematic search for new and useful information on a particular topic.

Descriptive research is used to describe characteristics of a phenomenon being studied. It addresses the "what" question (what are the characteristics of the population or situation being studied?).

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The researcher participated into the report change request of Rotodomes route profitability plan software.
Role: - Functional coordinator
Respondents: - Software development team members and client.
Sample size: - 10.
Sampling method: - Convenient.

The researcher used Observation, Survey techniques and Interviewing and Questionnaire tools during the research project. The report incorporates addition of the ratio relating to operating performance of airlines based upon the requirement gathering and analysis.

IV. SYSTEM DEVELOPMENT LIFE CYCLE - ABOUT THE PROJECT – CHANGE REQUEST

Change Request specifically created / simulated for providing understanding to Siddharth Phadnis – Airline ratio analysis report

Table No.1. Change Request

Sr No	Change Particulars	Change details
1	Change request No and date	07 dated 1-June-2019
2	Change request made by	Shri Nadgauda
3	Change context	Change to Airline Ratio Analysis Report – Routonomics
4	Change details	Add following ratios-
		Fuel Cost per frequency
		Yield per RPK
		Cost per RPK
5	Purpose of change	To know the cost and yield of the route per passenger kilometre
6	Process to be followed	Typical waterfall SDLC
7	Time allotted	Two and half months from the date of this change request
8	Deliverables	Requirement Document
		Design Document
		Test Cases and Results
		Tested change module

Project Planning

Project management plan- Allocation of phase wise tasks

PROJECT MANAGEMENT PLAN -- FOR CHANGES IN THE REPORT -- RATIO ANALYSIS -- ROUTONOMICS													
	Firm name	Aviation Management Consultants,											
	Project Name	Report -changes - Routonomics -Ratio Analysis											
	Start date	01-Jun-19											
	End date	31-Jul-19											
	SDLC Phase	**Task Code**	**Task Desc**	**Task Assigned**	**Timelines**							
					June--2019				**July--2019**			
					WK-01	**WK-02**	**WK-03**	**WK-04**	**WK-01**	**WK-02**	**WK-03**	**WK-04**
	Requirement											
		REQ-01	Understanding the Change Request									
		REQ-02	Requirement gathering	Siddharth								
		REQ-03	Requirement Analysis	Siddharth and Team Member								
		REQ-04	Requirement Review	Team Member								
		REQ-05	Preparation of Requirement Documentation	Siddharth and Team Member								

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SDLC Phase	Task Code	Task Desc	Task Assigned	Timelines							
				June--2019				July--2019			
				WK-01	WK-02	WK-03	WK-04	WK-01	WK-02	WK-03	WK-04
Design											
	DGN-01	Software architecture	Design Team Member								
	DGN-02	UI -Design	Design Team Member								
	DGN-03	Report Design	Siddharth								
	DGN-04	Database Design	Design Team Member								
	DGN-05	Dataflow Design	Design Team Member								
	DGN-06	Design Review	Design Team Member								
	DGN-07	Design Documentation	Siddharth and Design Team Member								

SDLC Phase	Task Code	Task Desc	Task Assigned	Timelines							
				June--2019				July--2019			
				WK-01	WK-02	WK-03	WK-04	WK-01	WK-02	WK-03	WK-04
Code Development											
	CODE-01	Creating Development and Testing Platform	Devt Team Member								
	CODE-01	Process for moving application from Development Environment to Test Environment	Siddharth and Devt Team Member								
	CODE-01	WBS	Devt Team Member								
	CODE-01	Code development - UI	Devt Team Member								
	CODE-01	Code development - Report	Devt Team Member								
	CODE-01	Code development - Stored procedures	Devt Team Member								
	CODE-01	Code Review	Devt Team Member								
	CODE-01	Prepare test cases- Units Testing	Devt Team Member								
	CODE-01	Unit Tests Execution	Devt Team Member								
	CODE-01	Unit Test Result Evaluation	Devt Team Member								
	CODE-01	Auto genrated Code Documentation	Devt Team Member								

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SDLC Phase	Task Code	Task Desc	Task Assigned	Timelines							
				June--2019				July--2019			
				WK-01	WK-02	WK-03	WK-04	WK-01	WK-02	WK-03	WK-04
Testing	TEST-01	Prepare Test Plan	Siddharth and Testing Team								
	TEST-01	Prepare test cases-Report Change - Functional	Siddharth and Testing Team								
	TEST-01	Prepare test cases-System	Siddharth and Testing Team								
	TEST-01	Prepare test cases-Stress Testing	Testing Team Member								
	TEST-01	Prepare Requirement Treacability Matrix	Siddharth								
	TEST-01	Test Execution	Siddharth								
	TEST-01	Test Results Evaluation	Testing Team Member								
	TEST-01	Prepare list of Defects	Siddharth								
	TEST-01	Moving the Defects to Development Environment	Testing Team Member								
	TEST-01	Prepare Test Documentation	Siddharth								

SDLC Phase	Task Code	Task Desc	Task Assigned	Timelines							
				June--2019				July--2019			
				WK-01	WK-02	WK-03	WK-04	WK-01	WK-02	WK-03	WK-04
Installation											
	INSTL-01	Executable File Generation	Technical Leader								
	INSTL-02	Prepare Installation Manual	Technical Leader								
	INSTL-03	Install as per Installation Manual	Technical Leader								

Fig. No. 1 Project Management Plan Phases

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PROJECT MANAGEMENT PLAN -- MILESTONE ANALYSIS -- FOR CHANGES IN THE REPORT -- RATIO ANALYSIS -- ROUTONOMICS										
	Firm name	Aviation Management Consultants,								
	Project Name	Report -changes - Routonomics -Ratio Analysis								
	Start date	01-Jun-19								
	End date	31-Jul-19								
	SDLC Phase	**Process -Tasks**	**Timelines**							
			June--2019				**July--2019**			
			WK-01	**WK-02**	**WK-03**	**WK-04**	**WK-01**	**WK-02**	**WK-03**	**WK-04**
	Requirement	Understanding the Change Request -------> Preparation of Requirement Documentation								
	Design	Software architecture								
		UI -Design -------> Report Design -----> Database Design -----> Review ------> Design Documentation								
	Programming Development	Creating Development and Testing Platform --->Process for moving application from Development Environment to Test Environment----> Code -UI ------> Code -Report-----> Unit Testing----> Auto Generation of Documents								
	Testing	Prepare Test Plan --> Test Case execution ---> Test Documentation								
	Installation	Executable file---> Installation Manual----> Installation								

Fig. No. 2 Project Milestones

About the SDLC Waterfall Model

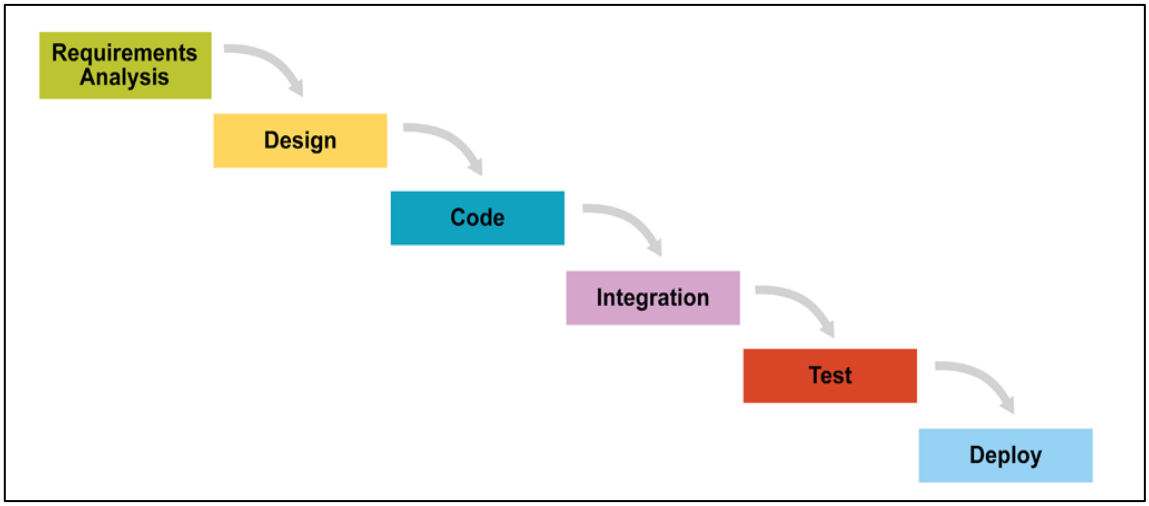

Fig. No. 3. SDLC Waterfall Model

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Requirement Phase

Requirement gathering -- Questionnaire

Routonomics is the airline profitability plan software developed by Aviation Management Consultants, Pune. One of the reports provided by such software is -- Airline Ratio Analysis Report. This report provides the ratio analysis of the operating performance analysis of the airline by Flight, Route, The analysis is provided with the graphical presentation. This report provides the analysis by Year and by Month. This report needs to have the operating profitability indicators in form of yield per passenger kilometre and cost per passenger kilometer The context is the airline ratio analysis report of Routonomics.

Gathering the requirement - The requirements are gathered from the change request, from the existing ratio analysis report. The requirements are analysed in the requirement analysis part.

Requirement analysis using data

Table No. 2 Requirement Analysis Using Data

Fuel Cost / FRQ	Fuel cost = Fuel Qty consumed per flight hour X Rate of Fuel per USG
	Fuel consumed per flight hour is as per aircraft manufacturer's data adjusted to average prevailing flight path weather condition.
	Frequency = Sum of the flights in the month
Capacity	
Block Hours	Block hours = Flight hours of the air journey + taxi time
Flight Hours	Flight hours = Flight hours of the air journey
ASK	ASK = Available Seat Kilometers = Number of seats in the aircraft X Distance in KMs
RPK	RPK = Revenue Passenger Kilometers = Number of passenger in the aircraft X Distance in KMs
Key Perf. Indicator	
Yield/RPK	Passenger revenue for the month / Passenger Kilometers
	Passenger revenue for the month = number of passengers X Fare
	Passenger KMs = number of passengers X Distance in KMs of the route
Cost / RPK	Total cost for the month / Passenger Kilometers
	Cost = Total costs relating to the route
	Passenger KMs = number of passengers X Distance in KMs of the route

Design Phase Design – Dataflow

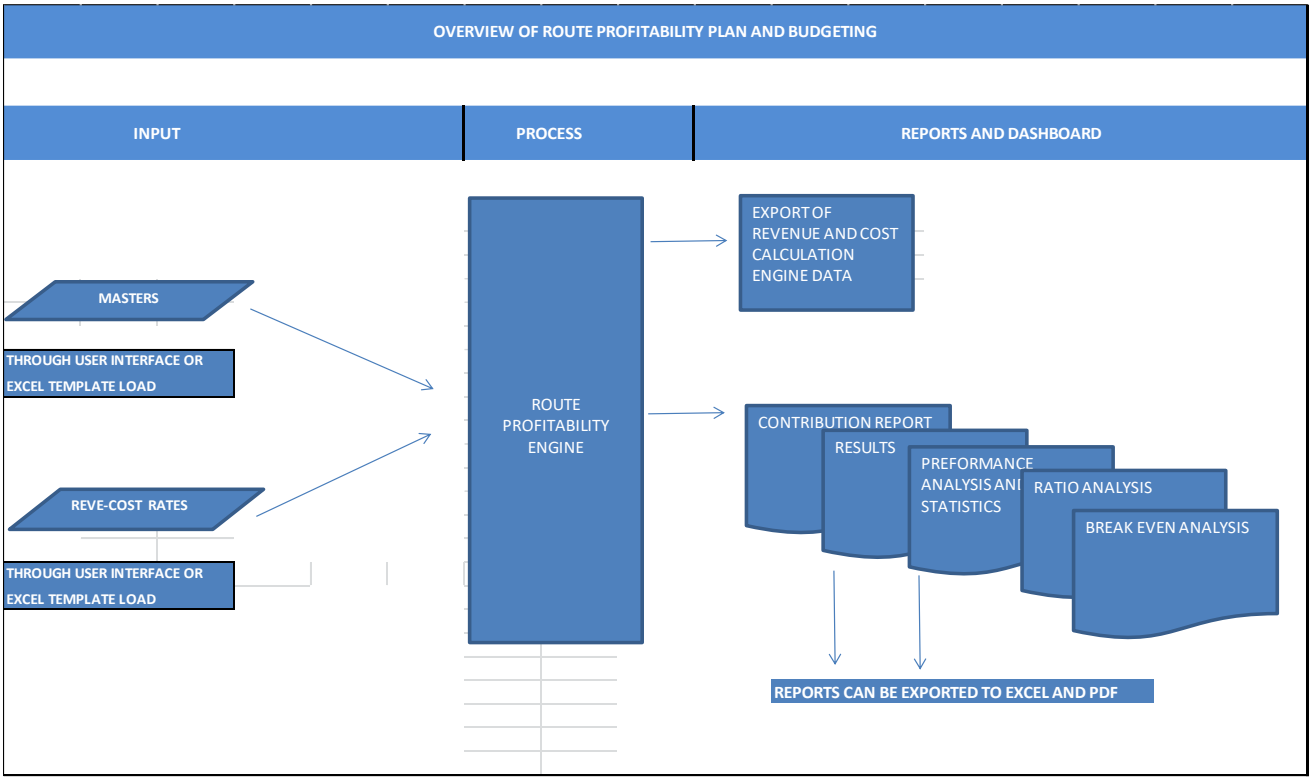

Fig. No. 4. Screenshots of UI Report Generation – User Interface

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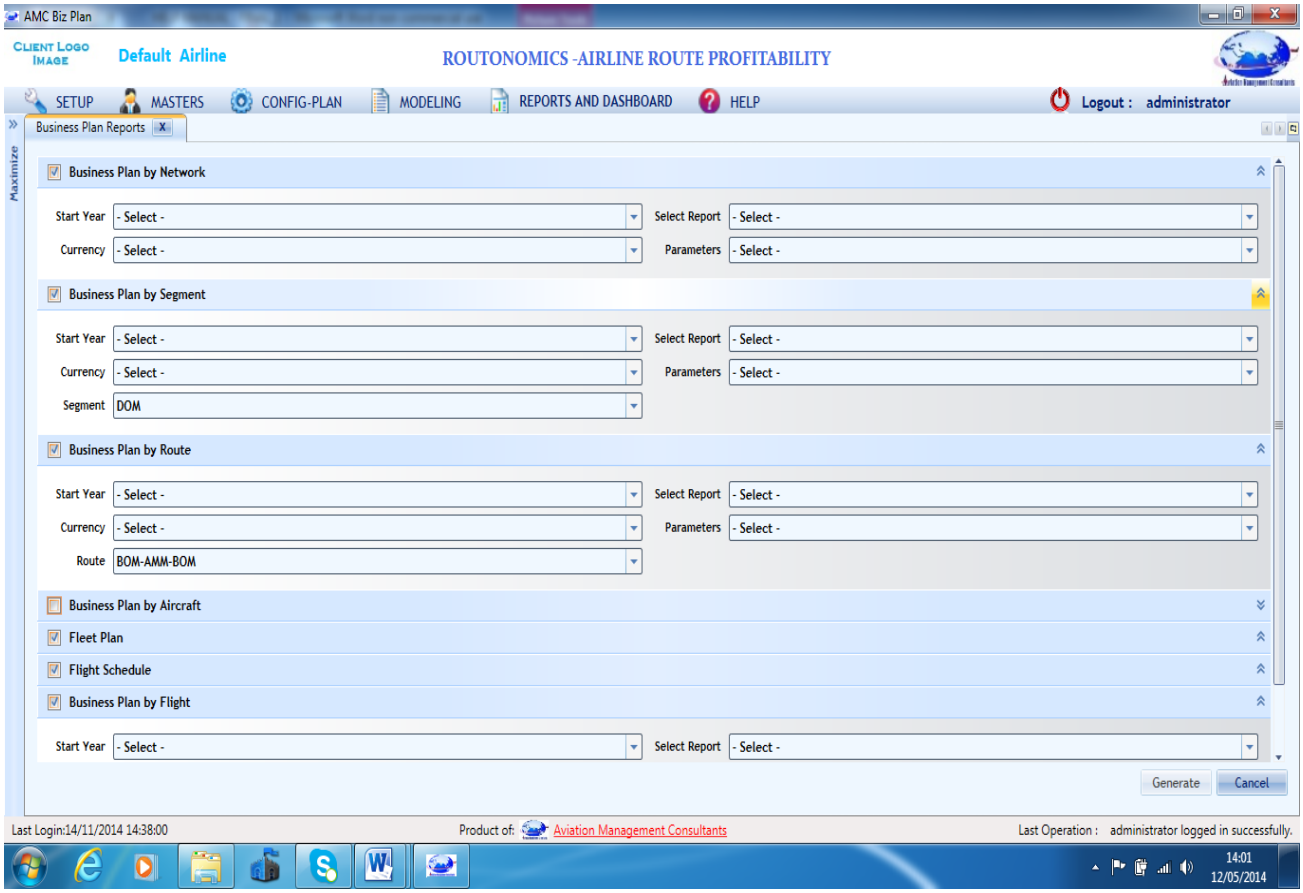

Fig. No. 5. Report Design - Sample Report of Airline –Ratio Analysis

Table No. 3. Network Analysis by Month

Network Ratio Analysis by Month													
Particulars	**UOM**	**Apr-2019**	**May-2019**	**Jun-2019**	**Jul-2019**	**Aug-2019**	**Sep-2019**	**Oct-2019**	**Nov-2019**	**Dec-2019**	**Jan-2020**	**Feb-2020**	**Mar-2020**
Passenger Rev-Nett	$ K	25,738.11	26,486.82	25,893.81	26,494.20	26,658.72	25,893.81	26,494.20	25,728.39	26,665.20	26,486.82	24,969.69	26,665.20
Cargo Rev-Nett	$ K	19.26	19.91	19.48	19.84	20.05	19.48	19.84	19.33	19.98	19.91	18.76	19.98
EBT/Sur/Other	$ K	5,695.26	5,859.98	5,730.61	5,861.65	5,899.44	5,730.61	5,861.65	5,692.97	5,900.77	5,859.98	5,525.89	5,900.77
Total Revenue	$ K	31,452.63	32,366.71	31,643.90	32,375.69	32,578.21	31,643.90	32,375.69	31,440.69	32,585.95	32,366.71	30,514.34	32,585.95
Fuel Cost	$ K	6,347.24	6,413.91	6,343.10	6,491.69	6,516.25	6,343.10	6,491.69	6,269.46	6,565.32	6,413.91	6,125.02	6,565.32
Aircraft Cost	$ K	8,350.11	8,413.68	8,345.34	8,461.87	8,478.02	8,345.34	8,461.87	8,301.92	8,505.29	8,413.68	8,190.16	8,505.29
Sector Cost	$ K	3,861.40	3,969.67	3,873.27	3,976.76	3,991.93	3,873.27	3,976.76	3,854.31	3,995.72	3,969.67	3,738.96	3,995.72
Pax Cost	$ K	2,666.65	2,743.88	2,686.96	2,743.87	2,764.45	2,686.96	2,743.87	2,666.81	2,764.07	2,743.88	2,589.58	2,764.07
Crew Cost	$ K	1,924.11	1,927.70	1,924.24	1,931.78	1,933.07	1,924.24	1,931.78	1,920.03	1,935.99	1,927.70	1,912.36	1,935.99
Direct Operating Cost	$ K	23,149.51	23,468.84	23,172.91	23,605.96	23,683.73	23,172.91	23,605.96	23,012.54	23,766.39	23,468.84	22,556.07	23,766.39
Gross Margin	$ K	8,303.12	8,897.87	8,470.99	8,769.73	8,894.48	8,470.99	8,769.73	8,428.15	8,819.56	8,897.87	7,958.27	8,819.56
Overheads	$ K	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Profit Before Tax	$ K	8,203.12	8,797.87	8,371.00	8,669.72	8,794.48	8,371.00	8,669.72	8,328.15	8,719.56	8,797.87	7,858.27	8,719.56
Profitability Anlysis-%													
Passenger Rev Nett-Total Rev	%	81.83	81.83	81.83	81.83	81.83	81.83	81.83	81.83	81.83	81.83	81.83	81.83
Cargo Rev Nett-Total Rev	%	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
EBT/Sur/Other-Toatl Rev	%	18.11	18.10	18.11	18.11	18.11	18.11	18.11	18.11	18.11	18.10	18.11	18.11
Total Rev	%	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	100.00
Fuel Cost-Total Rev	%	20.18	19.82	20.05	20.05	20.00	20.05	20.05	19.94	20.15	19.82	20.07	20.15
Aircraf Cost-Total Rev	%	26.55	25.99	26.37	26.14	26.02	26.37	26.14	26.41	26.10	25.99	26.84	26.10
Sector Cost-Total Rev	%	12.28	12.26	12.24	12.28	12.25	12.24	12.28	12.26	12.26	12.26	12.25	12.26
Pax Cost-Total Rev	%	8.48	8.48	8.49	8.48	8.49	8.49	8.48	8.48	8.48	8.48	8.49	8.48
Crew Cost-Total Rev	%	6.12	5.96	6.08	5.97	5.93	6.08	5.97	6.11	5.94	5.96	6.27	5.94
Direct Op. Cost-Total Rev	%	73.60	72.51	73.23	72.91	72.70	73.23	72.91	73.19	72.93	72.51	73.92	72.93
Gr Margin-Total Rev	%	26.40	27.49	26.77	27.09	27.30	26.77	27.09	26.81	27.07	27.49	26.08	27.07
Overheads-Total Rev	%	0.32	0.31	0.32	0.31	0.31	0.32	0.31	0.32	0.31	0.31	0.33	0.31
PBT-Total Rev	%	26.08	27.18	26.45	26.78	26.99	26.45	26.78	26.49	26.76	27.18	25.75	26.76

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Report Airline --Ratio Analysis													
Particulars	**UOM**	**Apr-2019**	**May-2019**	**Jun-2019**	**Jul-2019**	**Aug-2019**	**Sep-2019**	**Oct-2019**	**Nov-2019**	**Dec-2019**	**Jan-2020**	**Feb-2020**	**Mar-2020**
Passenger Rev Nett/FRQ	$/FRQ	77,060.21	76,996.57	77,064.91	77,018.02	77,048.32	77,064.91	77,018.02	77,031.11	77,067.05	76,996.57	77,066.94	77,067.05
Cargo Rev Nett/FRQ	$/FRQ	57.66	57.87	57.96	57.66	57.95	57.96	57.66	57.88	57.75	57.87	57.89	57.75
EBT/Sur/Other/FRQ	$/FRQ	17,051.69	17,034.83	17,055.40	17,039.68	17,050.39	17,055.40	17,039.68	17,044.81	17,054.24	17,034.83	17,055.22	17,054.24
Total Revenue	$/FRQ	94,169.56	94,089.27	94,178.27	94,115.37	94,156.67	94,178.27	94,115.37	94,133.80	94,179.04	94,089.27	94,180.06	94,179.04
Fuel Cost/FRQ	$/FRQ	19,003.72	18,645.09	18,878.27	18,871.19	18,833.09	18,878.27	18,871.19	18,770.85	18,974.92	18,645.09	18,904.37	18,974.92
Aircraft Cost/FRQ	$/FRQ	25,000.32	24,458.37	24,837.33	24,598.45	24,502.95	24,837.33	24,598.45	24,856.05	24,581.75	24,458.37	25,278.28	24,581.75
Sector cost/FRQ	$/FRQ	11,561.08	11,539.74	11,527.60	11,560.34	11,537.38	11,527.60	11,560.34	11,539.86	11,548.32	11,539.74	11,539.98	11,548.32
Pax Cost/FRQ	$/FRQ	7,983.99	7,976.40	7,996.90	7,976.36	7,989.74	7,996.90	7,976.36	7,984.46	7,988.65	7,976.40	7,992.52	7,988.65
Crew Cost/FRQ	$/FRQ	5,760.81	5,603.77	5,726.89	5,615.64	5,586.92	5,726.89	5,615.64	5,748.58	5,595.35	5,603.77	5,902.34	5,595.35
Direct Operating Cost/FRQ	$/FRQ	69,309.91	68,223.38	68,966.98	68,621.98	68,450.08	68,966.98	68,621.98	68,899.81	68,689.00	68,223.38	69,617.50	68,689.00
Gross Margin/FRQ	$/FRQ	24,859.65	25,865.89	25,211.29	25,493.39	25,706.59	25,211.29	25,493.39	25,233.99	25,490.04	25,865.89	24,562.56	25,490.04
Overheads/FRQ	$/FRQ	299.40	290.69	297.62	290.70	289.02	297.62	290.70	299.41	289.01	290.69	308.64	289.01
Profit Before Tax/FRQ	$/FRQ	24,560.25	25,575.20	24,913.68	25,202.69	25,417.57	24,913.68	25,202.69	24,934.58	25,201.03	25,575.20	24,253.91	25,201.03
Capacity													
Sector Frequency	#	334	344	336	344	346	336	344	334	346	344	324	346
Block Hours	#	1,481.06	1,499.39	1,482.06	1,515.72	1,521.72	1,482.06	1,515.72	1,464.73	1,533.05	1,499.39	1,430.07	1,533.05
Flight Hours	#	1,348.96	1,363.30	1,349.46	1,379.64	1,384.80	1,349.46	1,379.64	1,332.62	1,396.48	1,363.30	1,301.94	1,396.48
ASK	KMs-K	3,08,772.20	3,13,099.94	3,08,462.20	3,16,275.74	3,17,432.54	3,08,462.20	3,16,275.74	3,05,596.40	3,19,141.54	3,13,099.94	2,98,092.86	3,19,141.54
RPK	KMs-K	2,05,179.08	2,07,571.33	2,05,096.21	2,09,906.98	2,10,763.02	2,05,096.21	2,09,906.98	2,02,831.86	2,12,231.54	2,07,571.33	1,98,077.17	2,12,231.54
Key Perf. Indicator													
Cabin Factor	%	66.45	66.30	66.49	66.37	66.40	66.49	66.37	66.37	66.50	66.30	66.45	66.50
Yield/RPK	Cent	12.54	12.76	12.63	12.62	12.65	12.63	12.62	12.68	12.56	12.76	12.61	12.56
Cost/RPK	Cent	11.33	11.35	11.35	11.29	11.28	11.35	11.29	11.39	11.25	11.35	11.44	11.25
Yield/ASK	Cent	8.34	8.46	8.39	8.38	8.40	8.39	8.38	8.42	8.36	8.46	8.38	8.36
Cost/ASK	Cent	7.53	7.53	7.54	7.50	7.49	7.54	7.50	7.56	7.48	7.53	7.60	7.48
Avg Fare Nett	$/pax	446.72	446.79	446.09	446.93	446.36	446.09	446.93	446.58	446.47	446.79	446.32	446.47
Cabin Factor_ F	%	64.34	64.02	64.05	64.16	64.21	64.05	64.16	64.19	63.97	64.02	63.96	63.97
Cabin Factor_ J	%	63.93	64.05	63.81	63.94	63.95	63.81	63.94	64.03	63.87	64.05	63.97	63.87
Cabin Factor_ W	%	68.68	68.45	68.63	68.56	68.55	68.63	68.56	68.55	68.73	68.45	68.65	68.73
Cabin Factor_ Y	%	66.47	66.30	66.53	66.39	66.42	66.53	66.39	66.38	66.53	66.30	66.47	66.53
Yield/RPK_F	Cent	16.60	16.95	16.83	16.69	16.83	16.83	16.69	16.86	16.67	16.95	16.79	16.67
Yield/RPK_J	Cent	15.70	15.82	15.81	15.74	15.77	15.81	15.74	15.78	15.76	15.82	15.75	15.76
Yield/RPK_W	Cent	10.07	10.30	10.15	10.15	10.19	10.15	10.15	10.22	10.08	10.30	10.14	10.08
Yield/RPK_Y	Cent	12.50	12.71	12.58	12.58	12.60	12.58	12.58	12.64	12.52	12.71	12.56	12.52
Avg Fare Nett _ F	$-K	810.00	810.00	810.00	810.00	810.00	810.00	810.00	810.00	810.00	810.00	810.00	810.00
Avg Fare Nett _ J	$-K	558.69	555.17	557.68	557.31	556.58	557.68	557.31	556.55	558.71	555.17	557.53	558.71
Avg Fare Nett _ W	$-K	508.65	509.04	506.44	509.53	507.46	506.44	509.53	508.26	507.76	509.04	507.23	507.76
Avg Fare Nett _ Y	$-K	433.60	433.89	433.07	433.90	433.37	433.07	433.90	433.60	433.37	433.89	433.28	433.37
Traffic Production													
Passenger_F	#	412	422	416	422	428	416	422	412	426	422	400	426
Passenger_J	#	3,130	3,228	3,146	3,224	3,246	3,146	3,224	3,132	3,242	3,228	3,040	3,242
Passenger_W	#	2,788	2,849	2,824	2,853	2,893	2,824	2,853	2,782	2,898	2,849	2,716	2,898
Passenger_Y	#	51,286	52,784	51,660	52,782	53,158	51,660	52,782	51,286	53,158	52,784	49,790	53,158
Total Passenger	#	57,616	59,283	58,046	59,281	59,725	58,046	59,281	57,612	59,724	59,283	55,946	59,724

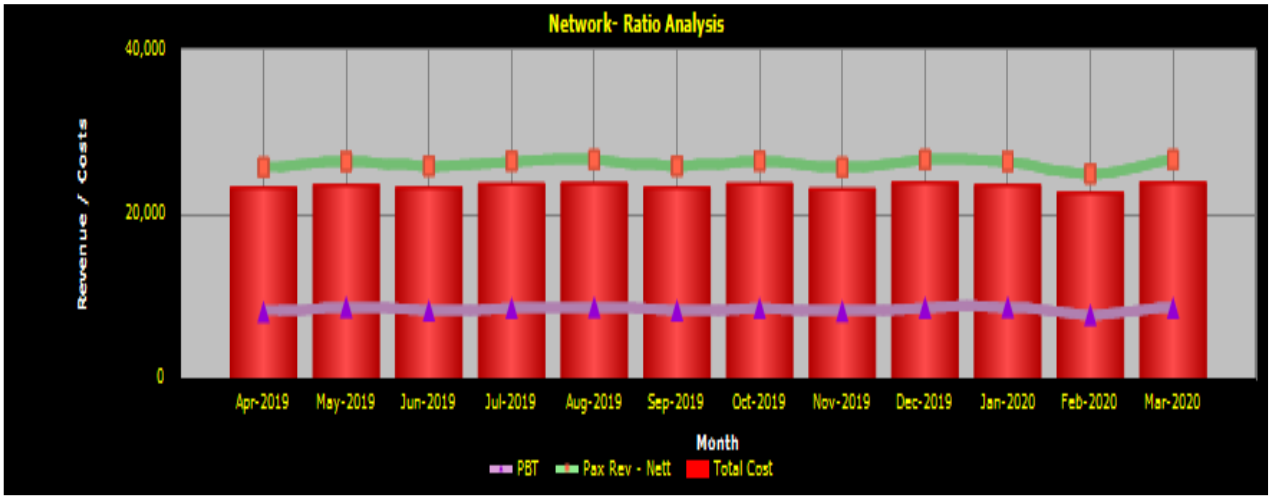

Fig. No. 6. Network Analysis by Month (Graphical)

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Code Development

Code standards

Code standards are the standards used for development of the software such as re-usable code, modular development, programming version controls.

Programming language used

The document provides the criteria used for selection of the programming language for development of the software. In developing the airline business plan software .net programming language has been used

Auto generation of source code

The programming code itself generates the source code documentation. The idea of auto-generating documentation is useful to programmers.

Testing Phase -

Table No. 4. Test Cases

TEST CASES -- CHANGE -- RATIO ANALYSIS REPORT								
Test Case No	**Test Case Desc**	**Test Object**	**Test data**	**Test Execution**	**Expected Test Result**	**Actual Result**	**Difference**	**Test Pass or Fail**
Change -001	Testing -- Change -Reports - Ratio Analysis	Ratio Analysis Report	As per the attached excel sheet	Enter the data as per the test data created	Calculated ratios of fuel cost and profitability / RPK	Match	Nil	PASS
				Test the UI of report with respect to screen fields				
				Click generate report button				
				Export the Ratio Analysis Report to excel				
				Compare the Fuel Cost, Profitability Ratio with the expected test results				
Change -002	Testing -- Change -Reports - User Interface	Report UI	Not Applicable	Test the UI of report with respect to screen fields	The ratio analysis report -- to be generated	Ratio analysis report -- generated	Nil	PASS
				Click generate report button				

Table No. 5. Test Data – for Test Case – Masters

CAPTURING TEST DATA FOR THE SETUPS AND MASTERS						
MENU	**USER INTERFACE**	**FIELDS**	**DATA ENTRY-1**	**DATA ENTRY-2**	**DATA ENTRY-3**	**DATA ENTRY-4**
SETUP	**COMPANY SETUP**					
		Company Code	TST			
		Name	Test Airline			
		FY Start Date -End Date	04/01/2019			
		FY Start Date -End Date	03/31/2020			
		Description				
		Option Checkbox	Keep Blank			
	SECURITY SETUP					
	APPLICATION USER ROLE					
		Log in as Administrator				
		Apllication User Role - New	ROLE_1			
		Select the new role	ROLE_1			
		Check the checkbox	Setup-Checkbox			
	APPLICATION USER					
		User Name	Shri			
		Role	ROLE_1			
		Passowrd	sairam_99			
		Re-enter password	sairam_99			
		Password Hint	SAI			
		Menu List	Auto-populated			
		Co Name	Auto-populated			
MASTERS	**CABIN CLASS**					
		Cabin Class Code	Y	W	J	F
		Name	Economy Class	Prem Economy	Business Class	First Class
	AIRCRAFT					
		Aircraft No	A320-1	ERJ-190		
		Description	Airbus-320	ER Jet		
		Cabin Class -Economy- Seating Capacity	153	180		
		Cabin Class -Premium Economy- Seating Capacity	0	0		
		Cabin Class -Business- Seating Capacity	12	10		
		Cabin Class -First- Seating Capacity	0	0		
		Acquisition Date	04/01/2019	04/01/2019		
		Disposal Date	03/31/2024	03/31/2024		
		Acquisition Method	DryLease	DryLease		
		Fuel Capacity-USG	6200	6875		
		MTOW-KG	83000	97000		

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Table No. 6. Test Data – for Test Case – Config

CAPTURING TEST DATA FOR THE CONFIG-FLIGHT SCHEDULE, REVENUE AND COST RATES							
REVENUE AND LF							
	Flight-Sector-AC	100-BOM-HYD-A320-1	101-HYD-BOM-A320-1	305-BOM-DXB-ERJ-190	306-DXB-BOM-ERJ-190		
	Segment	Auto-populated	Auto-populated	Auto-populated	Auto-populated		
	Yield/RPK-100th Part	11	11	11	11		
	Yield/RPK	Auto-populated	Auto-populated	Auto-populated	Auto-populated		
	Distance-KMs	Auto-populated	Auto-populated	Auto-populated	Auto-populated		
	Fare Seasonality Index-2019-20 April	108	108	108	108		
SECTOR CREW COST							
	Flight-Sector-AC	100-BOM-HYD-A320-1	101-HYD-BOM-A320-1	305-BOM-DXB-ERJ-190	306-DXB-BOM-ERJ-190		
	Aircraft	Auto-populated	Auto-populated	Auto-populated	Auto-populated		
	Crew Role	PLT,FOF,PUR,FLA	PLT,FOF,PUR,FLA	PLT,FOF,PUR,FLA	PLT,FOF,PUR,FLA		
	Hotel Accom Rate	100	100	100	100		
	Sector Allowance Rate -BHR	28,20,14,10	28,20,14,10	28,20,14,10	28,20,14,10		
	Per Diem	120	120	120	120		
	Member Count	Auto-populated	Auto-populated	Auto-populated	Auto-populated		
SECTOR COSTS							
	Flight-Sector-AC	100-BOM-HYD-A320-1	101-HYD-BOM-A320-1	305-BOM-DXB-ERJ-190	306-DXB-BOM-ERJ-190		
	Cost Element	Landing, Navigation	Landing, Navigation	Landing, Navigation	Landing, Navigation		
	Cost Driver	Auto-populated	Auto-populated	Auto-populated	Auto-populated		
	Cost Group	Auto-populated	Auto-populated	Auto-populated	Auto-populated		
	Rate	592 and 227	540 and 220	600 and 250	592 and 227		
PASSENGER COSTS							
	Flight-Sector-AC	100-BOM-HYD-A320-1	101-HYD-BOM-A320-1	305-BOM-DXB-ERJ-190	306-DXB-BOM-ERJ-190		
	Cabin Class	Y,W,J,F	Y,W,J,F	Y,W,J,F	Y,W,J,F		
	Non-revenue Pax -%	5	5	5	5		
	Cost Element	Food,IRS	Food,IRS	Food,IRS	Food,IRS		
	Cost Driver	Auto-populated	Auto-populated	Auto-populated	Auto-populated		
	Cost Group	Auto-populated	Auto-populated	Auto-populated	Auto-populated		
	Rate	Y---2.50 and 0.80	Y---2.50 and 0.80	Y---2.50 and 0.80	Y---2.50 and 0.80		
		W---13 and 0.80	W---13 and 0.80	W---13 and 0.80	W---13 and 0.80		
		J---13 and 0.80	J---13 and 0.80	J---13 and 0.80	J---13 and 0.80		
		F--20 and 1.25	F--20 and 1.25	F--20 and 1.25	F--20 and 1.25		

Types of Testing

Unit Testing

Usually, it's the job of a developer to do it. It focuses on the unit-level and assists in validating the internal implementation of a feature in the project.

Integration Testing

As the name suggests, the testers perform it to check whether the multiple components of a product work as expected or not.

System Testing This type of testing ensures the stability of the overall product. It usually happens after all the proposed features get implemented by the developers.

Performance Testing The performance testing is a type of testing which runs a Software application under high load and evaluates its behavior. Since every customer wants a product that can respond without any error during the peak load. Hence, the response time, throughput, reliability, and scalability of the application become crucial.

Load Testing It is a form of Performance Testing which measures the performance of a Software under real-time load conditions. This type of testing helps to discover the limits of an application to the point of breaking.

The end goal of this testing is to confirm the maximum operating capacity of the Software. Beta Testing Bets testing is a type of acceptance testing which intends to bring the customer perspective into validation. It means that the end-user (actual user) gets the opportunity to explore the usability, functionality, compatibility, and reliability of the product.

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V. DATA ANALYTICS

Q-1 -- What does Routonomics Software Provide?

Answer ROUTONOMICS has the in-built modelling of forecasting the profitability of an airline network hierarchy i.e. network, segments, routes, flights and aircrafts.

This is based on the projected -fleet plan, flight schedule, revenue and costs. The application provides the functionality to provide an airline business profitability plan for the next 5 years with month wise analysis.

Table No. 7. Data Analysis – Network Ratio Analysis by Month

Data Analytics -- Network Ratio Analysis by Month						
Particulars	UOM	Jan-2020	Feb-2020	Mar-2020	Data Analysis	
Passenger Rev-Nett	$ K	26,486.82	24,969.69	26,665.20	Passenger revenue is calculated from the number of passengers X Fare	The seasonality can be observed in Jan-March. The Feb month's revenue is slightly less than jan and March
Cargo Rev-Nett	$ K	19.91	18.76	19.98	Cargo revenue is calculated as Cargo Qty X Rate	
EBT/Sur/Other	$ K	5,859.98	5,525.89	5,900.77	EBT etc is the % of the passnger revenue	
Total Revenue	$ K	32,366.71	30,514.34	32,585.95		
Fuel Cost	$ K	6,413.91	6,125.02	6,565.32	Fuel consumption rate of the aircraft X Fuel cost rate per USG	
Aircraft Cost	$ K	8,413.68	8,190.16	8,505.29	These costs cover aircraft lease, depreciation etc -- mostly period costs	
Sector Cost	$ K	3,969.67	3,738.96	3,995.72	Sector caost cover parking cost, navigation socts, landing costs. These are calculated based on the frequency	
Pax Cost	$ K	2,743.88	2,589.58	2,764.07	Passenger costs are calculated -- based on the number of passengers X Rate	
Crew Cost	$ K	1,927.70	1,912.36	1,935.99	Crew costs are cew type specific	
Direct Operating Cost	$ K	23,468.84	22,556.07	23,766.39		
Gross Margin	$ K	8,897.87	7,958.27	8,819.56	Gross margin = Total Revenue - DOC	
Overheads	$ K	5,000.00	5,000.00	5,000.00	Overheads are based on the estimated amount fed in to the system	This is considered as fixed cost
Profit Before Tax	$ K	3,897.87	2,958.27	3,819.56	PBT = Gross margin - Overheads	
Profitability Anlysis-%						
Passenger Rev Nett-Total Rev	%	81.83	81.83	81.83	This is % of Passenger Rev Nett-Total Rev	The ratios are higher than the industry standards
Cargo Rev Nett-Total Rev	%	0.06	0.06	0.06	This is % of Cargo Rev Nett-Total Rev	
EBT/Sur/Other-Toatl Rev	%	18.10	18.11	18.11	This is % of EBT/Sur/Other-Toatl Rev	
Total Rev	%	99.99	100.00	100.00		
Fuel Cost-Total Rev	%	19.82	20.07	20.15	This is % of Fuel Cost-Total Rev	
Aircraf Cost-Total Rev	%	25.99	26.84	26.10	This is % of Aircraf Cost-Total Rev	
Sector Cost-Total Rev	%	12.26	12.25	12.26	This is % of Sector Cost-Total Rev	
Pax Cost-Total Rev	%	8.48	8.49	8.48	This is % of Pax Cost-Total Rev	
Crew Cost-Total Rev	%	5.96	6.27	5.94	This is % of Crew Cost-Total Rev	
Direct Op. Cost-Total Rev	%	72.51	73.92	72.93		
Gr Margin-Total Rev	%	27.49	26.08	27.07	This is % of Gr Margin-Total Rev	
Overheads-Total Rev	%	15.45	16.39	15.34	This is % of Overheads-Total Rev	
PBT-Total Rev	%	12.04	9.69	11.72	This is % of BT-Total Rev	

Q-2 -- What are the Main Reports in the Software?

Answer Contribution Analysis Report. The Contribution Report provides contribution analysis for various network objects. The contribution means Operating Revenue- Direct Operating Costs. On adding the Other Revenue, it provides the Gross Margin. The contribution analysis is provided based on the principles of direct costing, the contribution is the critical because if it enhances then the performance also enhances.

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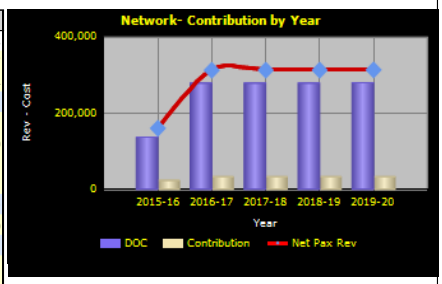
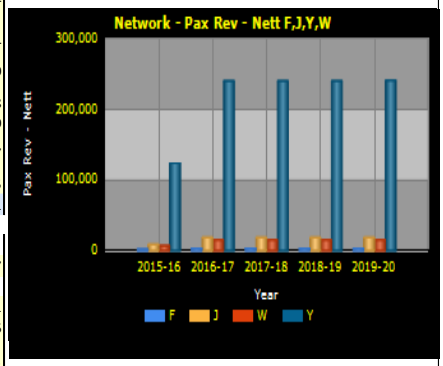
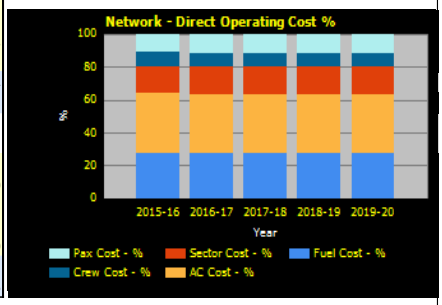
Table No. 8. Network Contribution by Year

Network Contribution by Year

Particulars	UOM	2015-16	2016-17	2017-18	2018-19	2019-20
Sector-Frq	#	1,950	4,066	4,068	4,068	4,078
Nett Pax Revenue	$ K	1,60,841.21	3,13,242.21	3,13,406.19	3,13,399.71	3,14,174.97
Less Direct Operating Cost	$ K	1,37,347.86	2,79,621.71	2,79,836.68	2,79,782.16	2,80,430.04
Contribution	$ K	23,493.35	33,620.50	33,569.52	33,617.55	33,744.93
Fuel Surcharge	$ K	3,946.88	8,266.50	8,271.58	8,271.34	8,291.22
Excess Baggage	$ K	6,292.29	12,319.82	12,326.59	12,326.03	12,356.70
MIscelleneous Revenue	$ K	17,871.25	34,804.69	34,822.91	34,822.19	34,908.33
Code Share Revenue	$ K	7,148.50	13,921.88	13,929.16	13,928.88	13,963.33
Other Revenue	$ K	35,258.92	69,312.88	69,350.24	69,348.43	69,519.59
Nett Cargo Revenue	$ K	115.90	235.16	235.30	235.30	235.80
Gross Margin	$ K	58,868.17	1,03,168.54	1,03,155.06	1,03,201.29	1,03,500.32
Gross Margin Ratio	%	36.60	32.94	32.91	32.93	32.94
Contribution Ratio	%	14.61	10.73	10.71	10.73	10.74
EBT/Su/Other/Cargo Rev to Pax Rev	%	21.99	22.20	22.20	22.20	22.20
Cargo Rev To Pax Rev	%	0.07	0.08	0.08	0.08	0.08
Capacity Seats Deployed	#	5,10,720	10,51,900	10,52,500	10,52,500	10,55,040
Traffic-Revenue passengers	#	3,33,125	7,01,463	7,01,890	7,01,882	7,03,567
Avarage Fare	$ / Pax	482.83	446.56	446.52	446.51	446.55
Cabin Factor	%	64.92	66.41	66.41	66.42	66.41
Contribution Detailed						
Nett Pax Revenue	$ K	1,60,841.21	3,13,242.21	3,13,406.19	3,13,399.71	3,14,174.97
Less Direct Operating Cost						
Fuel Costs	$ K	38,135.41	76,561.44	76,663.78	76,635.08	76,886.01
Aircraft Costs	$ K	49,405.55	1,00,548.30	1,00,612.64	1,00,591.72	1,00,772.56
Sector Costs	$ K	22,921.11	46,932.75	46,955.00	46,951.70	47,077.45
Crew Costs	$ K	11,440.72	23,111.86	23,117.23	23,116.06	23,128.98
Passenger Costs	$ K	15,445.07	32,467.37	32,488.03	32,487.61	32,565.05
	$ K	1,37,347.86	2,79,621.71	2,79,836.68	2,79,782.16	2,80,430.04
Contribution	$ K	23,493.35	33,620.50	33,569.52	33,617.55	33,744.93
Add EBT/Surcharge/Cargo Rev						
Fuel Surcharge	$ K	3,946.88	8,266.50	8,271.58	8,271.34	8,291.22
Exess Baggage	$ K	6,292.29	12,319.82	12,326.59	12,326.03	12,356.70
MIscelleneous Revenue	$ K	17,871.25	34,804.69	34,822.91	34,822.19	34,908.33
Code Share Revenue	$ K	7,148.50	13,921.88	13,929.16	13,928.88	13,963.33
Nett Cargo Revenue	$ K	115.90	235.16	235.30	235.30	235.80
Gross Margin	$ K	58,868.17	1,03,168.54	1,03,155.06	1,03,201.29	1,03,500.32
Gross Margin - Total Rev	%	30.00	26.95	26.93	26.95	26.96







Profitability Result

Result Report provides the calculation of profitability analysis for various network objects. The result means Revenue- (Direct Operating Costs+ Overheads). The result report provides the analysis such as percentage analysis of costs with respect to total revenue, revenue and cost per frequency. The analysis is provided with graphical presentation. This report provides the analysis by Year, by Year and Month.

Ratio Analysis Report

Ratio Analysis Report provides ratio analysis of the for various network objects. The ratio analysis provides analysis of the capacity deployed, LF, Yield, RASK, CASK analysis such as ratio of each cost to the total revenue, revenue and cost per frequency. The analysis is provided with the graphical presentation. This report provides the analysis by Year, by Year and Month.

Performance and Vital Statistics Report

Performance and Vital Statistics Report provides the details of profitability performance analysis and vital economic statistics for various network objects. The report provides the summarized position of revenue, cost, profitability with load factor, yield analysis, average fare analysis.

Break Even Analysis Report

Break Even Analysis Report provides break even analysis. The break even analysis presents the point, beyond which organization turns into profit. The break-even analysis provides BEP-Revenue Analysis, BEP-Capacity Utilization Analysis and so on with margin of safety analysis. The analysis is provided with the graphical presentation. This report provides the analysis by Year.

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Table No. 9. Network Break Even Analysis by Year

Network Break Even Analysis by Year

Particulars	Unit	2015-16	2016-17	2017-18	2018-19	2019-20	Average
Volume Of Oprations							
Sector Frequeny	#	1,950	4,066	4,068	4,068	4,078	3,646
No. of Seats	#	5,10,720	10,51,900	10,52,500	10,52,500	10,55,040	9,44,532
Block Hours	#	8,807.11	17,884.70	17,907.03	17,902.03	17,958.02	16,091.78
Flight Hours	#	8,032.82	16,277.56	16,299.06	16,294.40	16,346.08	14,649.98
Passenger Nos.	#	3,33,125	7,01,463	7,01,890	7,01,882	7,03,567	6,28,385
RPK	KMs-K	12,03,447.77	24,76,231.63	24,79,351.54	24,78,424.21	24,86,463.26	22,24,783.68
ASK	KMs-K	18,53,677.72	37,28,840.90	37,33,173.50	37,31,706.70	37,43,852.84	33,58,250.33
Cabin Factor	%	64.92	66.41	66.41	66.42	66.41	66.11
Contribution Analysis							
Revenue							
Passenger Rev(Nett)	$-K	1,60,841.21	3,13,242.21	3,13,406.19	3,13,399.71	3,14,174.97	2,83,012.86
Cargo and Other Rev(Nett)	$-K	35,374.82	69,548.04	69,585.54	69,583.74	69,755.39	62,769.50
	$-K	1,96,216.02	3,82,790.25	3,82,991.73	3,82,983.45	3,83,930.36	3,45,782.36
Variable Cost							
Fuel Cost	$-K	38,135.41	76,561.44	76,663.78	76,635.08	76,886.01	68,976.34
Variable Aircraft Cost	$-K	15,873.11	32,012.71	32,052.49	32,041.07	32,145.08	28,824.89
Sector Cost and Crew Var.Cost	$-K	24,949.18	51,002.15	51,029.79	51,025.32	51,163.99	45,834.09
Passenger Cost	$-K	15,445.07	32,467.37	32,488.03	32,487.61	32,565.05	29,090.63
	$-K	94,402.77	1,92,043.68	1,92,234.08	1,92,189.08	1,92,760.12	1,72,725.95
Contribution		1,01,813.25	1,90,746.57	1,90,757.65	1,90,794.37	1,91,170.24	1,73,056.41
Fixed Cost							
Fixed Aircraft Cost	$-K	33,532.46	68,535.63	68,560.20	68,550.70	68,627.53	61,561.30
Crew Fixed Pay	$-K	9,412.66	19,042.46	19,042.45	19,042.45	19,042.45	17,116.49
Overheads	$-K	1,392.86	1,200.00	1,200.01	1,200.00	1,199.99	1,238.57
	$-K	44,337.98	88,778.09	88,802.65	88,793.14	88,869.98	79,916.37
Profit	$-K	57,475.27	1,01,968.48	1,01,955.00	1,02,001.23	1,02,300.26	93,140.05
Breakeven Analysis							
BEP-Cabin Factor	%	28.27	30.91	30.92	30.91	30.87	30.38
BEP-Frequency	#	849	1,892	1,894	1,893	1,896	1,685
BEP-Block Hours	#	3,835.35	8,323.97	8,336.19	8,331.35	8,348.20	7,435.01
BEP-Flight Hours	#	3,498.16	7,575.97	7,587.64	7,583.19	7,598.85	6,768.76
BEP-Passenger Nos.	#	1,45,070	3,26,478	3,26,748	3,26,646	3,27,069	2,90,402
BEP-RPK	KMs-K	5,24,081.05	11,52,497.62	11,54,202.61	11,53,423.94	11,55,889.64	10,28,018.97
BEP-Revenue	$-K	85,448.74	1,78,159.77	1,78,292.61	1,78,235.14	1,78,478.86	1,59,723.02
Margin OF Safety							
MOS-Cabin Factor	%	36.65	35.50	35.50	35.51	35.54	35.74
MOS-Frequency	#	1,101	2,174	2,174	2,175	2,182	1,961
MOS-Block Hours	#	4,971.76	9,560.73	9,570.84	9,570.68	9,609.82	8,656.77
MOS-Flight Hours	#	4,534.66	8,701.59	8,711.42	8,711.21	8,747.23	7,881.22
MOS-Passenger Nos.	#	1,88,055	3,74,985	3,75,142	3,75,236	3,76,498	3,37,983
MOS-RPK	KMs-K	6,79,366.72	13,23,734.01	13,25,148.93	13,25,000.27	13,30,573.62	11,96,764.71
MOS-Revenue	$-K	1,10,767.28	2,04,630.48	2,04,699.12	2,04,748.31	2,05,451.50	1,86,059.34

Q-3-What is the Nature of Ratio Analysis Report?

Answer Ratio Analysis Report provides ratio analysis of the for various network objects. The ratio analysis provides analysis of the capacity deployed, LF, Yield, RASK, CASK analysis such as ratio of each cost to the total revenue, revenue and cost per frequency. The analysis is provided with the graphical presentation. This report provides the analysis by Year, by Year and Month.

Q-4-What are the Objectives – Served by this Report?

Answer The objective of this report is to provide the operating performance analysis of the airline profitability.
Explanation- This ratio analysis provides the gross margin ratio. The gross margin ratio means the proportion of Total revenue – Direct operating costs / Total revenue. The airline has to maintain certain gross margin to absorb the overheads, if it has insufficient gross margin then airline is unable to mitigate the overheads. The month wise trend of gross margin shows that the requisite gross margin is available or not. Based on this management determines whether to plan the route or not.

Q-5- Explain the Nature of Fuel Cost / Frequency, Yield Per RPK, Cost Per RPK Ratios?

Answer

Fuel cost per frequency

In the airline industry – one way journey is referred to as one frequency. For example – Flight 101 – is travelling from Mumbai – Delhi and return flight is Flight 102. Therefore, the frequencies are = 2. If the flight is daily then for the month the frequencies are = 60

Yield / RPK

Yield means revenue earned per passenger kilometres. In the airline industry, the revenue performance is measured by using yield. In the manufacturing industry it is average sale value per output unit and then it is compared with other firms within the same industry, or past periods or budget to evaluate the revenue performance. On the similar lines it is the yield is the measure of performance in the airline industry. The yield can be measured as follows—

Airline X = Avg Yield = Rs. 16

Airline Y= Avg Yield = Rs. 14

Airline Z = Avg Yield = Rs. 13

The yield is different for the routes, peak season, off season, extent of competition etc.

The trend analysis with period comparison is important for the management to take corrective actions.

The trend analysis of the yield is depicted in the graphical presentation's ass follows-

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Month	Yield / RPK -Rs.
Apr-18	8
May-18	9
Jun-18	7
Jul-18	7
Aug-18	6
Sept-18	10
Oct-18	11
Nov-18	13
Dec-18	15
Jan-19	16
Feb-19	9
Mar-19	7

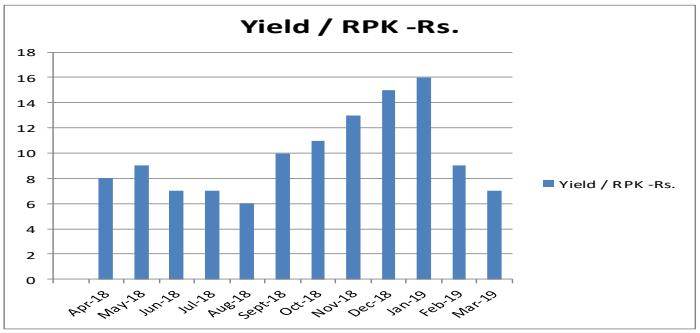

Fig. No. 7 Trend Analysis of the Yield

Cost per RPK

In the airline industry, the cost analysis is made by using Cost / RPK. In the manufacturing industry it is cost per output unit and then it is compared with other firms within the same industry, or past periods or budget to evaluate the cost saving. On the similar lines it is the Cost / RPK is the measure of performance in the airline industry. The Cost / RPK can be measured as follows—

Airline X = Cost / RPK = Rs. 10
Airline Y = Cost / RPK = Rs. 11
Airline Z = Cost / RPK = Rs. 9

The cost is different for the routes, peak season, off season, extent of competition etc. The trend analysis with period comparison is important for the management to take corrective actions. The trend analysis of the Cost /RPK is depicted in the graphical presentations as follows-

Month	Cost/ RPK Rs.
Apr-18	7
May-18	7
Jun-18	6
Jul-18	6
Aug-18	4
Sept-18	8
Oct-18	8
Nov-18	9
Dec-18	9
Jan-19	11
Feb-19	7
Mar-19	5

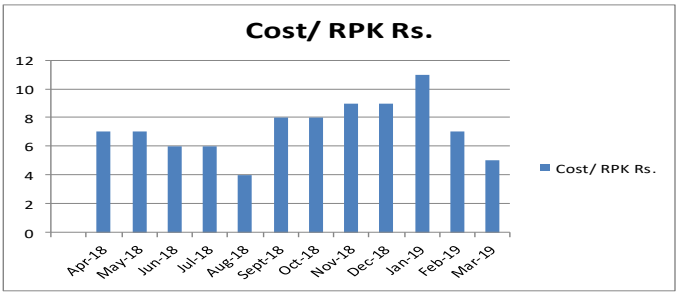

Fig. No. 8 Trend Analysis of the Cost/RPK

Q-6-How Fuel Consumption Rate Per Flight Hour is Determined?

Fuel consumption rate per flight hour

The fuel consumption rate per flight hour is dependent on the following factors –

Type of aircraft

Some aircrafts are more fuel efficient while some are not. The latest aircrafts are fuel efficient such as ERJ, Airbus -320 series, Boeing -777 series. The airline wants to deploy the most fuel-efficient aircrafts.

The fuel consumption rates are expressed in terms of US Gallon. Based on certain assumptions -the fuel consumption rate of Airbus -320 is on an average = 2,100 US Gallon per flight hour, ERJ-190 = 1,100 US Gallon per flight hour, Boeing 747 =3,000 US Gallon per flight hour.

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Aircraft Type	Fuel Consumption per Flight Hour-in USG
Airbus -320	2,100
ERJ -190	1,100
Boeing -747	3,000

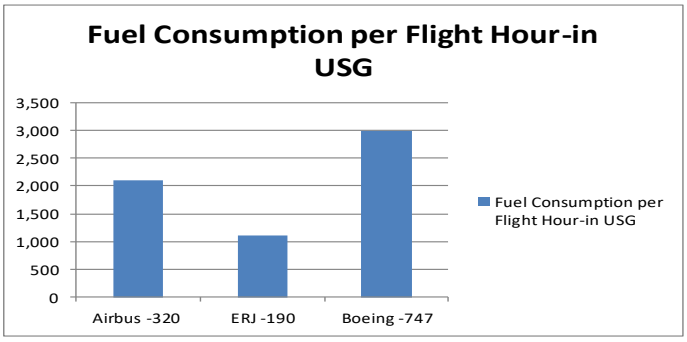

Fig. No. 9 Fuel Consumption Rate Per Flight Hour

Flight path

The flight path with moderate weather conditions, bad weather conditions cause fluctuating fuel consumption. A flight path with bad weather conditions consume high fuel.

Training quality of pilot

The trained pilots, ensure the proper height so as to save the fuel consumption without compromising the safety.

Weight of the passengers and cargo

Conclusion

Thus, essentially the type of aircraft determines the fuel consumption and so the fuel cost, therefore the deployment appropriate aircraft on the route is the important decision. If analysis provides the route profitability based on the deployment of the different aircrafts on the specific route, then the decision of appropriate aircraft can be taken with ample testimony.

Q-7-What is the Fuel Rate Per US Gallon?

The fuel rate means the fuel price per US Gallon. The airline requires the aviation fuel and its price is governed by the international demand and supply.

The fuel prices are different at various fuel filling stations such as fuel price at Mumbai, at London Heathrow-UK, at Dubai, at Seoul Korea. As per distance to be travelled, fuel tank capacity, fuel rats, the fuel is filled in at the specific fuel station.

The fuel rate per US gallon ranges from Rs. 400-700 currently. The imaginary example shows how the fuel rates can be different from in different fuel filling stations.

Fuel filling station	Fuel Price per US Gallon
Mumbai	600
Dubai	550
Lonon - Heathrow	720
Seoul	700

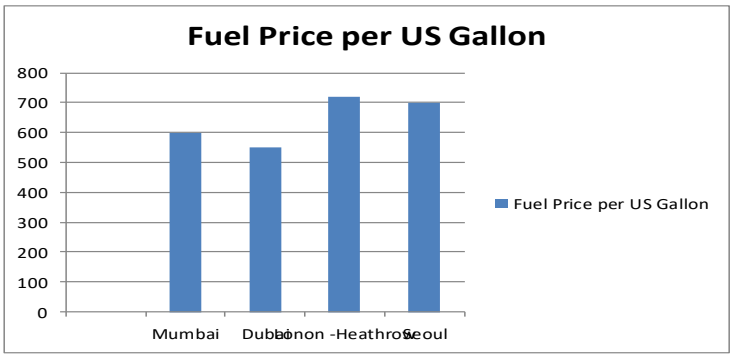

Fig. No. 10 Fuel Rate Per US Gallon

Q-8- What is Passenger KMs?

In the airline industry, the passenger Kilometers is the industry specific cost measurement unit.

Q-9-How Passengers KMs are Determined?

Let us understand this concept as follows—

If 100 passengers travel from Pune- Mumbai flight and 100 passengers travel from Pune- Seattle –USA flight. These both flights are economically comparable because the volume of operations of each flight is totally different even if the number of passengers are same. Therefore, the passenger kMs travelled is the key measurement concept in the airline industry. In case of Pune-Mumbai the passenger KMs are 100 X Distance from Pune –Mumbai 180 KMs = 18,000 Passenger KMS while in case of Pune-Seattle, the passenger KMS = 100 X Distance from Pune to Seattle 12,000 = 12,000,00 The Pune-Mumbai takes 10 minutes to reach Mumbai airport while Pune-Seattle flight takes 21 hours. Thus the revenue and cost structure re totally different

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This is explained graphically as follows---

Flight	Number of passenger	Distance in KMs
Pune-Mumbai	100	180
Pune-Seattle	100	12,000
Pune-Londoan	100	7,500
Pune-Seoul	100	7,000

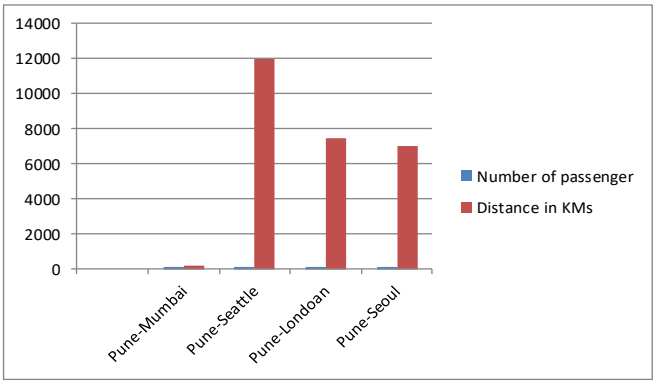

Fig. No. 11 No. of Passengers KMs

Q-10-What is Yield Per Revenue Passenger Kilometre?

This is already explained in the answer to Q-5. The only additions is that there is difference between passenger KMs and revenue passenger KMs.

Every passenger travelling in a flight need not be a paying passenger. Some passenger are the airline company's employee hence they travel free of charge, remaining passengers are paid passengers. Such paid passengers are referred to as revenue passengers and passenger KMS are calculated for such revenue passengers.

Mumbai-London

Type of passenger	Number of passengers	Passenger KMs No of passenger X Distance of 7,500 KMs
Non-paying passengers	20	1,50,000
Paid passengers - Revenue passengers	180	13,50,000
Total passenger	200	15,00,000

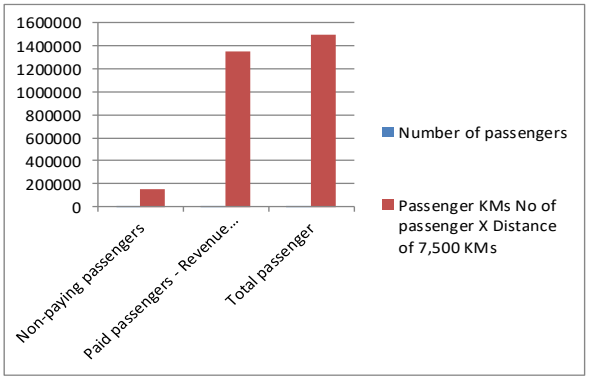

Fig. No. 12 Yield Per Revenue Passenger Kilometre

Q-11- What is Cost Per Revenue Passenger Kilometre?

This is already explained in the answer to Q-5. The only additions is that there is difference between passenger KMs and revenue passenger KMs.

Q-12-What are the Airline Objects for which the Report Should be Generated?

- Network
- Segment
- Route
- Flight
- Aircraft Regn

Q-13-What are Period Objects for the Reporting – Month, Year, Quarter?

- Month
- Year

Q-14-Do you Need Graphical Presentation?

Q-15-Which type of Graphs are Required – Trend, Bar Charts, Histogram etc ?

Yes, the column chart with trend line should be provided for each month as follows—
Trend line -- passenger revenue
Column chart -- total cost

Q-16-Do You Want the Reports to be Exported to Excel, PDF or Word?

Yes.

The system should provide the functionality to export the reports to-

- PDF
- Excel
- MS Word

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Q-17-What are the Currencies in Which you Need the Reports?

The system already provides the two currencies in which the report can be generated – these are

- Book keeping currency
- Reporting currency

A. Observation and Findings

Basis for observation and findings

My observation and findings are based on ----

- 2- months' working with Aviation Management Consultants, an airline software firm
- Study of Routonomics developed by the firm
- literature study on the airline route profitability software
- study on the airline industry in general
- contemporary trends in the technology
- my working as a functional assistant for the development team of Routonomics for developing the small report change -- specifically created for me to study the SDLC process.

My role was to assist in gathering

- the requirements
- analyse the requirements
- understand the design
- prepare the test data, test cases, execute the test cases
- understand the reports

Presentation of observation and findings

The observations and findings are presented in following perspectives –

1--SDLC management perspective
2--Technology perspective
3--Report perspective
4--Clients' perspective
5--Owner's perspective

B. SDLC Management Perspective

About the project management

I have observed that project management played very important role in the success of software project. The project was monitored with respect to the functional conformance, time, allocation of work, project milestone.

Project management is the key success factor in achieving any software development project.

About the SDLC

The firm followed --

- best SDLC management practices
- step wise methodical working
- disciplined project management approach
- clear cut communication between the team members
- proper direction from the owner
- proper IT infrastructure for software development

Generally, the perception about the software development is that the team members put the late hours, highly strenuous working conditions, tight deadlines. However, my experience was different. The most structured way was followed therefore, the working conditions were quite stress free.

About the peer review in the SDLC processes

I have observed the process of peer review played very important role in the entire SDLC processes. This prevented many defects to occur in the programming development

About the clear communication between team members

I observed that there was very clear communication between the development team about –

- Requirements
- Design
- Code which was affected
- Exact development to be made

The communication was made with various scenarios, step by step calculations as to how to calculate fuel consumption per frequency, yield / RPK and cost/ RPK.

In case there is a communication gap, the project leader ensured that it is removed. This was important because, if the development team being unclear about the change requirements then it was most likely to affect the existing code also.

The clear cut communication amongst the team members ensured the effective and efficient development of the software changes.

About the SDLC documentation

I observed that the documentation during the SDLC process was done meticulously such as –

- Requirement phase ---- System Requirement Document
- Design phase – Design Document
- Coding phase – Programming Document
- Testing phase – Test Cases and its results
- Defects-Defect Analysis Document

The proper documentation ensured that the knowledge acquired during the system development by the team members were documented, making knowledge became system dependent NOT person dependent.

C. Technology Perspective

About the use of conventional technology

The system was required to be installed at clients' locations for implementation. Now a day, the clients prefer to use the system through cloud computing on pay per use basis. The system may be deployed on cloud so as to get increased market coverage.

The system has in-built " airline business modelling logic" which is highly industry specific.

The highly powerful business modelling is the key for the success of any software development. Routonomics has that modelling power.

However, if it –

- Up-scaled to cloud computing
- Incorporates the heuristic component –based on the proven data pattern to make " what if analysis" to become a key component.
- Has dashboard reporting and adhoc query functionality
- Seamlessly integrate to the financial system to compare the actual vs plan analysis

Software architecture

The system was developed with .net as programming platform, SQL Express as database, Client –Server architecture of deployment.

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The software architecture was selected on the basis of the requirements of small airlines. However, now a day, even small airline wants to access the application system through cloud

D. Report Perspective

Routonomics provides very comprehensive reports for all airline objects such as flight, route, aircrafts etc.

Routonomics reporting lacks the " adhoc query" reporting. Adhoc query means, the question based on certain para meters of the user – example user wants the fuel cost for international routes etc.

E. Clients' Perspective

Routonomics is mission critical system for the client. This is because route profitability plan provides the benchmarking for the airline to control the decision making. The benchmarking is reflected in form of various key performance indicators contained in the reports.The system provides the estimation based on the management's estimation of the expense and income data.It does not have reporting of "what if analysis" based on the user defined criteria, making the system not dynamic.The big data analysis has brought in radical changes in approaching the business planning.Big data analytics is the often complex process of examining large and varied data sets, or big data, to uncover information -- such as hidden patterns, unknown correlations, market trends and customer preferences -- that can help organizations make informed business decisions.Now a day, the business planning is made by using big data analytics, such as for new route development, the data pattern of such route is provided by the big analytics team so as to ensure that new route is developed with all relevant decisions.The reporting of the key performance indicators need to be based on the artificial intelligence, so as to beat the contemporary competitive airline market.

VI. CONCLUSION AND SUGGESTIONS

The development team needs to be very clear about the objectives for which the system is being developed. The project is required to be strictly monitored as per the standard project management methodology. The set of best SDLC management practices is key to ensure that system meets the business requirements. The software / system should be scalable to the future business needs. The reporting should be business oriented.

A. Suggestions – Relating to Technology.

Cloud computing architecture

The cloud computing provides the access to the computer infrastructure through internet. In the cloud computing you do not require to spend on the IT infrastructure, software etc. Now a days, most of the companies prefer to have the arrangement of using the software on cloud –use and pay basis. However, your software has to be technically cloud compliant. The airline software under study is not cloud compliant and hence it is suggested that it be scaled up to make it cloud compatible.

Client –Server Architecture

The full-fledged client server architecture provides the most important advantage of ease of maintenance and future releases and to maintain centralised security. The software under study is server based for database only, needs to make it compatible to application and database both so as to reap the full benefits of client-server architecture.

B. Suggestions – Relating to user Training

Training video kit

Currently, the software under study requires to provide manual training.

It is suggested to have user training through video to provide the understanding of the application, its navigation articulated like tutor.

C. Suggestions – Relating to Airline Business Intelligence

The airline route profitability system is executive information system , facilitates the top management for critical decision making. The software under study has the estimation modelling in the field of airline profitability.

The estimates are fed by the respective airline managers. There has been major development in the area of using business intelligent data for decision making. The business intelligent data provides effective "what if analysis". It is suggested to have the airline business intelligence in-built into the software under study.

D. Suggestion-Relating to Budgetary Controls

The software under study does not have the functionality to compare the planned data with actual. It is suggested to develop the APIs to import the data from the external systems seamlessly in to the software, so as to provide Plan Vs Actual variance analysis.

E. Suggestion-Relating to Planned Balance Sheet

It is suggested to provide the forecasted balance sheet for the plan period to make the business planning complete in all respect

F. Suggestion-Relating to Reporting

It is suggested to have the adhoc query functionality, so the users get the required data view based on the adhoc query.

It is also suggested to have the dashboard in to the software so as to get the complete view of the airline operating performance indicators such as number of flights, fuel consumption, revenue, RPK, ASK etc covering all objects of airline.

DECLARATION

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Ethical Approval and Consent to Participate	No, the article does not require ethical approval and consent to participate with evidence.
Availability of Data and Material/ Data Access Statement	Not relevant.
Authors Contributions	All authors having equal contribution for this article.

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REFERENCES

1. Kasturi E, Prasanna Devi S, Viru Kiran S , 2016, Airline Route profitability analysis and Optimisation using Big Data anatics on aviation data sets under heuristis Technique, Procedia Computer Science, Elsevier B.V. https://doi.org/10.1016/j.procs.2016.05.131
2. Srecko Krile Et al, 2015, New approach in definition of multi stop flight routes, Transport Problem.
3. Teoh, Lay Eng, Khoo, Hooi Ling (2016), Fleet Planning Decision-Making: Two-Stage Optimization with Slot Purchase, Journal of Optimization. https://doi.org/10.1155/2016/8089794
4. Aleksandra Fedosova (2016), Comparison between Low-cost and Traditional Airlines Case study: easyJet and British Airways, Degree Thesis International Business Arcada.
5. Karim, Md,Choudhury, Musfiq,Bin Latif, Wasib (2019), The impact of training and development on employees' performance: an analysis of quantitative data, The International Journal of Business and Management Research.
6. www.sabre.com
7. Gangadhar, A., & Babulu, K. (2019). Design and Performance Analysis of Low Power High Speed CNTFET Binary Content Addressable Memory Cell for Next Generation Communication Networks. In International Journal of Innovative Technology and Exploring Engineering (Vol. 9, Issue 2, pp. 8–15). https://doi.org/10.35940/ijitee.a4016.129219
8. IKIZ, Y. D., ATICI-ULUSU, H., TASKAPILIOGLU, O., & GUNDUZ, T. (2019). Usage of Augmented Reality Glasses in Automotive Industry: Age-Related Effects on Cognitive Load. In International Journal of Recent Technology and Engineering (IJRTE) (Vol. 8, Issue 3, pp. 1–6). https://doi.org/10.35940/ijrte.c3853.098319
9. Harakannanavar, S. S., C R, P., & K B, R. (2019). Performance Analysis of Iris Recognition Using Multi Stage Wavelet Transform Decomposition and Bicubic Interpolation Technique. In International Journal of Engineering and Advanced Technology (Vol. 8, Issue 6, pp. 1–10). https://doi.org/10.35940/ijeat.e7322.088619
10. Nagpal, T., Jaiswal, A. K., & Panchal, B. S. (2022). To Study the Importance of HR Analytics Practice for SMEs in NCR Region. In International Journal of Management and Humanities (Vol. 8, Issue 9, pp. 1–14). https://doi.org/10.35940/ijmh.i1479.058922
11. Urban Population and Identification of Indicators for Affordable Housing in India. (2019). In International Journal of Recent Technology and Engineering (Vol. 8, Issue 2S11, pp. 1–8). https://doi.org/10.35940/ijrte.b1001.982s1119

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