IDENTIFICATION OF POSSIBLE REASONS THAT AFFECT DEPARTURE FLIGHT PUNCTUALITY

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Degree of Master of Science in Transport

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September 2015

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ABSTRACT

A flight is said to be delayed when an airline flight takes off and/or lands later than its scheduled time. The Federal Aviation Administration (FAA) considers a flight to be delayed when it is 15 minutes later than its scheduled time. Punctuality is one of the key performance indicators in the airline industry and an important service differentiator especially for valuable high-yield customers. In addition, improved on-time performance can help achieve significant cost savings.

This is a critical issue in the air transportation industry since it generates lot of problems to the operation and the inconvenience for the passengers. Once a delay is occurred it is totally affected to the entire airline network and it will totally effect to the passengers. Flight delays are an inconvenience to passengers. A delayed flight can be costly to passengers by making them late to their personal scheduled events. A passenger who is delayed on a multi-plane trip could miss a connecting flight. Anger and frustration can occur in delayed passengers.

This publishes a postgraduate thesis carried out under the topic "Identification of possible reasons that affect departure flight punctuality" and this is carried out as a case study on the National Carrier of Sri Lanka. This mainly focuses on identification of departure flight delays, identifying critical delay types and finding their reasons and finally identifying areas to develop policies and regulations which can be optimize the departure flight punctuality.

The findings of the preliminary analysis represents that out of average total departures per day there are 6% of Technical delays, 9% of Unavoidable delays, and 8% of Airport delays and 5% of Air Traffic Control delays. The average delay times per departure flight are 1.22 hrs if Technical delays, 0.34hrs if Unavoidable delays, 0.16hrs if Airport delays and 0.10hrs if Air Traffic Control delays.

During the secondary data analysis, some areas were identified as the areas that can be regularized using new policy and regulations or change and develop existing policy and regulations to increase the departure flight punctuality. Some of them are new policy or policy development on A/C rotation, regular and periodic maintenance that can reduce technical errors and failures, scheduled maintenance that will help to manage operation time. Further it is identified that unscheduled maintenance will increase the delay, internal QC and QA on safety and security is a must, policy on recruit maintenance professionals will help to manage emergencies, additional maintenance will reduce engine start up time delays, increasing maintenance will avoid equipment failures, new policy or policy development on intoxicated passengers will reduces delays, new policy on intoxicated passengers will reduces delays, internal organizational policy and regulations can mitigate late reporting and new policy for transfer passenger and baggage timings.

Under this study, only the delay data were considered to identify the areas that reduces the departure flight punctuality and any culture, society and the environment of the country were not taken into account. But the factors such as economic, social, environmental and political situation of the country, management changes, joint agreements, code share agreements, aircraft fleet changes, and new governmental policy and regulations also should be considered for the development and the implementation of new policy statements regarding the flight departure delays.

ACKNOWLEDGEMENT

I would like to convey my heartfelt gratitude to the each and every person who made my effort on this research become success.

First and foremost I would like to thank my research supervisor Prof. J. M. S. J. Bandara, Professor in Civil Engineering, Department of Civil Engineering, University of Moratuwa for the guidance and motivation given to the success.

I also convey my thanks to Mr. H. M. C. Nimalsiri, Director General Civil Aviation & CEO of Civil Aviation Authority of Sri Lanka and Mr. Deen, former Deputy Director Operations of Civil Aviation Authority of Sri Lanka for the valuable support provided for the arrangements with Sri Lankan Airline visits.

Next my thank goes to Capt. Navin Silva, Mr. Pulasthi Jayasingha, Senior Manager –Flight Operations, Secretary to the Senior. Manager Flight Operations and the staff of the Flight Operations PIC section of Sri Lankan Airlines.

Then I would like to express my thanks to the staff members of Civil Aviation Authority of Sri Lanka who gave the support in every aspects.

Finally I convey my gratitude to my family members, friends and all the people who gave the support, courage and guidance to make this success.

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LIST OF ABBREVIATIONS

FAA	Federal Aviation Administration
DGCA	Director General of Civil Aviation
CEO	Chief Executive Officer
CAASL	Civil Aviation Authority of Sri Lanka
ICAO	International Civil Aviation Organization
SARPS	Standards and recommended practices
PIC	Punctuality improvement Committee
MSNBC	American basic cable and satellite channel
ATC	air traffic control
AAR	airport arrival rate
ADR	airport departure rate
LAHSO	Land and Hold Short Operations
GDP	Ground Delay Program
AFP	Airspace Flow Program
CZ	China Southern Airline
BIA	Bandaranaike International Airport
LHR	Lahore
CMB	Colombo
EU	European Union
ECJ	European Court of Justice
UK	United Kingdom
CAA	Civil Aviation Authority
IATA	International Air Transport Association
BA	British Airways
TUI	Touristic Union International
KLM	Koninklijke Luchtvaart Maatschappij N.V. (Royal Dutch Airlines)
HAD	Halmstad in Sweden
C&V	Ceiling and Visibility
TRACON	Terminal Radar Approach Control
EWR	Newark Liberty International Airport (IATA: EWR)
DOT	Department of transportation
LGA	New York La Guardia Airport
NAS	National. Airspace System
U.S.	United States
MJ	Mihin Lanka
IT	Information Technology

CHAPTER 01: INTRODUCTION

1.1 Background

About 200 years ago, King Louis the 18th of France used to say, "Punctuality is the politeness of the kings". Very appropriate words indeed, as every airline wants to be polite to customers and be the king amongst its competitors. Punctuality differs widely between airlines. It has become a competitive differentiator, both in positive and negative ways and customers do care strongly about it. More importantly, punctual airlines appear to be more profitable (Allen & Hamilton, 2002). Departure delay has increased significant in past decade since the increasing demand of air transport (Yuan, 2007) with the increment of number of flights.

Bandaranaike International Airport (BIA) has recorded 27.3% of its total departing flights as delayed in the quartile of the year (Madhavi, 2013). Madhavi (2013) further found that the departure flight delays at BIA occur due to three main causes which are Airline related causes, airport related causes and late arrival of the aircraft from its previous flight. It is necessary to minimize the number of delays and the delay times to avoid the numerous problems which generate in the future. This research is carried out to identify the possible reasons that affects departure flight punctuality as a case study to the Srilankan Airlines departing flights from Bandaranaike International Airport.

Srilankan Airlines is the Major National Carrier in Sri Lanka. The Flight Operations Punctuality Improvement Section of Srilankan Airlines does Delay Analysis on delay types at each destinations. However, the delays are not mitigated or minimized in an acceptable level throughout previous years. Since there is no any regulatory background of flight punctuality, it is needed to develop and implement regulatory controls and manage critical delays.

The ICAO (International Civil Aviation Organization) is an organization which is responsible for setting of Standards And Recommended Practices (SARPS) relating to International Civil Aviation. But there are not such regulations relating to the flights delay or delay operations of aircrafts. Therefore, it is unquestionably needed at least to have national level regulatory solution. Therefore this study describes a new approach to develop new policies and regulations to overcome the problems in the future.

This study consists of five chapters and first chapter is the introduction, second chapter reviews the literature. Third chapter discusses the research design and the fourth chapter is the data analysis and interpretation. Finally fifth chapter goes to the conclusion and recommendation.

1.2 Research Problem

There is no industry wide standard definition or measure of departure flight delay. Airline flight delays, may negatively affect passengers in many ways. Delays can increase passengers' anger, uncertainty, dissatisfaction, and inconvenience with the service provided, time loss and also a major revenue and time loss for airlines and airports.

Therefore identification of possible reasons that affect departure flight punctuality and managing those is very essential today. Therefore the research question of this study can be identified as follows.

1. What are the main critical delay categories?
2. What are the delay reasons of those critical categories?

1.3 Research Objective

The objective of the study is mainly focused on;

1. Identification of delay situation of the Civil Aviation Operations,
2. Identification of departure flight delay categories,
3. Identification of critical categories and possible reasons that affect departure flight punctuality

1.4 Methodology

The methodology of the research can be summarized to the following figure. It basically consists three stages such as preliminary Study, Detailed investigation and Analysis and presentation. This will be described in details further under chapter 2, 3 and 4.

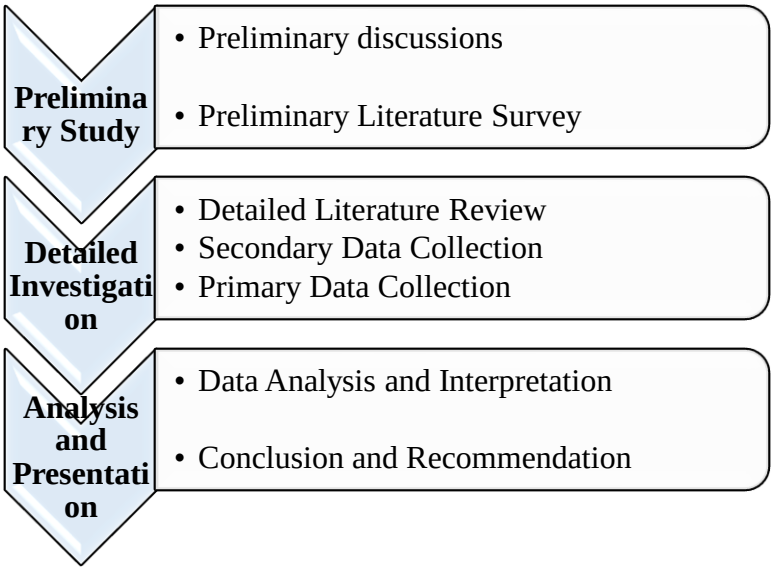


Figure 1.1: Research Methodology

1.5 Scope and Limitations

This study is mainly focused on analysis of departure flight delays at Srilankan Airlines. Srilankan Airlines departure flight delay data for two years from June 2011 to June 2013 was collected for this study. Srilankan Airlines PIC (Punctuality Improvement Committee) of the Flight Operations Division has changed their electronic software system in the year 2010. Therefore it is decided to collect the departure delay data from the year 2011. Since the second International Airport was opened in March 2013, Srilankan airlines has to divert their operations via Mattala Rajapaksa International Airport after March 2013. Therefore the schedules became quite different as compared to the previous condition. Therefore the delays only up to the year 2013 were considered.

The factors such as social, economic, environmental and the political situation of the country have not been considered for this study.

CHAPTER 02: LITERATURE REVIEW

2.1 Introduction

This chapter focuses on reviewing the recent studies on departure flight delay in different aspects. There are hardly any research done on identification of reasons for departure flight delays in Sri Lanka but there are quite number of papers to collect information on flight delays in other parts of the world. In this chapter various flight delays categories, reasons for delays, international and national level practices, passengers and legal point of views, measures already taken up to reduce delays and increase punctuality and the drawbacks of the flight delays were discussed.

2.2 Aircraft delays and its Punctuality

Generally, "A flight is considered delayed when an airline flight takes off and/or lands later than its scheduled time". The Federal Aviation Administration (FAA) considers a flight to be delayed when it is 15 minutes later than its scheduled time.

Punctuality is one of the key performance indicators in the airline industry and an important service differentiator especially for valuable high-yield customers. In addition, improved on-time performance can help achieve significant cost savings. Airlines report delay costs from 0.6% to up to as much as 2.9% of their operating revenues (Allen & Hamilton, 2002).

Although there are lot of Annexes published by ICAO, but no any Standards And Recommended Practices (International policy and regulations) regarding flight delays. Therefore there are no any national level policy and regulations have been developed and this will lead lot of delays in the aircraft operations for airlines.

2.3 Reasons for delay

Determining causes for aviation delay is essential for formulating and evaluating approaches to reduce air traffic delays. According to the article "Analysis of delay causality", convective weather and reduced ceiling and visibility were found to be the leading contributors to large delays (Allan, Beesley, Evans, & Gaddy, 2002). It has found that 41% of the cumulative arrival delay (delay relative to schedule) on days in the period averaging more than 15 minutes of delay per arrival occurred on days characterized by convective weather either within or at considerable distances from the terminal area. Of the remaining delays, 28% occurred on days

characterized by low ceiling/visibility conditions, while 14% occurred on fair weather days with high surface winds, and 2% were caused by distant non-convective storms. Known causes other than weather accounted for 9% of the delays, and causes were unknown for 6%. When delay types (airborne, gate, taxi out etc.) were categorized by the type of weather causing the delay, it was found that: departure delays (gate & taxi out) were much larger than arrival delays for thunderstorms in the terminal area and taxi out delays were the dominant type when delays were caused by distant convective weather (Allan, Beesley, Evans, & Gaddy, 2002).

Allan et.al further found that operating daily at or near capacity, any event reduces capacity immediately creates delays. Detailed understanding of the causes of delays would be needed for formulating effective long term solutions. The different types of delay (gate delay, taxi out delay, airborne delay, and arrival delay) are broken out to assess the contributions of the different types of weather events such as terminal convection, high winds, low ceilings and visibility, and en route weather and etc. Gate and taxi out delays, which account for a large fraction of that airport's delay, are particularly sensitive to the presence of convective weather both within the Terminal Radar Approach Control and en route. In general, convective weather poses a more difficult problem for air traffic managers than low ceilings or high surface winds, because convection not only affects the departure and arrival frequency but also blocks flight routes in the region. Both systems report two main types of flight delay, airborne and arrival. (Allan, Beesley, Evans, & Gaddy, 2002).

The local weather is the dominant contributor to the delay considering about weather and it could be divided into two main groups. One group included delays directly attributable to weather and the other group included delays attributable to causes unrelated to weather. It could be further assigned to one of three subcategories in the first group such as thunderstorms, low ceilings and/or visibility, and high surface winds or one of three in the second such as delay due to weather elsewhere in the country, delay unrelated to weather, and delay where cause was unknown (Allan, Beesley, Evans, & Gaddy, 2002).

Since 2003, the United States Bureau of Transportation Statistics has been keeping track of the causes of flight delays. Some of the causes of flight delays are as follows:

- Maintenance problems with the aircraft
- Crew problems
- Aircraft cleaning
- Baggage loading

- Fueling
- Extreme weather, such as tornado, hurricane, or blizzard
- Airline glitches. Congestion in air traffic
- Late arrival of the aircraft to be used for the flight from a previous flight
- Security issues

The number of flight delays has increased as staff has been cut back as a result of the financial distresses following the September 11 attacks. In 2000, approximately 25% of all flights in the USA and Europe were delayed by more than 15 minutes (Allen & Hamilton, n.d.). This can be attributed to increasing congestion of air space and poor operational performance of air traffic control and airport facilities. However, the individual improvement potential within an airline's reach is significant and this potential requires a significant vision by the airline's management.

The travel news of MSNBC news website indicates, that the severe thunderstorms threatened Mid-Atlantic States in the year 2013, forcing airports to delay heavily traveled flights between New York and Boston. Flights to the New York City area from Boston were delayed almost three hours during the morning commuter rush, according to the Federal Aviation Administration, while other flights at Boston's Logan International Airport were delayed almost an hour, it said (Travel News, 2012).

According to Bureau of Transportation Statistics, Airline Service Quality Performance, the delays are categorized as On time Delay, Air Career Delay, Weather Delay, National Aviation System Delay, Security Delay, Aircraft arriving Late, Cancelled and Diverted and the brief descriptions of them are as follows;

- **Air Carrier:** The cause of the cancellation or delay was due to circumstances within the airline's control (e.g. maintenance or crew problems, aircraft cleaning, baggage loading, fueling, etc.).
- **Extreme Weather:** Significant meteorological conditions (actual or forecasted) that, in the judgment of the carrier, delays or prevents the operation of a flight such as tornado, blizzard or hurricane.
- **National Aviation System (NAS):** Delays and cancellations attributable to the national aviation system that refer to a broad set of conditions, such as non-extreme weather conditions, airport operations, heavy traffic volume, and air traffic control.

- **Late-arriving aircraft:** A previous flight with same aircraft arrived late, causing the present flight to depart late.
- **Security:** Delays or cancellations caused by evacuation of a terminal or concourse, re-boarding of aircraft because of security breach, inoperative screening equipment and/or long lines in excess of 29 minutes at screening areas.

Airline flight delays have come under increased scrutiny lately in the popular press, with the Federal Aviation Administration data revealing that airline on time performance was at its worst level in 13 years in 2007. Flight delays have been attributed to several causes such as weather conditions, airport congestion, airspace congestion, use of smaller aircraft by airlines, etc. (Deshpande, 2012)

The Federal Aviation Administration (FAA) categorizes delays into gate delay, taxi-out delay, en route (in flight) delay, terminal delay and taxi-in delay. Each category of delay arises when the aircraft requires more time in that regime than was scheduled. (Muller & Chatterji, 2002).

Weather is the main contributor to delays in the air traffic control (ATC) system. Traffic volume delays are caused by an arrival/departure demand that exceeds the nominal airport arrival rate (AAR)/airport departure rate (ADR). The demand may also exceed the airport capacity if AAR and ADR are reduced due to weather conditions at the airport, equipment failure or runway closure. ATC equipment outages are also responsible for a small number of delays. In addition to the above-listed causal factors for delays, introduction of new equipment and operational procedures have been known to contribute to the delays. Restrictions on Land and Hold Short Operations (LAHSO), a change of procedure, also contributed to an increase in delay. LAHSO is designed to permit simultaneous use of intersecting runways. The landing aircraft is instructed to stop just before the intersecting runway so that another aircraft may use it at the same time. Delays may also be attributed to airline operations procedures (Muller & Chatterji, 2002).

Muller and Chatterji, (2002) had further explained that the first contributing factor is the organization of operations into a hub and spoke system by the airlines. The hub spoke operations cause series of aircraft to arrive together and then depart together. This type of operation is desirable from an airline point of view because it allows the passengers, aircraft and crew to be rerouted to various destinations. They also provide airlines the opportunity to consolidate passengers into some flights while canceling others.

A recent empirical study found that air traffic congestion due to airline hub spoke and over scheduling of flights at airport facilities are the primary causes of flight delays (Nicholas, 2007). BTS Bureau of Transportation Statistics data provides the following flight delay reasons (the proportion of all flights delayed is in additions); weather (6.4%), late arriving aircraft (5.9%), air carrier delay due to maintenance, equipment, or crew problems (5.2%), heavy traffic volume (1.6%), closed runways (0.4%), security delays (0.1%), and other (0.5%). The primary drivers of delays: weather and late arriving of aircrafts are subjected to seasonal fluctuations with poor weather typically occurring in the winter while late arrivals are more common during the busy summer travel season. (Nicholas, 2007).

Delay factors or causes are varied as aircraft mechanical failures, unscheduled maintenances, passenger or crewmember absences, weather, terrorism, airport capacity, air traffic control (ATC), embarkation, administration, human factors and delay propagation, etc. Sometimes a delay results from a single reason, but the most come with multiple causes. Especially exacerbating in those hub airports, the uneven distribution of aircraft movement brings on the concentration of departures and arrivals in narrow time band through daily operation, which induces more serious congestion, lower airport circulation efficiency, higher cost penalties and higher probability in flight delays (Yuan, 2007).

In the network analysis of flight delays paper done by Ning Xu, & et al., each flight segment is considered as a component in a network. All components are linked together through the common factors; the delay variables are also linked together based on their correlation chronologically, so that the model can represent the connection among the flight segments and also the correlation among the delay variables as per the table 2.1.

Table 2.1: Delay factors and Reasons

Delay variable	Factors influence the delay
Turn around delay	Gate Delay GDP Delay Airline Scheduled Gate out Delay Weather
Gate out delay	Turn around Delay Gate in Delay

Taxi out Delay	Departure Queue Size Arrival Throughput Act Gate Out Time, Run way Configuration En Route storm
Departure Queue size	GDP time, Act Departure Demand Arrival Throughput Arrival Throughput Airline
Airborne Delay	Predicted En Route Time Weather Arrival Throughput En Route storm
Predicted en route time	Airline, Accumulated Delay En Route Storm Weather
Taxi in Delay	Departure Queue Size Arrival Queue Size Departure Throughput Arrival Throughput
Gate In Delay	Accumulated Departure Delay Airborne Delay Taxi In Delay Airline, Scheduled Gate In Time Departure Throughput

Source: (Ning, Kathryn, Chun, Shannon, & Lance, 2007)

2.4 Global/International Operating Practices

Hanna (2011) found that in the United States, passengers are not entitled for compensation when a delay occurs, not even a cut of fees airlines must pay federal authorities for long delays. Airlines are required to pay for lodging costs of passengers if the delay or a cancellation is through their own fault, but not if the cause is beyond their control, such as weather. In the

United States, the Federal Aviation Administration estimates that flight delays cost airlines $22 billion annually. Airlines are forced to pay federal authorities when they hold planes on the tarmac for more than three hours for domestic flights or more than four hours for international flights.

The FAA's current Traffic Flow Management system, used when certain airports or flight paths become too congested, relies on the use of the Ground Delay Program (GDP), introduced in 1981, and the Airspace Flow Program (AFP), introduced in 2007. When a GDP event is implemented, such as during the recent Hurricane Irene sweep up the East Coast, the FAA coordinates ground departure times to control the arrival rate into a congested airport; in an AFP, the FAA uses the same approach to adjust the amount of traffic flying into congested airspace. These two tools account for approximately 30 percent of all air transportation delays, according to the research of Hanna in 2011.

Flight delays were highest for regional airlines such as American Eagle, SkyWest, and Mesa Airlines, which also have the greatest percentage of cancelations and connecting passengers. Delay rates were lowest for low cost carriers such as Southwest, JetBlue, AirTran, and Frontier, since these airlines tend to have fewer connecting passengers and often fly into airports that are less capacity constrained. Worst airports for connections is a main among the delays. Passengers scheduled to transfer in Newark, Chicago O'Hare, New York's La Guardia and Kennedy, Washington Dulles, or Philadelphia experienced the longest average connecting passenger delays, with the itineraries of over 10 percent of passengers disrupted. The worst transfer airports based on departure cancelation rates included Washington's Reagan, Boston's Logan, and Dallas/Fort Worth International airports. At Hartsfield-Jackson Atlanta, Chicago O'Hare, and Dallas/Fort Worth airports the airports with the highest number of planned passenger connections 40 percent of all domestic passengers' missed connections and 43 percent of all disruptions to one-stop passengers occurred (Hanna, 2011).

Hanna (2011) further found that delays are worst in the summer (June, July, and August) and winter (December, January, February) months, with passenger delays 56 percent higher at these times than in the remaining six months. The average passenger delay in the summer months was 37.4 minutes; in winter, 36 minutes; for the remaining six months, 23.5 minutes. September and November were the only two months with average passenger delays of less than 20 minutes. Passengers benefit by flying airlines offering more flights to their destinations. Fearing and his coauthors find that the average delay to disrupted nonstop passengers on routes

with at least 10 daily flights per carrier is 31.4 percent lower than the overall average for disrupted passengers. The average delay on routes with at most three daily flights per carrier is 15.3 percent higher than the overall average.

In some regions, airlines has to pay fees for their appropriate authorities on behalf of long delays at airports to reduce the waiting times at the airports for international commercial flights.

2.5 Airlines Point of View and their Operating Practice

Punctuality performance differs generally across airlines. Punctuality targets are usually defined in terms of 15 minute punctuality, i.e. a flight is still counted as departing on-time, if the plane goes off-blocks within 15 minutes of the scheduled time of departure. (Allen & Hamilton, 2002).

According to the US Congress Joint Economic Committee, the cost associated with domestic flight delays in the United States during 2007 was estimated at $25.7 billion ($12.2 billion in increased airline operating costs, $7.4 billion in passenger time lost, and $6.1 billion in costs to related industries) (Hanna, 2011).

Air Canada website mentions that "some delays are within an airline's control, whereas others, like those caused by severe weather or airport and air traffic disruptions, are simply out of our hands". In the case of an extended delay to an Air Canada or Air Canada Express flight which is expected to last:

- **2 hours or more:**
    - Passenger may change his reservation at no cost by choosing a new departure date within 7 days of original travel date. If the passenger change the departing flight, passenger can also, at the same time, choose a new return flight to match the same length of stay, if necessary.
    - The passenger may retain the unused portion of his ticket and use it toward future travel on Air Canada.
    - The passenger may request a refund for the unused portion of ticket.
- **4 hours or more:**
    - When the delay is caused by circumstances within Air Canada's control, an Air Canada airport agent will offer a voucher for use at an airport restaurant or for Onboard Café service.

- **8 hours or more:**
    - For circumstances within Air Canada's control - If flight has been rescheduled to depart the next day, it may be entitled to meal vouchers, transportation to and from the airport as well as hotel accommodations (subject to availability) .
    - For circumstances outside Air Canada's control - If your flight has been rescheduled to depart the next day, Air Canada representatives will provide with hotel contact information where the passenger can obtain valued customer rates.

If any of the circumstances occurs, China Southern Airlines is free from any prior notice of change of the type of plane or flight course, and will cancel, suspend, delay or postpone the flight in accordance with relevant regulations to follow the law, regulations, rules, command or requirement, to ensure the flying safety, and other uncontrolled and unforeseeable reasons. If the carrier, due to any of the above reasons, cancels or delays a flight, and correspondingly fails to provide passengers with the booked seats (including cabin class), or fails to stop at the stopover or destination for passengers, or makes passengers miss the connecting flight. China Southern Airlines would adopt the following measures when considering the reasonable needs of affected passengers; (China, 2012)

— To arrange the following CZ flight with seats available;
— To endorse with the consent of traveler and relating carrier;
— To change the segment listed on the original ticket, and arrange CZ or other flights to send the passengers to destination or stopover;
— To deal with it according to involuntary refund rules.

Most of airlines try to minimize or overcome the departure flight delays through their operating processes. As the national carrier of Sri Lanka, Srilankan Airlines also do their own evaluations and tries to minimize the delays. They improve their punctualities according to the past experiences and they have their separate unit for the task. As an example when there are ground delay problems they schedule the ground movement functions little bit earlier. Because the proactive delay compensation procedures are highly cost to them. Therefore preventive is better than proactive.

2.6 Srilankan Airlines, National Carrier of Sri Lanka

Srilankan Airlines Chief Executive Officer had said that the first quarter (Jan-March) punctuality records have revealed an impressive high average, exceeding the airline's

punctuality benchmarks for all flights departing Colombo and destinations in the entire network, (The Sunday Leader newspaper, 2012). It further revealed that the punctuality average maintained for flights departing Colombo within 15 minutes of the scheduled time has been 89 per cent, surpassing the airline's benchmark of 85 per cent with the month of March achieving a percentage as high as 92. Punctuality for flights departing Colombo within 3 minutes of the scheduled time is 73 per cent, exceeding again, the airline's benchmark of 70 per cent, he said.

It further reported that the Srilankan Airline's System wide Departure Punctuality Average for flights within 15 minutes of the scheduled time, for the first quarter, is only a fraction short of the benchmark of 85 per cent, having achieved an average of 83 per cent. Srilankan Airlines is the sole ground handler at Bandaranaike International Airport (BIA) and currently handles approximately 1800 of its own flights and an additional 1900 flights of other airlines, totaling approximately 3700 monthly flight movements. In the midst of handling a large volume, the airline has taken every measure to improve its own 'on-time' departures. "This is a clear indication of a high level of performance and the trend is attributed to several effective measures introduced to the system to improve punctuality" (SL NEWS 2012).

Punctuality is one of the key indicators of performance and an important service differentiator. Also it has a significant effect on cost savings. The reasons for flight delays fall into the categories of 'avoidable' and 'unavoidable conditions. The results reveal that Srilankan Airlines has managed all 'controllable' factors reasonably well. Some 'uncontrollable' factors that have affected recent flights are Air Traffic Controls due to unfavorable weather, airspace closures in South India and tsunami warnings which have had a ripple effect on air traffic movements. Other common factors that contribute to delays are late arrival of passengers and air traffic congestion in busy airports.

All departments in Srilankan Airlines involved in the preparation of a flight dispatch, have taken up the challenge to achieve 'on-time' departures. The Punctuality Improvement Committee (PIC) is entrusted to get to the root causes of any delays. Getting a flight to leave 'on time' is a challenging task for airlines across the world. Airlines have to ensure that they comply with safety regulations, enhanced security checks, airport congestion, weather and unforeseen operational conditions. Srilankan is continuously enhancing the check-in, baggage handling and airport formalities to improve efficiencies that contribute to 'on-time' departures. (News, 2012).

2.7 Passenger Perception

Today airline business market is a very competitive one. The passenger who consume the services from the airline is always expecting and willing to receive zero defects service and high quality service. The operational service delays in the whole end to end supply chain will lead to negative passenger perception on airline services. The flight departure delays will lose the departure passengers satisfaction, service expectation, service perception, service value and the image on the airline.

It is not to insult, disgrace or contempt the national carrier of Sri Lanka. But there are numerous passenger reviews, feedbacks in the internet (World Wide Web) system on bad perception of Sri Lankan Airlines due to the service supply chain delays and one of them can be identified as below.

"LHR-CMB-LHR: Flight was one hour late due to slow baggage loading. The cabin crew quickly served a round of drinks, an average meal with no drinks and got the cabin in sleep mode. This went on for over 5 hours during with no drink round was made & when I reported it the only interest was to note the sound worked" (Wright, 2012).

2.8 Optimization of the Flight Punctuality

Allen Boos and Hamilton, 2002 founded more information on punctuality, how Airlines can improve on time performance and etc. There are three main controls to push the punctuality such as network planning and control, Aircraft availability, and ground operation and departure process. Sound network planning and control is the foundation for high punctuality. Aircraft availability is the second main lever in the punctuality framework. If the punctuality target is really taken seriously it needs to have an impact on fleet planning and structure. Airline operations typically do not have the processes and systems in place that are necessary to monitor supplier performance in an adequate way. Traditional airline supplier measurement systems focus on costs and product quality, whereas assessing timely performance on a minute by minute scale is not widely applied. This is a major deficiency in the case of the very complex multi user and multi participant ground handling processes. Airlines need to use all three of the main levers described above simultaneously in order to be successful.

Monitoring and Sampling directs to evaluate process performance in the overall departure process, supplier processes, and the activities in problem areas. Process monitoring requires

that key milestones in the departure process are defined and measured. Some airlines conduct spot check on such milestones, taking samples from a number of flights on a regular basis; others go as far as using automated electronic time-stamps that feed into online monitoring systems. Data from process monitoring allows the dissection of the departure process, identifies the origins of delays and the impact on the overall airline delay rate (Allen & Hamilton, 2002).

2.9 Regulatory and Legal aspect

Achieving punctuality is a leadership challenge throughout the organization from strategy and planning all the way to frontline operations. However, there are many levers that airlines can pull to address this challenge. It is not only today, in our fast moving business world, that punctuality matters. History has seen many famous advocates of punctuality.

Allen and Booz founded that it is of utmost importance to reach agreement amongst all the key parties involved on the root causes of the delays. Regardless of the method of analysis used, the results must identify problem areas, root causes and their order of magnitude. It is important to spend time on this effort until a common understanding of the problems is reached, otherwise most of the impact of the analyses on future performance will be lost.

As soon as the root causes are visible and agreed on, the path to remedying them is usually clear and the different improvement options can be evaluated. These options typically fall into two categories such as internal measures and supplier related measures (Allen & Hamilton, 2002). Internal measures include:

- Resources, capacity and infrastructure. These refer to measures such as using dedicated resources for critical processes, reserve aircraft, or investments in system improvements.
- Process design and optimization aiming at doing things in innovative new ways, which have not been thought of or attempted before.
- Empowerment, motivation and discipline. These factors include incentives, new policies, clear roles and responsibilities for the staff involved.

And Supplier related measures include:

- Service level agreements, which address not only what to deliver but also when to deliver it.

- Operational planning and interface design, integrating the activities and processes of each supplier within the entire network of operations.
- Continuous monitoring and feedback as well as incentives and penalties which close the feedback loop in the supplier relationship and which assign clear "consequences" to good or bad performance levels.

In the United States, the Transportation Department imposes a fine of $27,500 per passenger for planes left on the tarmac for more than four hours without taking off.

According to the http://www.which.co.uk/consumer-rights/travel-rights website retrieved on 19th of June 2012 mentioned that when a passenger at an airport and discover your flight is delayed, the passenger's legal position depends on where you are flying to and from. If the passenger is travelling with an airline based in the EU or with a non EU based airline flying from an EU airport, then the passenger is protected by the Denied Boarding Regulation. The regulation states that the airline has an obligation to offer the passenger assistance if the passenger's delay is expected to go beyond a certain point. The passenger should check the airline's Condition of Carriage to see what entitled to the Denied Boarding Regulation and applies if;

- The passenger have a confirmed booking
- The passenger checked in on time, or if no check-in time was given, then at least 45 minutes before your flight was scheduled to depart
- The passenger is departing from an EU airport, or from a non-EU airport and flying into an EU airport on a 'community carrier' (an airline with its headquarters and main place of business within the EU. That includes all European discount and no-frills airlines).

If the passenger is protected by the Denied Boarding regulation, the passenger is entitled to:

— Two free phone calls, faxes or e-mails; and
— Free meals and refreshments appropriate to the delay; and
— Free hotel accommodation and hotel transfers if an overnight stay is required.
— The above applies:
— When a flight under 932 miles (for example, London to Venice) is delayed for at least two hours

— When a flight within the EU that is more than 932 miles (for example, London to Athens) is delayed for at least three hours
— When a flight that isn't within the EU but is between 932 and 2,174 miles is delayed for at least three hours
— When any other flight is delayed for at least four hours.

It has reported that the right of UK air passengers to force airlines to pay compensation for long flight delays has been suspended by the High Court. A European Court of Justice (ECJ) ruling gave passengers the right to compensation for long delays, not just cancellations. But the High Court has, at the request of UK airlines, referred the matter back to the ECJ for a further hearing. It means UK courts will not hear any more cases until the ECJ rules again. The Civil Aviation Authority (CAA), which enforces the airline regulations, said it would defend the current position at the next ECJ hearings (BBC news).

And also it further reported about the changed rules. European rules awarded airline passengers cash compensation if their flights were cancelled, but not if they were delayed. If passengers were delayed the airlines had only to offer meals, refreshments, two free telephone calls and, for an overnight delay, hotel accommodation and transfers to and from the hotel. That changed when the ECJ effectively re wrote the original 2004 regulations, and said that people whose flights were delayed should be treated as if their flights had been cancelled. That meant cash compensation should be awarded, in addition to their other rights, if delays lasted longer than three hours. However, the UK airline industry opposed the move. BA, Easy jet, the tour operator TUI and the International Air Transport Association (IATA) took the matter to the High Court, to persuade it to ask the European court to look at the issue again.

Separately, some airlines have been fighting their obligation to pay food and hotel costs, for instance following the widespread disruption caused by the volcanic ash cloud over much of Europe during the spring. The European Commission threatened to take legal action against the Dutch airline KLM which has been reimbursing its passengers for the cost of just one day and one night's delay. Ryan air initially threatened not to reimburse passengers whose flights were cancelled due to the ash cloud, but it backed down under pressure from the UK and Irish authorities (Pollock, 2010).

The Passenger Compensation Regulation 261/2004 is an EU Regulation established common rules on compensation and assistance to passengers in the event of denied boarding, flight cancellations, or long delays of flights. It repealed Regulation (EEC) No 295/91, and went into effect on 18 February 2005. It sets out the entitlements of air passengers when a flight that they intend to travel on is delayed or cancelled, or when they are denied boarding to such a flight due to overbooking, or when the airline is unable to accommodate them in the class they had booked. There are three broad categories of compensation and assistance that may be required in the case of cancellations or denied boarding; cash compensation, rerouting or refunding and refreshments, communication and accommodation.

In the case *Wallentin-Hermann v Alitalia—Linee Aeree Italiane SpA* (Case C-549/07) of 22 December 2008, the European Court of Justice in Luxembourg ruled on the interpretation of Article 5 of the regulation relating to cancellations, specifically paragraph 3 which states: An operating air carrier shall not be obliged to pay compensation in accordance with Article 7, if it can prove that the cancellation is caused by extraordinary circumstances which could not have been avoided even if all reasonable measures had been taken (C-549/07, 2008).

Yu (2012) found that the new federal rules designed to prevent long tarmac delays for international passengers, provide greater compensation if fliers are bumped off flights and make airlines better disclose extra fees take effect. The consumer protection rules, from the Transportation Department, will let the department impose fines on U.S. and foreign airlines of up to $27,500 per passenger if they leave an international flight on a tarmac for more than four hours without taking off. And also raise compensation if passengers are bumped from an oversold flight. They'd get double the price of their tickets up to $650 if their arrival at their destination is delayed just a few hours. Currently, compensation is equal to the ticket value, up to $400. Longer delays would trigger payments of four times the value of their tickets, up to $1,300. That compensation is capped at $800.

And also the consumer protection rules require airlines to prominently disclose all ancillary fees on their websites, including fees for checking bags, providing meals and canceling reservations. But Steve Lott, spokesman for the Air Transport Association that represents major carriers, says, that the Market forces, not additional regulations, are already providing customer benefits. The Transportation Department had proposed more rules. But the airlines complained they'd need more time to adapt to them. The provisions require airlines to promptly notify passengers at the boarding gate, on airline websites and via their phone reservation systems of

flight cancellations and delays of more than 30 minutes and allow customers to cancel reservations without payment for at least 24 hours if they're made at least a week before departure. And also include all government taxes and fees in advertised fares. Airlines typically exclude them (Yu, 2011).

The Civil Aviation Administration of China has introduced a policy of no takeoff limits at major airports in an effort to deal with the serious problem of flight delays. It has said that, except in the case of bad weather or military exercises, flights from the country's eight major airports should not be delayed. Netizens, however, say the measure could cause "mid-air traffic jams" and compromise flight safety. Following are the views of China Daily's mobile news readers. The new measure means more problems than benefits for passengers. Mid-air traffic jams will increase the fuel costs of airlines, prompting them to raise ticket prices. Besides, even after taking off on time, flights may have to "wait" in mid-air, which can be dangerous. The move may improve the on-time takeoff performance of airports, but it will not solve the overall problem of flight delays (Oliva, 2014).

Although there is no any regulations on flight delays, here are Acts, rules, regulations for passenger compensation regarding the flight delays. Since those are implemented after the incidents, these could be identified as proactive regulatory measures.

2.10 Reduction of delay / Increase punctuality

An airplane's ability to absorb delay while airborne is limited and costly. Because of this, the air traffic control system anticipates and manages excessive demand for scarce shared resources, such as arrival runways or busy airspace, so that the delay necessary for buffering can be spread out over a larger distance, or taken on the ground before departure (Boesel, 2003).

The development of a ground based system for predicting aircraft wake vortex behavior and prescribing safe, weather dependent spacing criteria for wake avoidance is summarized. The system was operated at the Dallas Fort Worth International Airport from 1997 to 2000, and demonstrated the feasibility of automating the required weather measurements, wake predictions, and wake measurements. Comparisons between predicted wake behavior to that observed by two ground based lidar systems and a ground wind line system are made. The potential runway arrival rate increase with the system operating average 5 percent, with up to 11 percent available on some days. The utility of the system software for performing tradeoff

studies is illustrated, as in an alternate architecture useful for parallel runaway operations with minimal ground sensor requirements (Cornelius & David, 2000).

Allan (n.d) found that the cumulative arrival delay, 41% occurred on days characterized by convective weather either within or at considerable distances from the New York terminal area. Of the remaining delay, 28% occurred on days characterized by low ceiling/visibility conditions, while 14% occurred on fair weather days with high surface winds, and 2% was caused by non-convective distant weather (most likely snowstorms). Other no weather related causes accounted for 9% of the delays. We were unable to determine causes for 6% of the cumulative delay on HAD days. The cumulative delay distribution of average hourly arrival delay on HAD days for four delay categories: thunderstorms in the TRACON (local convective weather), en route convective weather, ceiling and visibility, and high wind.

The associated hourly delays during convective events are the most severe of any weather category. Thunderstorms tend to disrupt air travel severely because level 3 or greater thunderstorms generally have tops from 25,000 to 50,000 feet too high for most aircraft to fly over. Then thunderstorms are present in TRACON airspace, delays are almost 1.5 hours or greater for 20% of all hours that have average delay exceeding 15 minutes. Arrival delays sometimes exceed five hours in duration. Cancellations and diversions are also worse on these days than with any other weather category (not shown). In fact, delays associated with convective weather both inside and outside New York TRACON airspace account for approximately 41% of all arrival delay at EWR. Low ceiling and poor visibility (C&V) are similar to thunderstorms in total annual impact and second in average delay per event (Allan et.al, 2001).

Allan (n.d.) further elaborated that more than 50% of the total delay due to C&V was attributed to preplanned departure delays. This is likely caused by the long duration of many C&V events. There are other factors besides low ceiling and visibility involved in some of these cases. Many cases occurred during east coast storms, which can include heavy rain, freezing rain, snow, strong winds, and high vertical wind shear. Significant vertical wind shear was present on about 20% of C&V days. On these days, delays were generally 10 percent greater than the overall C&V average, while cancellations averaged 50 percent higher. Average delays were 10 percent greater during severe winter weather events, but cancellations nearly doubled, due to because of the relatively long-lead time in the prediction of snowstorms. Snowplow and runway treatment operations also contribute to increased delays. Overall, however, low C&V

was the leading, persistent factor contributing to delay on all days in this category. High wind days ranked third on the list in terms of average delay per event, and constituted over 14% of delay during the period of the study. This is a category that is often overlooked when considering the relationship between adverse weather and delays.

The simplest way of reducing delays was not to increase the speed and efficiency of the system to meet the scheduled time, but to push back the scheduled time to absorb the system delays. Studies have identified the stages of flight in which delays occur and the causal factors that result in delays. For example, the DOT classifies delays as gate delay, taxi-out delay, airborne delay and taxi-in delay. According to their contribution to the total delay, 84% of all delays occur on the ground (gate, taxi-out, taxi-in), out of which 76% are prior to takeoff (gate, taxi-out), suggesting that focusing on ground delay prediction will have the most impact on improving forecasting algorithms. Surface movement inefficiencies are not the only reason for delays on the ground. Ground delay programs, en route capacity constraints, aircraft maintenance issues, ground services (fuel, baggage and catering), customer service issues, late aircraft/crew arrival, and poor weather conditions elsewhere all contribute to surface delays (Muller and Chatterji, 2002).

The FAA is currently considering whether to implement congestion based pricing for landing and take-off rights in lieu of the existing weight-based landing fee structure at New York La Guardia Airport (LGA). The current weight-based landing (and take-off) fees do not reflect the market value assigned to using this scarce resource. Airport runways suffer from "the tragedy of the commons" since there is an incentive to over-use a resource when its benefit clearly exceeds the cost. Congestion costs rise, however, as more of a carrier's flights are delayed due to the over scheduling of its own flights at the airport. (Or, carriers are more cognizant of congestion costs when its own aircraft are the source of the airport congestion). Congestion-based pricing can efficiently reduce airport congestion if it causes carriers to internalize the delay externality. Before implementing such a fundamental policy shift, it behooves us to gather more about the causes of flight delays from both the airline and passenger perspectives (Nicholas, 2007).

The Ground Delay Program (GDP) is an air traffic flow management mechanism used to decrease the rate of in-coming flights into an airport when it is projected that arrival demand will exceed capacity. Under a GDP, a set of flights destined for a single airport is assigned

ground delays. In recent years, air traffic has experienced a dramatic increase. This increase has not been supported by a corresponding development of airports and related systems. As a consequence, both the European Airspace System and the United States National. Airspace System (NAS) are suffering from increased congestion. A short-term strategy for reducing or eliminating air traffic congestion is delay in the form of ground delay. The Ground Delay Program (GDP) is a mechanism used to decrease the rate of in-coming flights into an airport when it is projected that arrival demand will exceed capacity. Ground delay is the action of delaying take-off beyond a flight's schedule departure time. The motivation for doing so is that as long as an airborne delay is unavoidable, it is safer and cheaper for the flight to absorb this delay on the ground before take-off, rather than in the air (Michael & Lulli).

In future, in order for traffic planning tools that are intended to reduce delay to be effective during adverse weather, they must be especially tailored to address the connection between the specific problem areas and the type of adverse weather. Knowledge of the relative weather impacts on both arrival and departure delays is critical to the success of this process – allowing developers of these tools to prioritize the way in which current and future weather products should be used to support the automation. A key finding of this study was that departure delay is a major problem during convective events both near and far from EWR, while airborne delay does not appear to be a significant problem in New York on HAD days. This finding, along with other key results, suggests that new technology and tools for traffic planners, particularly those managing highly congested airspace such as New York, needs to be focused not only on the arrival problems, but equally, if not more, on departures (Allan, Beesley, Evans, & Gaddy, 2002).

Punctuality is a key leadership challenge throughout the organization and should rank high on the management agenda from strategy and planning all the way to front line operations. In rising to this challenge airlines need to take a strategic perspective and apply a comprehensive framework that addresses the three main levers for punctuality improvement that are within their reach Network planning and control, Aircraft availability, Ground operations and departure process.

2.11 Disadvantages of Flight Delays

Flight delays, which appears more frequently and seriously; the flight delay can also significantly damage airline's profitability and reputation. On the other hand, the problems are

raised at the same time. Because of the limitation of the operation resources, the load factors have been in excess of 75% on the current aviation market; the increasing amount of air vehicles and their flight frequency has also forced the airlines apply even more demanding operation schedules, which directly results in serious airport congestion and more frequent flight delays. As one vital factor in air-fleet management, the dispatch reliability and schedule punctuality can not only significantly damage airlines' profitability and their reputation, and also becomes hindrance which would slow down the overall industry growing. High demand of air transport demands and the limitation of the resources (such as available aircrafts, pilots, on-board attendants, airport gate space, ground service and staff, etc.) becomes a contradiction to be faced by the operators. In this bottle-neck like situation, airlines have to make the flight schedules even more compact and demanding, which leads to a higher probability of the occurrence of flight delays (Yuan, 2007).

John Nicholos and Buhong (2008) found that the bad weather can cancel the flights and delay flights by hours or days. This can cost the passenger valuable vacation or business time, and can even leave the passenger stranded at the airport. If the flight is canceled, it'll be competing with hundreds of other passengers for hotel rooms or alternate flights, which can be very expensive. Traveling by air is often more expensive than traveling by train, bus or car. A direct flight from Cincinnati to Milwaukee may take less than an hour, but it can cost hundreds of dollars. It's often cheaper, though more time consuming, to buy a few tanks of gas and drive to your destination. Most airlines, especially budget carriers, charge baggage fees for any luggage you check in. As of September 2010, one airline (Spirit) even charges for carry-on bags. This can add hidden costs to your trip, especially when you must take a lot of luggage along for a long vacation.

In December 2007, U.S. airline delays reached their highest monthly level since the Bureau of Transportation Statistics began tracking flight delays in 1995 as 32 percent of domestic flights arrived late. Furthermore in 2007, U.S. airline delays reached their highest annual level since 1999, as 24 percent of all domestic flights arrived late. To address this problem, the FAA recently threatened to fine airlines with persistent delays. One drawback with a counting measure of delays is that the duration of delay plays no role in the calculation (e.g., no distinction is made between flights delayed sixteen minutes vs. sixty minutes). An implication of using a counting measure for delays is that airlines have no incentive to shorten flight delays for flights that are already considered "delayed". This criticism of the "flight-counting"

measure is similar to that of the official poverty measure – the headcount ratio. With the headcount ratio, the overall poverty of a society is calculated as the proportion of the people below the poverty line; a person whose income is just below the poverty line and a person who has no income at all are treated the same by the measure (John, Nicholas, & Buhong, 2008).

Analyzing the causes of flight delays has quite changes and different structures among researchers, because of the crucial importance of airlines and airports decision making. Different papers have studied and categorized delay from various perspectives and it can be summarized in the table 2.2 delay classification.

Table 2.2: Delay Classification

Study	Delay cause category
Wong & Tsai, 2012	• Airport facilities or governmental authorities • Flight operations and crewing • Cargo and mail handling • Technical and aircraft equipment • Passenger and baggage handling • Reactionary • Weather • Air traffic control restrictions • Miscellaneous
Guest, 2007	• Airline-related • Airport-related • En-route • Weather
IATA Delay codes	• Aircraft and Ramp Handling • Technical and Aircraft Equipment • Passenger and baggage • Damage to Aircraft • Flight Operations and Crewing • Weather • Air Traffic Flow Management Restrictions • Airport and Government Authorities • Reactionary
Mueller & Chatterji, 2002	• Weather • ATC equipment problems • Runway delays • Traffic related delays • Other
Ning, Kathryn, Chun, Shannon, & Lance, 2007	• Turn around delay • Gate out delay • Taxi out delay

	• Departure Queue size • Airborne Delay • Predicted en route time • Taxi in Delay • Gate In Delay
Yuan, 2007	• Operational procedures • Aircraft technical problem and maintenance • Other
Federal Aviation Administration (FAA)	• gate delay • taxi-out delay • en route (in flight) delay • terminal delay and taxi-in delay
Bureau of Transportation Statistics	• On time Delay • Air Career Delay • Weather Delay • National Aviation System Delay • Security Delay • Aircraft arriving Late • Cancelled and Diverted
Sri Lankan Airlines	• ATC • Airport facilities • Engineering • Technical • Unavoidable • Weather • Special Operations • Commercial • Governmental • Crew Management • Commercial Revenue • IT • Overseas stations • Airport Services • Flight Operations • Passenger Convenience • Cargo • Inflight • Security • Catering • MJ Delays

Airline service is composed of set of processes. Passengers may have distinct expectations at different stages of the service chain. There may be a gap between passenger service expectations and actual service received. The flight delay is one of the main factor of the mentioned gap. This will gain more disadvantages for the airline.

Departure flight delays affect for its airline service quality, perceived value, passenger satisfaction and airline image and those determine the passenger's future behavioral intensions.

In this chapter, it was used the FAA definitions for the aircraft delays and its punctuality. Although there are numerous classifications and categorizations for departure flight delay reasons, this study focused on the Sri Lankan Airlines Departure flight delay categorization. Further this chapter found the information on global/international operating practices and delay occurrences, airline point views on flight delays and their operating practices, Srilankan Airlines as the national carrier in Sri Lanka, passenger perceptions regarding the airline, services which they received, optimization of the flight punctuality and performances, regulatory and legal aspect of flight delays, reduction of flight delays and optimize the punctuality, and the disadvantages of the flight delay.

CHAPTER 03: RESEARCH DESIGN

3.1 Introduction

This Chapter explains the methodology adopted throughout the research study and provides an overview of the approach which the specific objectives of this study are achieved. Furthermore the statistical tools and data analysis methods have been explained in details under this section.

3.2 Identification of Critical Categories

Since there are lot of departure flight delay categories, it was needed to identify most critical categories to select as samples for further analysis. Further details are discussed under chapter 4.1.

3.3 Population and sampling

The thesis is based on flight departure delay occurrences during the period of seven hundred and thirty operating days (25 months / two years) between June 2011 and June 2013 at Srilankan Airlines. It was considered only the departure flight delays more than 15 minutes.

Population

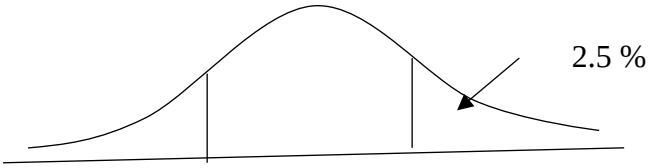
750 days (24 months) from June 2011 and June 2013, Scheduled Departure Flights operating from Bandaranaike International Airport.

Sample

Since the data range is (population size) very large, it was selected a sample to analyze. Here the cluster sampling technique was used to identify the sample. At the beginning the average delays per each delay categories (the delay categories are shown in the table 4.1) was calculated and the clusters were selected around the average values. Since this is a small ungrouped distribution, the arithmetic mean is similar to the average value. Then the sample mean and the population mean is nearly similar numbers (it can be shown as the following hypothesis: mean value of the sample and the population). The ***bold italic numbered*** months are represented the clusters in the table 4.1.

Since the cluster sampling technique represents the whole population, the sample was selected based on the average delays per month.

Sample size for each category = 3 and assume the mean of the population is equal to the sample's mean. Considered under 95% confidence interval to achieve objectives.



Pop size 750 days (25 moths)

Sample size 90 days (3 months)

Hypothesis;

H0: sample mean is equal to population mean

H1: sample mean is not equal to population mean

For Technical Delay Category

	Population	Sample
$\bar{x}$	57.36	57.66
σ	21.49	4.49
n	25	3
$Z_{\alpha/2} = 1.645$		

Operating rule:

Accept H_0 if sample lies within 95% area.

Accept H_0 if z is in between $Z_{-\alpha/2} = -1.645$ and $Z_{\alpha/2} = 1.645$

$$z = (\bar{x} - \mu)/ (\sigma/\sqrt{n})$$

$$= 57.36-57.66 / (4.49/1.73)$$

$$= - 0.1155$$

This is within the limit. Therefore H_0 can be accepted.

3.4 Data Collection

This study attempts to identify the departure flight delay reasons under each delay categories and find out the most possible reasons that can be controlled. Although there are so many delay categories, few categories are acted as critical and it was needed to identify the critical delay categories to identify the possible delay reasons. Therefore the data collection was carried out at two phases such as a secondary data collection and a primary data collection.

The secondary data was collected from Srilankan airlines, the national carrier of Sri Lanka to identify the critical delay categories.

Primary data was collected using an online web questionnaire and the questionnaire was prepared based on the findings of the secondary data analysis. Four main critical delay categories were selected after the secondary data analysis. The questionnaire contains the delay reasons under each main critical delay categories such as Technical, Airport Facilities, Unavoidable and the Air Traffic control. The questionnaire prepared to collect data is attached in the Appendix B.

The findings of the secondary data analysis are the reasons for each departure delay categories. And further, study needed to identify the possible reasons that can be affected flight departure punctuality. Therefore it was needed to identify the flight departure delay reasons under each category that can be controlled through operational or regulatory process. Therefore using the findings of the secondary data analysis the questionnaire was developed.

In general, the study wanted to collect data from aviation industry personnel. Therefore general details were included in the first part of the questionnaire such as profession, working area and the understanding of number of departure delays and the delay timings per flight at BIA.

Then it was included the flight departure delay reasons under each category to respond whether those can be controlled using new policy and regulations. It was included some proposed policy statements to get the information and ideas from industry professionals. The responders can respond using a numbering scale from 1to 5 with totally agree, agree, don't know, disagree and totally disagree.

3.5 Data Organization

All the data collected was entered to worksheets for the analyze purpose. The secondary data collected from Srilankan airlines for two years period from June 2011 to June 2013 was entered to worksheets as per table 4.1: Monthly departure delays by category.

CHAPTER 04: DATA ANALYSIS AND INTERPRETATION

As it has described under chapter 03, there were two steps of collecting data for this study. Therefore the analysis process of those data can be described as follows.

4.1 Secondary data analysis- Data Analysis 1st phase

The collected data as per the section 3.5 under Chapter 03, was analyzed. First, it was calculated the monthly wise departure flight delay percentages to get an idea about the whole population.

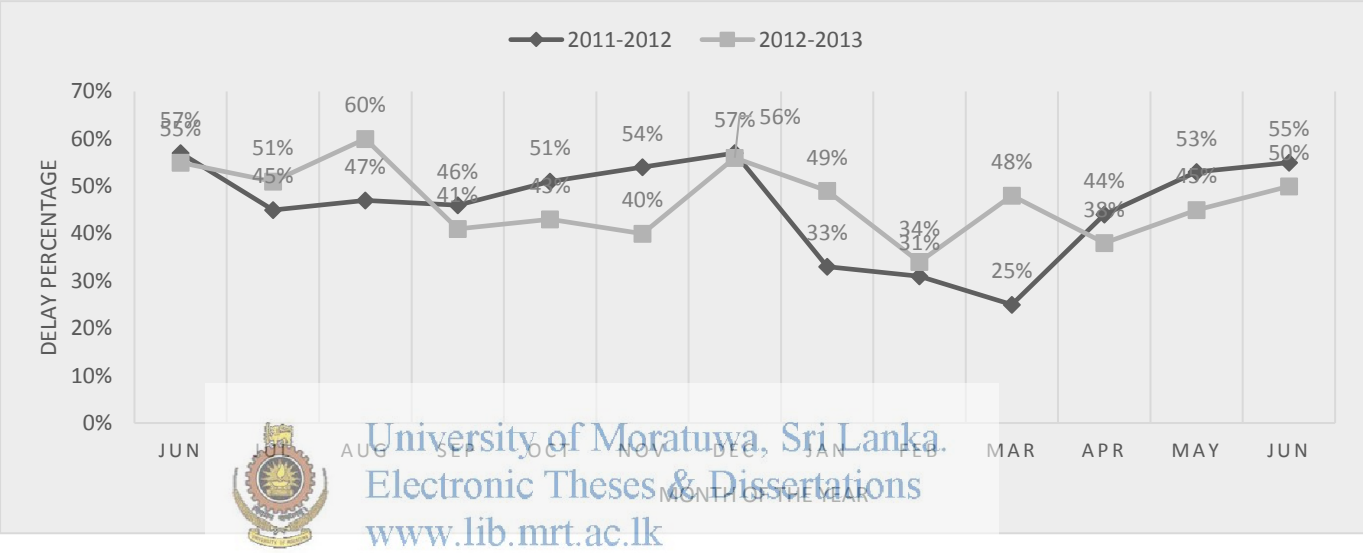


Figure 4.1: Annual Flight Departure Delay Percentages

Then, the total delays by category was calculated as per the table 4.2 summary of the departure delays.

Then calculated the average number of delays per year, average number of delays per month, and average number of delays per day. Finally the average number of delay percentages per day were calculated based on the average number of total fight departures per day.

It was ignored the average number of delays per day is equal to zero. The delay categories such as commercial and commercial revenue identified as the categories that can be affected the revenue of the airline. Therefore the reasons of those categories can't be controlled. The delay reasons for airport services will be covered under the airport facilities and it is hardly difficult to control the weather delay reasons. Therefore finally, it was identifies four main delay categories as critical such as technical, air traffic control, airport facilities and unavoidable.

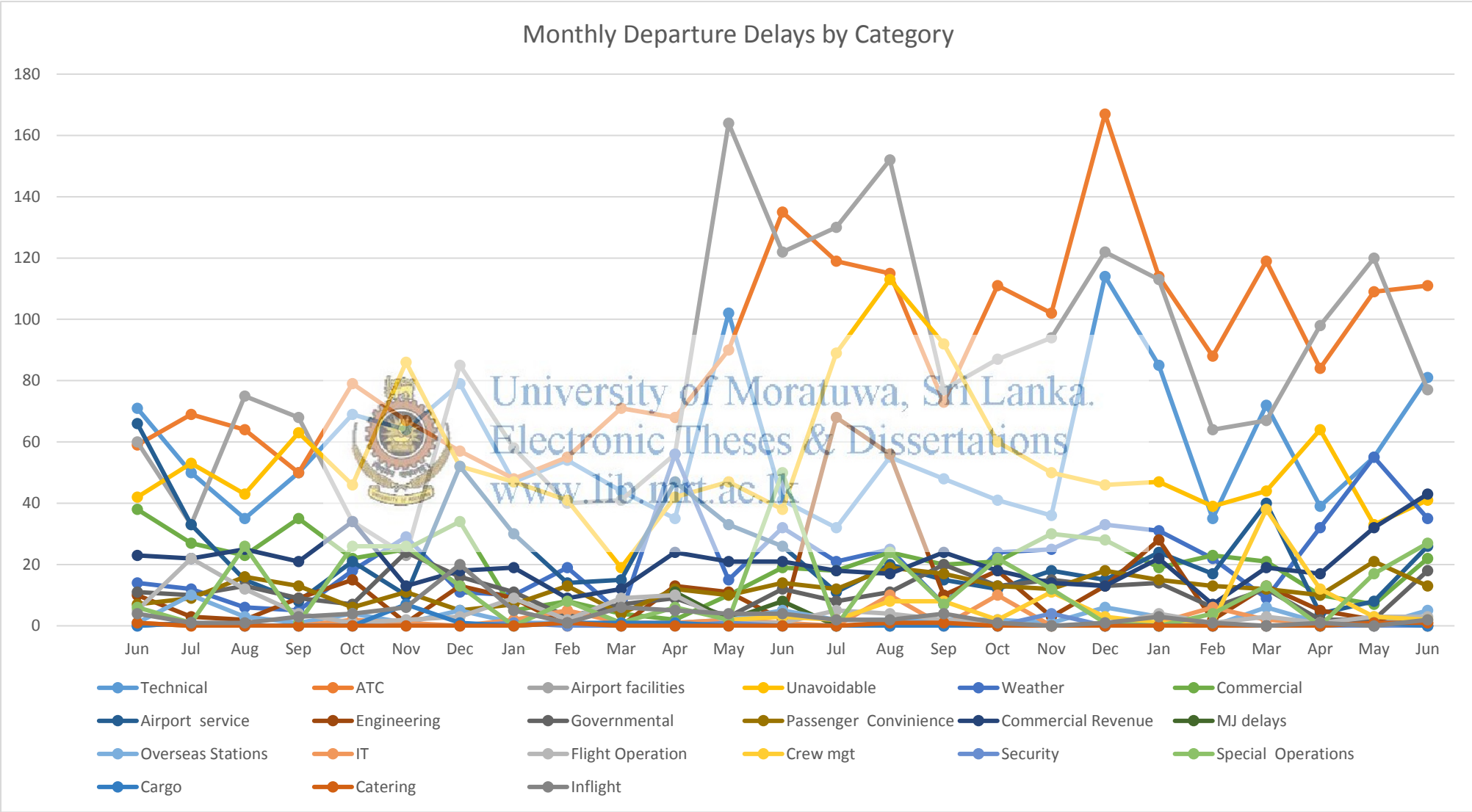


Figure 4.2: Flight Departure Delays by Category

Table 4.1: Monthly wise Number of Departure Delays by Delay Categories

Year	2011							2012												2013					
DELAY CATEGORY	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Technical	71	50	35	50	69	***64***	79	47	***54***	44	35	102	41	32	***55***	48	41	36	114	85	35	72	39	55	81
ATC	59	69	64	50	79	67	57	48	55	71	68	***90***	135	119	115	73	111	***102***	167	114	***88***	119	84	109	111
Airport facilities	60	33	75	68	34	23	***85***	58	40	41	56	164	122	130	152	***77***	***87***	94	122	113	64	67	98	120	77
Unavoidable	42	***53***	43	63	46	86	***52***	47	41	19	42	47	38	89	113	92	***60***	50	46	47	39	44	64	33	41
Weather	14	12	6	5	18	29	11	10	19	4	56	15	32	21	25	7	24	25	33	31	22	9	32	55	35
Commercial	38	27	23	35	22	25	34	5	8	4	2	10	19	18	24	20	21	30	28	19	23	21	10	7	22
Airport service	66	33	15	8	21	10	52	30	14	15	47	33	26	11	20	15	12	18	15	24	17	40	4	8	26
Engineering	10	3	2	9	15	1	13	9	0	0	13	11	2	68	56	10	18	3	13	28	2	13	5	2	1
Governmental	11	10	13	9	7	24	16	11	3	7	9	3	12	8	11	20	13	15	13	14	6	12	2	2	18
Passenger Convenience	7	9	16	13	6	11	5	7	13	4	12	10	14	12	19	17	13	12	18	15	13	12	10	21	13
Commercial Revenue	23	22	25	21	34	13	18	19	9	12	24	21	21	18	17	24	18	14	13	22	7	19	17	32	43

MJ delays											11	2	8	0	0	1	0	0	0	0	0	0	0	0	0
Overseas Stations	1	10	3	1	4	1	5	1	1	0	1	2	5	2	2	2	2	1	6	3	0	6	1	0	5
IT	1	0	0	0	2	1	0	2	5	1	1	2	1	0	10	0	10	0	0	1	6	2	1	0	0
Flight Operation	5	22	12	4	1	2	3	9	2	9	10	1	1	5	4	2	1	0	0	4	1	3	1	3	3
Crew mgt												2	3	2	8	8	2	11	3	1	1	38	12	3	2
Security	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0
Special Operations	6	1	26	1	26	26	13	0	8	1	6	2	50	0	24	7	22	12	1	0	4	13	0	17	27
Cargo	0	1	0	0	0	2	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Catering	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1
Inflight	4	1	1	3	4	6	20	5	1	6	5	4	4	2	2	4	1	0	1	3	1	0	1	0	2
Total Departures	**738**	**793**	**763**	**741**	**759**	**728**	**821**	**933**	**877**	**940**	**911**	**991**	**968**	**1047**	**1097**	**1034**	**1059**	**1059**	**1059**	**1072**	**961**	**1012**	**992**	**1036**	**1010**

The arithmetic mean value = Σ total no of departure delays / Σ total departures, and this will closely equal to the average value (Average number of delays/ total departures per day *100)

The following figure 4.3 shows the variance and the mean value for Technical Delay Category.

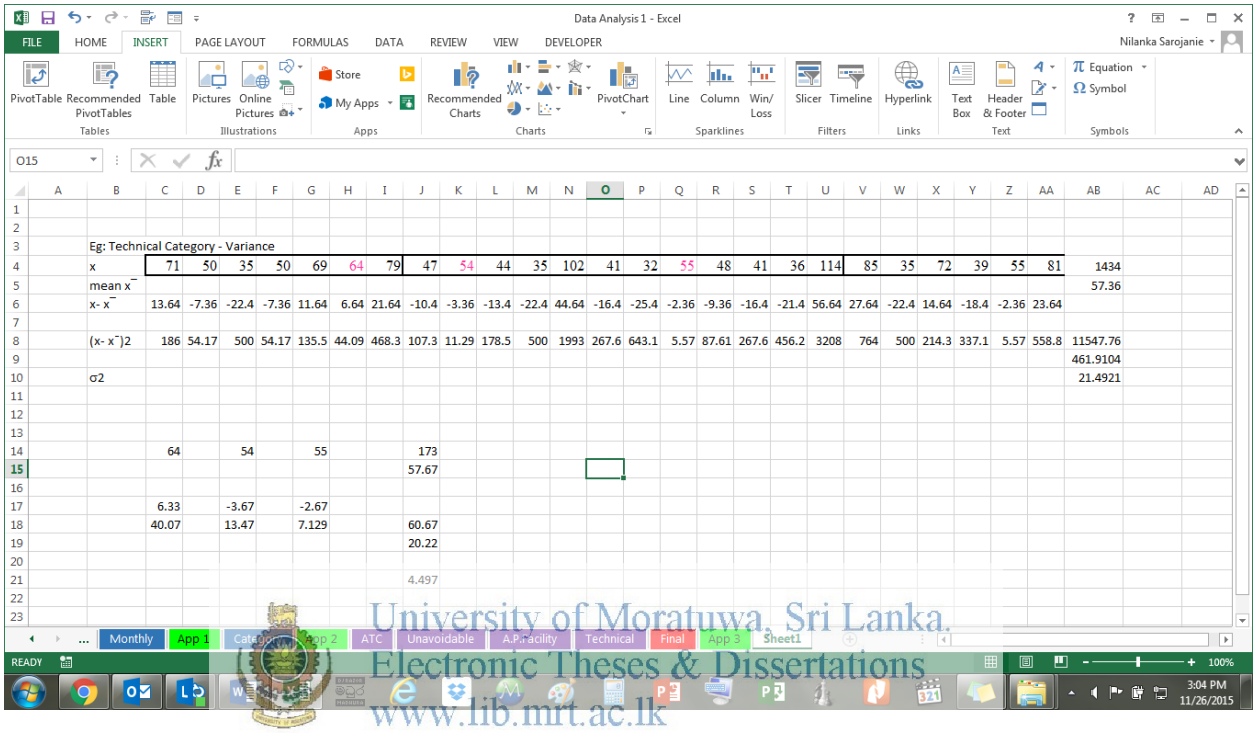


Figure 4.3: Variance and the mean value for Technical Delay Category

After identifying the critical departure delay categories, the sample was selected based on the arithmetic mean value of delays per month. As an example the arithmetic mean value of delays per month for technical category is 60 (table 4.2). The clusters were selected with the representation of arithmetic mean value of delays per month as November 2011, February 2012 and August 2012 and the values are 64, 54 and 55 (Table 4.1).

Table 4.2: Summary of number of Departure Delay Percentages

YEAR / DELAY CATEGORY	**Total number of delays by category**	**Avg no of delays per year**	**Avg no of delays per month**	**Avg no of delays per day**	**Avg delay % per day**
Technical	1434	717	**60**	**2**	**6%**
ATC	2224	1112	**93**	**3**	**9%**
Airport Facilities	2060	1030	**86**	**3**	**9%**
Unavoidable	1337	669	**56**	**2**	**6%**
Weather	550	275	23	1	2%
Commercial	495	248	21	1	2%
Airport Services	580	290	24	1	2%
Engineering	307	154	13	0	1%
Governmental	269	135	11	0	1%
Pax Convenience	302	151	13	0	1%
Commercial Revenue	506	253	21	1	2%
MJ Delays	22	11	1	0	0%
Overseas Stations	65	33	3	0	0%
IT	46	23	2	0	0%
Flight Operations	108	54	5	0	0%
Crew Mgt	96	48	4	0	0%
Security	7	4	0	0	0%
Special Operations	293	147	12	0	1%
Cargo	13	7	1	0	0%
Catering	6	3	0	0	0%
Inflight	81	41	3	0	0%
Total Departures	23401	11701	975	33	

Using the above values, it was considered the each delay of above clusters and those were entered to separate sheet with the details of Year, Month, Date, Flight number, delayed time more than 15 min, reasons for delays, and calculated the number of delay flights per month, total delayed time per month and the arithmetic mean delay time per flight for each critical categories as follows (Table 4.3). The departure delay times for each category can be shown in histograms as follows.

Table 4.3: Average Departure Delay times per Departure Flight

Category	**Delay time per flight (hrs.)**
Technical	1.22
Unavoidable	0.34
Airport Facility	0.16
ATC	0.10

The table 4.3 shows the average departure delay times per departure flight.

Since the average values are represented the whole set of data, the values may be differ from the majority due to the high end points also included. The following Scatter plot diagrams display the values of delay times for each departing flight for whole set of data.

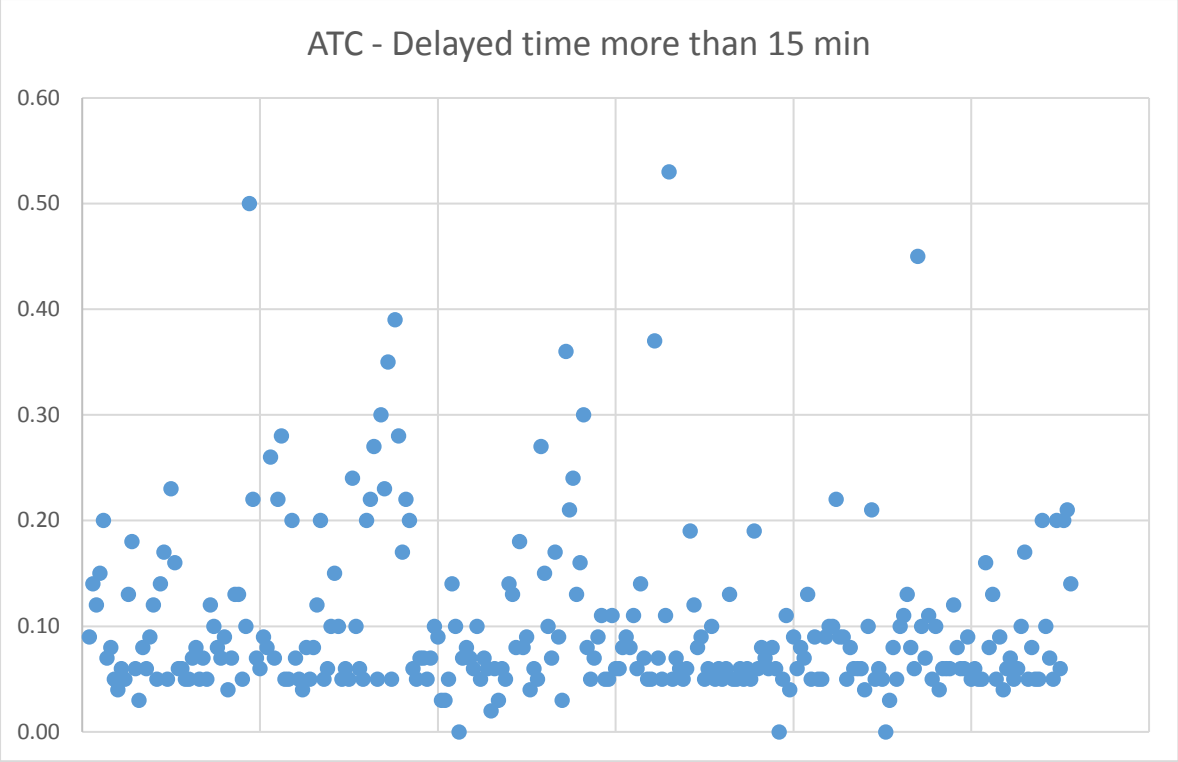


Figure 4.4: ATC Departure Delays Scatter plot

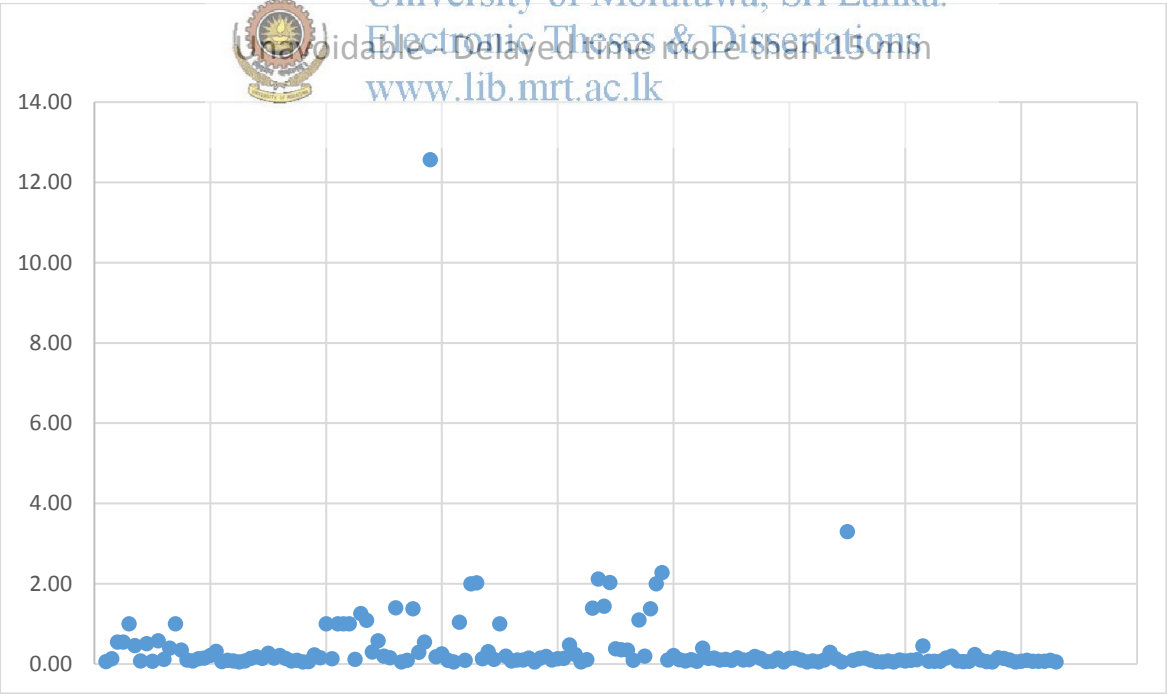


Figure 4.5: Unavoidable Departure Delays Scatter plot

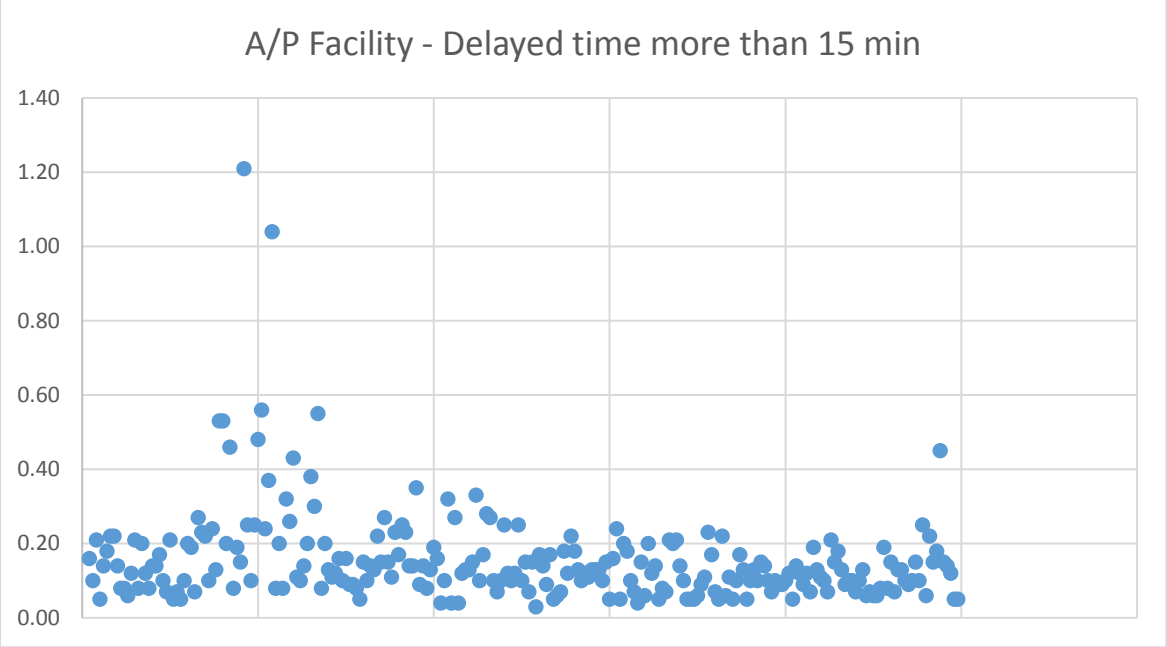


Figure 4.6: A/P Facility Departure Delays Scatter plot

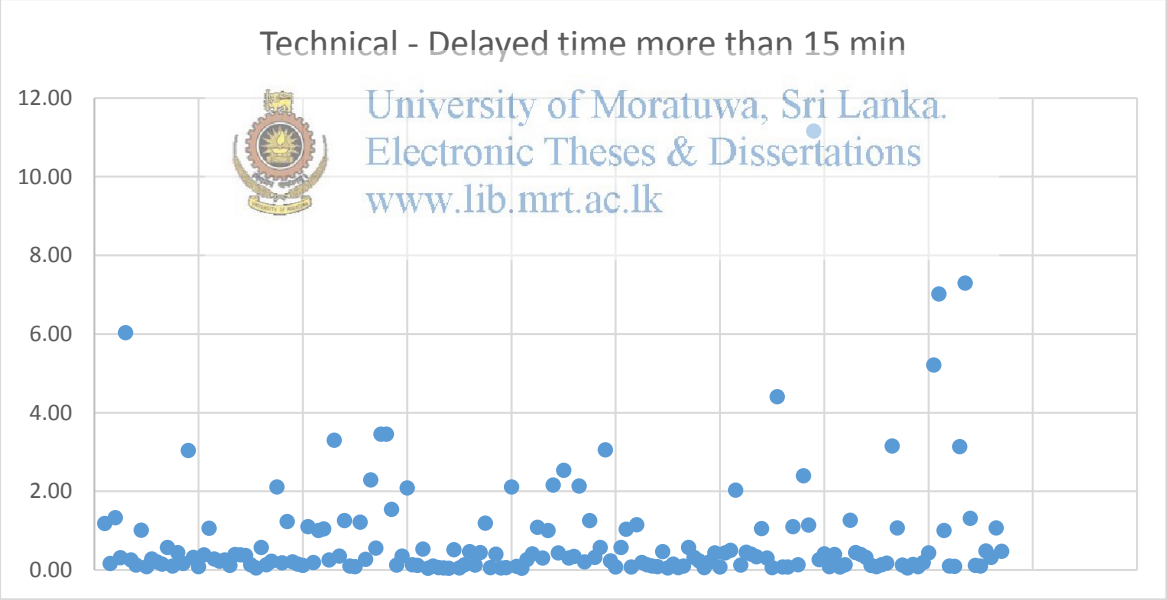


Figure 4.7: Technical Departure Delays Scatter plot

The average departure delay time per flight are shown in table 4.3 and it was calculated the number of flight delays of each delay reason under each critical categories. It is shown in the table 4.4.

Table 4.4: Summary of Delay Reasons

Delay Category	Avg Del time per Flight	Reason	No. of delays	Root causes
ATC	0.1	A/C Rotation	51	Long taxi time of arrival A/C s
				Delaying of other A/C s
				ATC problems
		Ground Movement Congestion	173	Awaiting pushback
		Last minute Bay Change	1	Last minute Bay Change
		Late Reporting of Crew	3	Other A/C rotations
				Long taxi time of arrival A/C s
		T/R Passenger & Baggage	47	Long taxi in time
				Long taxi out time
				Multiple taxies
Unavoidable	0.34	A/C Rotation	27	Offload Claus tropic Passengers
				Locating of Missing Transfer Passengers
				Medical emergency
				Offload gate no show passengers
				ATC delay in MLE
				A/C blocking taxiway
				Security
		Late engine start up	6	Additional time taken
				Tow tug breakdown
		Bird Strikes and Foreign Objects	4	Bird Strikes
				Foreign Objects
		Late completion of boarding	10	Equipment failure
				Boarding Delay
				FMC breakdown
				Loading and unloading delay due to FMC breakdown
		Late departure clearance	14	Offloading Passenger due to no show
				Runway closure MLE
				Maintain Arrival Slot
		Late reporting	13	Late reporting of Cabin Crew
				Late reporting of Captain
				Crew due to Runway closure MLE
		Offloading Passenger and Baggage	54	Intoxicated Passenger
				Missing of passengers
				Offloading Passenger due to no show
		Other	3	Late closure of Door
				Late receiving of load sheet
				Late closure of check in counter - Visa clarifications
		Rectifications	6	Discrepancy btw Load shtt & cockpit reading
				Passenger step breakdown while moving
				Seating issue rectification
				DCS system failure
				Seating discrepancies due to A/C change
				Technical issue rectification by Captain
		Route changes	3	A/C change
				waiting for SPML
		T/R Passenger & Baggage	14	Single Runway operation in SIN
				Offloading gate no show passengers
				Runway closure MLE
				detained by security for carrying liquids
				T/R Passenger & Baggage
		Transfer Passenger and Baggage	11	Medical emergency
				Transfer Passenger and Baggage
A/P Facility	0.16	A/C Rotation	32	Late completion of loading
				Closure of check in counters
				Congestion at baggage scanning area
				unavailability of boarding gates
				Congestion at multiple bay
				Runway closure MLE
				Runway closure BOM
				Runway closure CMB
				Congestion at the gate
				Runways closure COK
				Intermittent belt breakdown
				Late completion of boarding

				Security check
		Closure of Check in counters	7	Congestion at checking area
				Congestion at multiple bay
		Congestion at immigration	13	Congestion at immigration
		Late closure of check in counters	2	Congestion at checking area
				Congestion due multiple departures
		Late completion of boarding loading	130	Congestion at checking area
				Congestion at boarding gates
				Congestion due multiple departures
				Late completion of loading
				Heavy Baggage scanning
				Congestion at baggage scanning area
				Congestion at departure gates
				Congestion at multiple bay
				Power failure
				Congestion at rapid ex
				Bay change & taxi changes
		Late departure clearance	43	MLE Runway closure
				Runway closure COK
		Other	7	Awaiting cabin crew due Runway closure BOM
				Late completion of cleaning
				Late boarding cabin crew due to Unavailability of coaches
				Late minute bay change
				Avoid Haj terminal congestion
				Late arrival bridge operator
				Late reporting of bridge operator
		T/R Passenger & Baggage	14	Runway closure CMB
				Intermittent belt breakdown
				Late completion of boarding
				Closure of check in counters
				Congestion at baggage scanning area
				Congestion at multiple bay
				Runway closure BOM
				Last minute A/C change due ALA defect
				Cabin emergency exit unserviceable
		A/C change	8	Water leak
				Weather radar unserviceable
				Security pin of bulk cargo door broken
				Other
		A/C rotation	31	Unavailability of A/C
				Insufficient Ground time
				Unavailability of ADA
				A/C change
				Other
		Avionics fault	2	Avionics skin air inlet valve replace
				Avionics fault
		Awaiting	8	Pax transfer due unavailability of A/C
				Passengers due Unavailability of A/C
				Tec crew due Unavailability of A/C
				Awaiting T/R of passengers and baggage
				instructions for Over Weight
Technical	0.81			Operating Captain due Arrival A/C delay
				Crew duty time limitation
		Cabin defect	2	Fixing stickers in the cabin
				Cabin defect
		Door problems	6	Cargo door seal replacement
				Bulk door indication
				Security pin of bulk cargo door broken
				Door slide bottle low pressure
				Rear CGO hold unable to close
				Door lock unserviceable
		Engine fault	9	Engine valve fault
				Engine fault rectification
				Engine over heat
				Engine fluctuation rectification
				Engine fuel leak rectification
				Replacing of engine
				Engine oil leak
		Full G/S provision due APU failure	7	APU unserviceable
		Insufficient Ground time	3	Ovens unserviceable

				Unavailability of A/C
				Engine change & actuator replacement
		Late boarding and loading	5	Late completion of loading
				Late boarding clearance due Wheel Change
				Late receiving of T/R baggage
		Maintenance	8	Maintenance Check
				Late release of A/C
				Scheduled maintenance
				Sked maintenance
				Schedule Maintenance -Engineering requirement
				Unscheduled maintenance
		Offloading of Passenger and Baggage	2	In plane system inoperative
				Other
		Other	5	Late positioning of A/C
				LIAC
				Clarifying T/log for engineering
				FMGS data base reloading
				Delivering boarding cards to transfer pax
		Rectification	38	Change water filter
				Fuel leak rectification
				Alternative break unserviceable
				Oxygen leak rectification
				Landing gear door actuator replacement
				PA system failure
				APU fire bottle replacement
				GDM shortage , Box unserviceable
				Accumulator replacement
				Trim deactivation
				Main pump fault & ADD raised
				Engine oil leak rectification
				Radar System failure
				EPR mode fault rectification
				Multiple defects
				IR2 fault
				Flap fault
				CIDS fault rectification
				Waste tank indication fault
				Break unit rectification
				Cockpit PA system failure
				Seat inoperative
				Compressor fault
				Seat recalibration
				Brake residual pressure
				Fuel pump fault
				IR fault
				IRS alignment defect
				Seat hydro lock replaced
				Rudder trim fault rectification
				Green hydraulic leak rectification
				Resetting of hot Air message on status page
		T/R Passenger and Baggage	31	Arrival A/C delay
				Water leak
				Auto pilot inoperative
				Engine oil leak rectification
				Radar System failure
				F/O side PITOT heat fault
				Flap fault rectification
				Arrival A/C delay
				Manual loading & unloading
				Scheduled maintenance
				Unavailability of A/C
		Transfer of Passenger and Baggage	3	Unavailability of A/C
				Late positioning of A/C
		Weather Radar Failure	3	system inoperative
				system inoperative
				Weather radar unserviceable
		Wheel changes	2	Wheel changes

4.2 Primary data analysis – Data Analysis 2nd phase

Primary data was collected using a questionnaire and the questionnaire was prepared based on the information of the findings of secondary data analysis, (see table 4.4). The questions were prepared to get the opinion of industry personnel such as Pilots, Air Traffic Controllers, Airline operation personnel, Civil Aviation Inspectors and etc. It was considered the opinion on the reasons that can be controlled and the policy statements.

Based on the responses for the questionnaire, the data was organized to a worksheet. All the responses were considered for the analysis. The findings of the analysis can be shown as follows.

Table 4.5: Responses for delay reasons – ATC

Area	Delay Reasons	Responses
Q1	1. A/C Rotation	50.0%
	2. Ground movement Congestion	75.0%
	3. Last Minute Bay Change	37.5%
	4. Late reporting of crew	75.0%
	5. T/R Passenger and baggage	62.5%

Under the ATC category (table 4.5), the second column shows the responses for delay and the third column shows the responses/opinions on the reasons that can be controlled. As an example: it can be identified the most possible reason that can be controlled based on the responses is “Ground movement of Congestion”, and the next possible reason is “Late reporting of crew”.

Table 4.6: Responses for Statements - ATC

Qs	Answer	Responded Percentage
Q1.1. Introducing or changing existing policy can be controlled the ground movement congestion	1. Totally Agree	12.5%
	2. Agree	37.5%
	3. Don’t know	37.5%
	4. Disagree	0.0%
	5. Totally Disagree	12.5%
Q1.2. Arrival/ Departure taxi time can be maintained	1. Totally Agree	0.0%
	2. Agree	50.0%
	3. Don’t know	12.5%
	4. Disagree	25.0%

	5. Totally Disagree	12.5%
Q1.3. Internal organizational policy and regulations can mitigate late reporting	1. Totally Agree	25.0%
	2. Agree	37.5%
	3. Don't know	12.5%
	4. Disagree	0.0%
	5. Totally Disagree	25.0%
Q1.4. New policy for transfer passenger and baggage timings	1. Totally Agree	62.5%
	2. Agree	0.0%
	3. Don't know	25.0%
	4. Disagree	0.0%
	5. Totally Disagree	12.5%

The table 4.6 shows the professionals opinions on proposed policy statements. 50% responders are agree with the statement 1.1 "Introducing or changing existing policy can be controlled the ground movement congestion", 50% responders agree with the statement 1.2 "Arrival/ Departure taxi time can be maintained", 62.5% responders agree with the statement 1.3 "Internal organizational policy and regulations can mitigate late reporting" and 62.5% responders agree with the statement 1.4 "New policy for transfer passenger and baggage timings".

Table 4.7: Responses for delay reasons – Unavoidable

Area	Delay reasons	Responses
Q2	1. A/C rotation	75.0%
	2. Late engine start up	37.5%
	3. Bird Strikes and foreign objects	37.5%
	4. Late completion of boarding	75.0%
	5. Late departure clearance	25.0%
	6. Offloading passenger and baggage	75.0%
	7. Late reporting	62.5%
	8. Technical rectifications	50.0%
	9. Transfer passenger and baggage	100.0%
	10. Route changes	25.0%

Under the Unavoidable category (table 4.7), the second column shows the responses for delay and the third column shows the responses/opinions on the reasons that can be controlled. As an example: it can be identified the most possible reason that can be controlled based on the responses is "Transfer passenger and baggage", and the next possible reason is "A/C rotating and Offloading passenger and baggage".

Table 4.8: Responses for Statements – Unavoidable

Qs	Answer	Responded Percentage
Q2.1. Providing infrastructure and training facilities will help to reduce emergencies	1. Totally Agree	25.0%
	2. Agree	37.5%
	3. Don't know	25.0%
	4. Disagree	12.5%
	5. Totally Disagree	0.0%
Q2.2. Additional maintenance will reduce engine start up time delays	1. Totally Agree	25.0%
	2. Agree	37.5%
	3. Don't know	12.5%
	4. Disagree	12.5%
	5. Totally Disagree	12.5%
Q2.3. Increasing maintenance will avoid equipment failures	1. Totally Agree	25.0%
	2. Agree	25.0%
	3. Don't know	25.0%
	4. Disagree	12.5%
	5. Totally Disagree	12.5%
Q2.4. Trainings and experiences will help to maintenance personnel	1. Totally Agree	37.5%
	2. Agree	12.5%
	3. Don't know	12.5%
	4. Disagree	25.0%
	5. Totally Disagree	12.5%
Q2.5. New policy on intoxicated passengers will reduces delays	1. Totally Agree	25.0%
	2. Agree	25.0%
	3. Don't know	25.0%
	4. Disagree	0.0%
	5. Totally Disagree	25.0%
Q2.6. New policy to avoid offloading due to no show	1. Totally Agree	25.0%
	2. Agree	50.0%
	3. Don't know	12.5%
	4. Disagree	0.0%
	5. Totally Disagree	12.5%

The table 4.8 shows the professionals opinions on proposed policy statements. 62.5% responders are agree with the statement 2.1 "Providing infrastructure and training facilities will help to reduce emergencies", 62.5% responders agree with the statement 2.2 "Additional maintenance will reduce engine start up time delays", 50% responders agree with the statement 2.3 "Increasing maintenance will avoid equipment failures", 50% responders agree with the statement 2.4 "Trainings and experiences will help to maintenance personnel". 50% responders

agree with the statement 2.5 “New policy on intoxicated passengers will reduces delays” and 50% responders agree with the statement 2.6 “New policy to avoid offloading due to no show”.

Table 4.9: Responses for delay reasons – A/P Facility

Area	Answer	Responses
Q3	1. Security checks and searches	87.5%
	2. A/C rotation due to congestion in some areas	62.5%
	3. Closure of check in counters	75.0%
	4. Late completion of boarding	87.5%
	5. Late departure clearance	37.5%
	6. T/R passenger and baggage	75.0%

Under the A/P Facility category (table 4.9), the second column shows the responses for delay and the third column shows the responses/opinions on the reasons that can be controlled. As an example: it can be identified the most possible reason that can be controlled based on the responses is “Security checks and searches”, and the next possible reason is “Late completion of boarding”.

Table 4.10: Responses for delay reasons – Technical

Area	Answer	Responses
Q4	1. A/C change due to technical problems	62.5%
	2. A/C rotation due to insufficient resources	87.5%
	3. Avionics faults	62.5%
	4. Awaiting of passengers, crew, ops captain	62.5%
	5. Cabin defects	62.5%
	6. Full G/S provision due to APU failure	50.0%
	7. Insufficient ground time	62.5%

Under the Technical category (table 4.10), the second column shows the responses for delay and the third column shows the responses/opinions on the reasons that can be controlled. As an example: it can be identified the most possible reason that can be controlled based on the responses is “A/C rotation due to insufficient resources”.

Table 4.11: Responses for Statements – Technical

Qs	Answer	Responded Percentage
Q4.1. Regular and periodic maintenance can reduce technical errors and failures	1. Totally Agree	62.5%
	2. Agree	0.0%
	3. Don't know	0.0%
	4. Disagree	25.0%
	5. Totally Disagree	12.5%
Q4.2. Scheduled maintenance will help to manage operation time	1. Totally Agree	62.5%
	2. Agree	25.0%
	3. Don't know	12.5%
	4. Disagree	25.0%
	5. Totally Disagree	0.0%
Q4.3. Unscheduled maintenance will increase the delay	1. Totally Agree	62.5%
	2. Agree	25.0%
	3. Don't know	0.0%
	4. Disagree	0.0%
	5. Totally Disagree	12.5%
Q4.4. Internal QC and QA on safety and security is a must	1. Totally Agree	75.0%
	2. Agree	12.5%
	3. Don't know	0.0%
	4. Disagree	0.0%
	5. Totally Disagree	12.5%
Q4.5. Policy on recruit maintenance professionals will help to manage emergencies	1. Totally Agree	75.0%
	2. Agree	12.5%
	3. Don't know	0.0%
	4. Disagree	0.0%
	5. Totally Disagree	12.5%

The table 4.11 shows the professionals opinions on proposed policy statements. 62.5% responders are agree with the statement 2.1 "Regular and periodic maintenance can reduce technical errors and failures", 87.5% responders agree with the statement 4.2 "Scheduled maintenance will help to manage operation time", 87.5% responders agree with the statement 4.3 "Unscheduled maintenance will increase the delay", 87.5% responders agree with the statement 4.4 "Internal QC and QA on safety and security is a must" and 87.5% responders agree with the statement 4.5 "Policy on recruit maintenance professionals will help to manage emergencies".

Based on the responses an assumption was made to accept the responses. The acceptance of the responses for each Categories can be shown in the column "Eligibility" of each tables, from Table 4.12 to Table 4.18.

Assumption: More than 50% responses received for the answer 1 are considered as the reasons that can be controlled. More than 50% responses received for both the answer 1 and 2 are considered as the statements that can be accepted.

The justification of the assumption can be described as follows.

Mathematically, the probability that an event will occur is expressed as a number between 0 and 1. In here the responses can agree or disagree with the answers. The responses for the statements are independent events. Those are not affected by previous or any other.

Occasionally, the probability of event A is represented by P (A). If P (A) equals zero, event A will almost definitely not occur. If P (A) is close to zero, there is only a small chance that event A will occur. If P (A) equals 0.5, there is a 50-50 chance that event A will occur. If P (A) is close to one, there is a strong chance that event A will occur. If P (A) equals one, event A will almost definitely occur. Therefore more than 50% of the responses were accepted in this situation.

The acceptance of the responses for each Categories can be shown in the column "Eligibility of each tables, Table 4.6 to Table 4.11.

Table 4.12: Possible reasons - ATC

Area	Answer	Responses	Eligibility
Q1	1	50.0%	No
	2	75.0%	Yes
	3	37.5%	No
	4	75.0%	Yes
	5	62.5%	Yes

According to the assumption, Ground movement Congestion, Late reporting of crew, T/R Passenger and baggage can be identified as the most possible reasons that can be controlled under the Air Traffic Control Departure Delay Category.

Table 4.13: Selected Statements - ATC

Qs	Answer	Responded Percentage	Summation of 1 & 2	Eligibility
Q1.1	1	12.5%	50.0%	No
	2	37.5%		
	3	37.5%		
	4	0.0%		
	5	12.5%		
Q1.2	1	0.0%	50.0%	No
	2	50.0%		
	3	12.5%		
	4	25.0%		
	5	12.5%		
Q1.3	1	25.0%	62.5%	Yes
	2	37.5%		
	3	12.5%		
	4	0.0%		
	5	25.0%		
Q1.4	1	62.5%	62.5%	Yes
	2	0.0%		
	3	25.0%		
	4	0.0%		
	5	12.5%		

The third and fourth policy statements such as "Internal organizational policy and regulations can mitigate late reporting" and "New policy for transfer passenger and baggage timings" can be accepted based on the responses.

Table 4.14: Possible reasons – Unavoidable

Area	Answer	Responses	Eligibility
Q2	1	75.0%	Yes
	2	37.5%	No
	3	37.5%	No
	4	75.0%	Yes
	5	25.0%	No
	6	75.0%	Yes
	7	62.5%	Yes
	8	50.0%	No
	9	100.0%	Yes
	10	25.0%	No

A/C rotation, Late completion of boarding, Offloading passenger and baggage, Late reporting of crew and Transfer passenger and baggage can be identified as the most possible reasons that can be controlled under the Unavoidable Departure Delay Category.

Table 4.15: Selected statements – Unavoidable

Qs	Answer	Responded Percentage	Summation of 1 & 2	Eligibility
Q2.1	2	25.0%	62.5%	Yes
	3	37.5%		
	2	25.0%		
	1	12.5%		
	0	0.0%		
Q2.2	2	25.0%	62.5%	Yes
	3	37.5%		
	1	12.5%		
	1	12.5%		
	1	12.5%		
Q2.3	2	25.0%	50.0 %	No
	2	25.0%		
	2	25.0%		
	1	12.5%		
	1	12.5%		
Q2.4	3	37.5%	50.0 %	No
	1	12.5%		
	1	12.5%		
	2	25.0%		
	1	12.5%		
Q2.5	2	25.0%	50.0 %	No
	2	25.0%		
	2	25.0%		
	0	0.0%		
	2	25.0%		
Q2.6	2	25.0%	50.0 %	No
	4	50.0%		
	1	12.5%		
	0	0.0%		
	1	12.5%		

The first and second policy statements such as “Providing infrastructure and training facilities will help to reduce emergencies“ and “Additional maintenance will reduce engine start up time delays” can be accepted based on the responses.

Table 4.16: Possible reasons - Airport Facilities

Area	Answer	Responses	Eligibility
Q3	1	87.5%	Yes
	2	62.5%	Yes
	3	75.0%	Yes
	4	87.5%	Yes
	5	37.5%	No
	6	75.0%	Yes

Security checks and searches, A/C rotation due to congestion in some areas, Closure of check in counters, Late completion of boarding and T/R passenger and baggage can be identified as the most possible reasons that can be controlled under the Airport Facility Departure Delay Category.

Table 4.17: Possible reasons - Technical

Area	Answer	Responses	Eligibility
Q4	1	62.5%	Yes
	2	87.5%	Yes
	3	62.5%	Yes
	4	62.5%	Yes
	5	62.5%	Yes
	6	50.0%	No
	7	62.5%	Yes

A/C change due to technical problems, A/C rotation due to insufficient resources, Avionics faults, Awaiting of passengers, crew, operating captain, Cabin defects and insufficient ground time can be identified as the most possible reasons that can be controlled under the Technical Departure Delay Category.

Table 4.18: Selected statements - Technical

Qs	Answer	Responded Percentage	Summation of 1 & 2	Eligibility
Q4.1	1	62.5%	62.5%	Yes
	2	0.0%		
	3	0.0%		
	4	25.0%		
	5	12.5%		
Q4.2	1	62.5%	87.5%	Yes
	2	25.0%		

	3	12.5%		
	4	25.0%		
	5	0.0%		
Q4.3	1	62.5%	87.5%	Yes
	2	25.0%		
	3	0.0%		
	4	0.0%		
	5	12.5%		
Q4.4	1	75.0%	87.5%	Yes
	2	12.5%		
	3	0.0%		
	4	0.0%		
	5	12.5%		
Q4.5	1	75.0%	87.5%	Yes
	2	12.5%		
	3	0.0%		
	4	0.0%		
	5	12.5%		

All of the policy statements can be identified under Technical Departure Delay Category due to all the statements have got more than 50% responses.

CHAPTER 05: CONCLUSION & RECOMMENDATION

Punctuality is not only a quality issue but it reduces costs. Punctuality differentiates airlines from their competitors and it is a leader ship challenge of the airline. Punctuality is a powerful performance indicator that drives total operational excellence. When an airline runs a punctual operation with high service quality, most other indicators are likely to be in the green.

Based on the findings of the primary data collection from the questionnaire, it can be summarized all the possible reasons that can be controlled under each departure flight delay categories.

- ATC category - Ground movements congestion, Late Reporting of crew, Transfer passenger and baggage handling
- Unavoidable category - A/C rotation, Late completion of boarding, offloading passenger and baggage, late reporting of Transfer passenger and baggage
- A/P facilities category - Security checks and searches, A/C rotation, Late completion of boarding, Closure of check in counters, late reporting and transfer passenger and baggage
- Technical category - A/C change due to technical problems, A/C rotation due to insufficient resources, Avionics faults, Awaiting for passengers, crew and operating staff, Cabin defects, Full G/S provision due to APU failure and insufficient ground time

Based on the findings of the primary data analysis, the professionals have given the opinions on the following statements. Therefore it can be recommended that the following statements as the areas to develop policy and regulations to control, minimize and absorb the number of departure delays and departure delay time per flight.

- Internal organizational policy and regulations can mitigate the late reporting of crew
- New policy for transfer passenger and baggage timings
- Providing infrastructure facilities and training programmes
- Additional maintenance will reduce engine start up time delays
- Policy on recruitment of maintenance professionals will help to manage emergencies
- Regular and periodic maintenance can reduce technical errors and failures
- Scheduled maintenance will help to manage operation time
- Unscheduled maintenance will increase the delay

- Internal QC and QA on safety and security is a must

Here, it was only considered the Srilankan Airlines departure flight delays departing from Bandaranaike International Airport. Since, now it is in the process of implementing Civil Aviation Facilitation, the passenger facilitation at airports will be increase. Then the total departure delay times will be reduced. Most of the aircrafts belong to Srilankan airlines the national carrier of Sri Lanka are old now. But since there were arrival of new aircrafts recently, the departure delays such as technical errors and the A/C rotation will be reduced. There are lot of passenger services due to achievement of Srilankan Airlines from 2014. It was the joining one world global alliance on 1st May 2014.

It was not considered the cultural factors, society and social factors, environmental factors and political situations of the country. The Management of the Srilankan airlines has changed time to time due to the changes of the political situations in the country.

As further studies, it is necessary to incorporate the above external factors with the findings of this study to draft policies and regulations to control the number of departure delays and the departure delay times.

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APPENDICES

Appendix A : Definitions

Maximum delay - the longest delay assigned to any one flight in the GDP;

Delay variability - the standard deviation of the carrier's average delay. A small value of delay variability means average delays are quite similar for all carriers, while a large value shows a dissimilarity among the carriers' average delay;

Airborne delay - the en route delay that will be incurred if all flights depart at their planned departure times.

Block time- time which is given from one destination to another, take off from A to land B

Transit time- after landing, transit the passengers and cargo from one aircraft to another and take off

Turnaround time- time taken by the aircraft at the airport to come back, from landing to take off

Transfer passenger and baggage- Passengers and baggage making direct connections between two different flights.

Terminal - The main building or group of buildings where the processing of commercial passengers and cargo, and the boarding of aircraft occurs

Person with disabilities – Any person whose mobility is reduced due to a physical incapacity (sensory or locomotors), an intellectual deficiency, age, illness or any other cause or disability when using air transport and whose situation needs special attention and the adaption to the person's needs of the services made available to all passengers.

Passenger area - All the ground space and facilities provided for passenger processing. This includes aprons, passenger buildings, vehicle parks and roads.

Movement Area – that part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the maneuvering area and the apron(s).

International Airport – Any airport designated by the Contracting State in whose territory it is situated as an airport of entry and departure for international air traffic, where formalities incident to customs, immigration, public health, animal and plant quarantine and similar procedures are carried out.

Disruptive/Intoxicated Passenger – A passenger who fails to respect the rules of conduct at an airport or on board an aircraft or to follow the instructions of the airport staff or crew members and thereby disturbs the good order and discipline at an airport or on board an aircraft.

Airside – The movement area of an airport, adjacent terrain and buildings or portions thereof, access to which is controlled.

Aircraft maintenance area - All the ground space and facilities provided for aircraft maintenance. This includes aprons, hangars, buildings and workshops, vehicle parks and roads associated therewith. Such an area is normally designated as a security restricted area.

Aircraft in flight - An aircraft from the moment when all its external doors are closed following embarkation until the moment when such doors are opened for disembarkation.

Aerodrome – A defined area in land or water associated with buildings, installations and equipment which is either wholly or partly used for take-off, landing and surface movement of aircraft.

Appendix B : Questionnaire

I, Nilanka Sarojanie, a student of M.Sc. in Transportation at University of Moratuwa am expecting your valuable ideas regarding Aircrafts delay in Sri Lanka. Aircrafts Delay is a crucial problem in today's aviation industry. Therefore the information collected will be used to identify the policy and Regulations for Mitigating Aircrafts departure delays in Sri Lanka.

Please complete this questionnaire by selecting the appropriate boxes and select the relevant fields. It will only take few minutes to complete and any information you provide will be completely anonymous and will be treated in the strictest confidence and used for study purpose only.

Questionnaire Instructions
Please complete the questionnaire according to your view as a representative of regulating authority / an airline / training school / airport or authority or an industry expert. Please send the form after filling. If you need any additional information concerning the questionnaire or assistance in filling the questionnaire, please do not hesitate to contact:
Sarojanie : 0715471264

e mail : sansarojanie@yahoo.com or sansarojanie@gmail.com

Please select the relevant fields/ Responsible area.

Profession

- ○ Engineer
- ○ Pilot
- ○ Inspector
- ○ Instructor
- ○ Consultant
- ○ Industry personnel
- ○ Educational Institute
- ○ Other

Responsible Area

- ◉ Flight Operations

- Cabin Safety
- ATC
- Aerodrome
- Air Navigation
- Security
- Legal
- Airport Facility
- Airworthiness
- Other

The main four delay categories are mentioned below. Rank 1 to 4 (1 as the highest and the 4 is the lowest). Delay Categories are "ATC", "Unavoidable", "A/P facilities" and "Technical".

(a) What is your order of ranking on "number of delays per day" ? Please list down. (Eg: 1 - ATC , 2 - Technical, ... etc)

1. ……..
2. ……..
3. ……..
4. ……..

(b) What is your order of ranking on "Delay time per flight" ? . Please list down. (Eg: 1 - ATC , 2 - Technical, ... etc)

1. ……..
2. ……..
3. ……..
4. ……..

1. ATC Category

The areas of reasons for the ATC category as follows. Please select the areas that can be controlled the departure delays with introducing new policies and regulations?

- A/C Rotation
- Ground Movement Congestion
- Last minute Bay Change
- Late Reporting of Crew
- T/R Passenger & Baggage

Please tick the following statements from 1.1 to 1.4 based on your views.

	1	2	3	4	5	
Totally Agree	○	○	○	○	○	Totally Disagree

1.1. Introduction/Changes in Policy on awaiting push back clearance can be controlled the ground movement congestion

1	2	3	4	5
○	○	○	○	○

1.2. Arrival/ departure taxi time should be maintained at a constant

1	2	3	4	5
○	○	○	○	○

1.3. Internal organizational policy and regulations can mitigate the problems on late reporting of operating crew and the technical crew

1	2	3	4	5
○	○	○	○	○

1.4. "Transfer passenger and baggage handling takes more time due to long taxi in time and long taxi out time and also multiple taxies". Introducing new policy and regulations can reduce these type of delays.

1	2	3	4	5
○	○	○	○	○

2. Unavoidable Category

The areas of reasons for the Unavoidable category as follows. Please select the areas that can be controlled the departure delays with introducing new policies and regulations?

- ☐ A/C Rotation
- ☐ Late engine start up
- ☐ Bird Strikes and Foreign Objects
- ☐ Late completion of boarding
- ☐ Late departure clearance
- ☐ Offloading Passenger and Baggage
- ☐ Late Reporting
- ☐ Technical rectifications
- ☐ Transfer Passenger and Baggage

☐ Route changes

Please tick the following statements from 2.1 to 2.6 based on your views.

	1	2	3	4	5	
Totally Agree	○	○	○	○	○	Totally Disagree

2.1. Emergency situations can't be controlled introducing new policies. But providing infrastructure and facilities and training programmes will help to reduce delay due to emergencies

1	2	3	4	5
○	○	○	○	○

2.2. Additional maintenance and availability of resources reduce the time consumption on engine start up

1	2	3	4	5
○	○	○	○	○

2.3. Increasing maintenance can avoid the equipment failure FMC breakdown and etc.

1	2	3	4	5
○	○	○	○	○

2.4. Providing training programmes and professional qualifications will help to maintain the availability of usable equipment without failure or breakdown

1	2	3	4	5
○	○	○	○	○

2.5. Introducing new policy can prohibit the policy on intoxicated passengers, on time arrival by passenger for boarding.

1	2	3	4	5
○	○	○	○	○

2.6. New policy can avoid the offloading passenger and baggage due to no show

1	2	3	4	5
○	○	○	○	○

3. Airport Facility Category

The areas of reasons for the A/P Facility category as follows. Please select the areas that can be controlled the departure delays with introducing new policies and regulations?

- ☐ Security checks and searches
- ☐ A/C rotation due to congestion in some areas
- ☐ Closure of check in counters
- ☐ Late completion of boarding
- ☐ Late departure clearance
- ☐ T/R passenger and baggage

4. Technical Category

The areas of reasons for the Technical category as follows. Please select the areas that can be controlled the departure delays with introducing new policies and regulations?

- ☐ A/C change due to technical problems
- ☐ A/C rotation due to insufficient resources
- ☐ Avionics faults
- ☐ Awaiting for passengers, crew, ops Capt.
- ☐ Cabin defects
- ☐ Full G/S provision due APU failure
- ☐ Insufficient Ground time

Please tick the following statements 4.1 to 4.5 based on your views.

	1	2	3	4	5	
Totally Agree	○	○	○	○	○	Totally Disagree

4.1. Regular maintenance and periodic maintenances can reduce the technical errors and failures

1	2	3	4	5
○	○	○	○	○

4.2. Scheduled maintenance will help to manage the time for operation of an aircraft

1	2	3	4	5
○	○	○	○	○

4.3. Unscheduled maintenance will increase the delay in operations of an aircraft

1	2	3	4	5
○	○	○	○	○

4.4. Internal Quality Control and Quality Assurances on safety and security before departure is a must.

1	2	3	4	5
○	○	○	○	○

4.5. Policy on recruit professionals regarding technical maintenances will help availability of human resource for emergencies or rectifications

1	2	3	4	5
○	○	○	○	○

Please submit the form after fill.

Submit