

Impact of Covid-19 Pandemic on Passenger Air Travel Demand to Sri Lanka

Mahekha DAHANAYAKA^a, Varuna ADIKARIWATTAGE^b

^{a,b} *Department of Transport & Logistics Management, University of Moratuwa, Katubedda, Sri Lanka*

^a*E-mail: mahekha15@gmail.com*

^b*E-mail: varunaa@uom.lk*

Abstract: The purpose of this research is to evaluate the impact of the Covid-19 pandemic on passenger air travel demand to Sri Lanka. The research addresses the impact on air travel demand and its recovery after being disrupted by global pandemics such as the Covid-19. The first two objectives are to identify the main demand drivers of air travel and air travel market segments to Sri Lanka. Then, to assess how the market segments have been influenced by Covid-19 through demand drivers. This research attempted to systematically integrate the available information such as regional level recovery forecasts given by organizations such as IATA, prior estimates of travel market segmentation and expert judgment on a market segment's potential to recover to derive an estimate of demand recovery at the level of individual travel market segment.

Keywords: Passenger air travel demand, Covid-19 pandemic, Air travel demand in Sri Lanka, Forecasting travel demand, Analytical hierarchy process

1. INTRODUCTION

Air transport is one of the fastest modes of public transport and an important sector in the world's economy and development. In history, every few years the air travel industry faced a black swan event or an economic crisis. Gulf War, 9/11 attacks, SARS, the eruption of the Eyjafjallajökull volcano, global recession are some of the crises faced by the air travel industry in the past. In 2020 the impact of the Covid-19 pandemic on global air travel has resulted in a drastic drop in air passenger demand. Furthermore, the impact of the Covid-19 pandemic is much widespread in the global context than any other such exogenous shock the aviation industry has faced in the past. Therefore, ICAO (2020) has predicted that in 2021 first three months will face a seat capacity reduction globally ranging from 34% to 47% and global passenger demand will decline by 504 to 681 million passengers. Further, Sri Lankan air passenger demand will be influenced comparatively by global downturns. Therefore, the research is focused on evaluating the impact of the Covid-19 pandemic on passenger air travel demand in the Sri Lankan context.

Air travel and international travelers entering by air add 8.9 percent of GDP to the Sri Lankan economy (Lanka, n.d.). According to the data of Sri Lanka Tourism Development Authority, in the first three months of 2020, the tourist arrivals have dropped below 30% compared to 2019 and it has an estimated loss in tourism revenue from USD 107 million USD 139 million (Antyra Solutions, 2020). Further, Sri Lanka experienced the worse impact on air travel with the travel restrictions imposed on Sri Lankan boundaries from April 2020 onwards as a measure to minimize the threat of the Covid-19 virus entering the country with air travel. International airports were closed for scheduled air travel. Except for the repatriation flights, air travel in all major segments reduced to almost zero. Key sectors of the national economy such as tourism, foreign employment directly depend on the air transportation of passengers. Thus, aviation is a critical service sector that provides much needed global connectivity for several key sectors of the national economy.

The impact of the Covid-19 pandemic on air travel is an emerging research area where most of the researchers focus on evaluating the impacts and formulating strategies to face the new normal. Pandemics can be considered as a form of slow-onset disasters. Unlike sudden or fast onset disasters, the outbreak lasts for a much longer duration and thus the impact on society is highly unpredictable. The Covid-19 pandemic is still developing globally, thus the recovery phase happens parallel to the disaster response. Thus, it is important that sectors such as air transportation attempt to estimate the future demand scenarios under such extremely volatile conditions that will intern assist better planning of transportation to serve supply.

Predicting future demand for air travel in this current context is extremely challenging. Conventional demand forecasting techniques such as time series, trend analysis, or econometric models extensively rely on the continuation of past trends into the future. Exogenous impacts such as pandemics, therefore, disrupt past trends, thus new methods must be sought to estimate future demand levels.

The main objective of this research is to evaluate the impact of the Covid-19 pandemic on the air travel demand to Sri Lanka and develop a methodology to estimate the level of recovery that can be expected during the year 2021. This study goes on to hierarchically cluster the overall air travel market of Sri Lanka based on the region of origin/destination and travel purpose. Covid 19 impact on the Sri Lankan air travel market is modeled as a hierarchical structure with two levels, where the impact to demand drivers cause changes in demand within each market segment. At the first level, the pandemic is impacting the demand drivers, this impact to demand drivers cause changes in demand within each market segment. A two-level AHP analysis is performed using expert opinion. At the first level, it evaluates the relative weight of demand drivers under the conditions of pandemic response. Then, at the second level, the relative ability of each market segment to recover was weighted. Finally, the relative weights are used to estimate a value for the conditional probability of recovery given each market segment.

Using the methodology followed in this study it was possible to estimate the demand for air travel in the Sri Lankan market during the year 2021 as part of market recovery from the global pandemic. The results show that in the air travel market between Sri Lanka and the Asian region, the work travel market, recreational travel market, and business market are the markets of the highest ability to recover compared with other markets in the post-covid-19 conditions. Further, according to ICAO (2020) scenario 1-path 1 the probability of recovery given the work travel market is the highest (50.07%) among other markets. The least recovery probability compared to 2019 demand is with the religious market segment in all four scenarios. Overall scenario1-path 1a gives less market recovery percentages for all markets compared to

other scenarios. When considering passenger air travel between Sri Lanka and the Middle East region, the Business travel market and work market have the highest ability to recover compared with other markets in the post-covid-19 conditions. According to ICAO (2020) scenario1-path 1 the probability of recovery given the business travel market is highest (64.25%) than work and recreational markets and this scenario shows the highest recovery in travel markets among other scenarios. Further, the least recovery probability compared to 2019 demand is with the recreational market segment in all four scenarios.

The paper is organized as follows: Section 1 gives an introduction, Section 2 reviews the literature, Section 3 outlines the methodology of the study and Section 4 presents the results of the research. Section 5 outlines a discussion of the results and Section 6 provides conclusions, limitations of the research, and recommendations.

2. LITERATURE REVIEW

2.1 Historical Crises that Impacted Passenger Air Travel Demand

Global aviation is regularly facing systemic shocks in the demand-side and cost aspects. The Gulf war in 1999, the 9/11 terrorists attack in 2001, the SARS pandemic in 2003, the Global recession in 2008, and the Eyjafjallajökull eruption in 2010 are some major events that impacted on air transport sector globally. The Gulf war which occurred in 1991 led to a 30% reduction in international air travel and airline losses peaked at \$4.8bn in 1992. The 9/11 terrorist attack also influenced air travel demand which dropped by 31% of passenger traffic in the United States in the five months following September 2001 (Pearce, 2006). In 2003 the world faced the SARS pandemic which firstly emerged in Southeastern China and spread in 26 countries reporting 8000 cases worldwide. Asian region countries were impacted mainly by the SARS outbreak which lasted about eight months. Airlines also faced the influence of border closure due to outbreaks and SARS caused a loss of \$6 billion in revenue for global airlines. Most Asian airlines' monthly passenger numbers dropped by 35% after the outbreak. The Global recession which took place in 2008 the first estimate by IATA for the foreseen total airline losses following Covid-19. Global passenger traffic was expected to decline by 3% in 2009 due to the recession. In 2010, the Eyjafjallajökull eruption impacted mainly the European air space disrupting 100,000 flights, and 10 million passengers were stranded during the eight-day crisis. According to IATA airlines lost around £130 million in revenue per day and Europe's tourism business was impacted with a loss of between £5 million and £6 million per day.

2.2 Determinants of Air Travel Demand

Determining drivers of air travel demand are essential in the process of forecasting the demand. It can be notified that GDP and population are the salient factors of air travel demand as discussed in most researches (Abed et al.,2001; Drago & Ratko, n.d.; Kopsch, 2012; Aderamo, 2010; Marazzo et al., 2010; Wei & Hansen, 2006; Dobruszkes et al., 2011; Wu et al., 2011; Phyo et al., 2017). Moreover, Bernstein (2014) identified that per capita income, GDP,

population, distance, service frequency are additional salient factors that contribute to air travel demand. Hakim & Merkert (2017) has focused on South Asian low-income countries and concluded that salient factors foreign direct investment, income, jet fuel price, and flight frequency depict a substantial impact on air travel demand. In the Sri Lankan context, GDP, growth of the tourism industry, exchange rate, and oil prices are the salient demand factors identified according to the literature. The demand drivers of air travel have changed with the influence of the Covid-19 pandemic. IATA air passenger market analysis has explained demand indicators of passenger air travel that influenced by the pandemic, which are GDP, travel restrictions, perception of safety, confidence to do business, unemployment rate, and seat capacity (Points, 2020).

2.3 Forecasting Methods to Analyze the Impact of the Historical Crisis

Different forecasting methods have been used to forecast the recovery of air travel demand after certain crisis events impacted the aviation industry. Lee et al. (2005) have developed an intervention analysis technique to examine the recovery of the September 11 attack in the United States air passenger enplanement. The intervention analysis method is an expansion of the ARIMA approach which provides a stochastic modeling tool to evaluate the impact of the September 11 crisis on air travel demand. Similarly, Min et al., (2010) have used ARIMA with an intervention model to assess the effect of global incidents that happened during 2000-2010 on the air movements in Taiwan. Moreover, it has used the autoregressive distributed lag approach (ARDL) to evaluate short term and long term impacts of economic growth and unexpected disruptions to the United States passenger market and air freight services (Chi & Baek, 2013). Additionally, ARDL performs better which gives a more robust analysis for small sample sizes. The cross-sectional regression model has used by Gillen & Lall (2003) which concluded that the 9/11 attacks negatively impacted airlines especially the American region other than Europe or the Asian region.

2.4 Forecasting Methods for Air Travel Demand

In aviation, forecasting is one of the major events in the overall planning process. The time horizon of the forecasting also differs as short-term, medium-term, and long-term (ICAO, 2006). Commonly, forecasting methods are categorized into three main groups: quantitatively, qualitatively, and decision analysis which represents a mixed method of the previous two (ICAO, 2006).

Quantitative methods such as time-series analysis methods depend heavily on historical data and the assumption of historical patterns will continue well into the future (E-c et al., 2002). Causal analysis is another method that implies the cause and effect relationship as suggested by the name itself. In the short term, the trend forecasting based on historical growth trends seems to be reliable and consistent. Regression analysis is a causal method which is a famous technique of forecasting civil aviation demand (ICAO, 2006). Abdullah, et al. (2013) have established a model using the regression technique to determine domestic air travel demand in Saudi Arabia. In aviation, international airport passenger traffic forecasts are mainly done by econometric models with drivers like GDP, yields, etc. (E-c et al., 2002).

When there is limited or no past data and situations where past trends have been disrupted due to exogenous shocks, quantitative techniques cannot be used with validity. The qualitative methods can be used when the past recorded data are not available or scarce for forecasting. Delphi method is one of the qualitative forecasting methods used to forecast the future through the consolidation of expert opinions. It follows two stages: firstly, a selected group of experts are offered a questionnaire and they are invited to answer in a probable manner that develops the forecast activity. The initial answers are then evaluated and prepare composite results are returned to the group of experts allowing them to revise them (ICAO, 2006).

The decision analysis is a combination of both qualitative and quantitative analysis methods. One of the methods is a market research and industry surveys for traffic forecasting that aims to examine the characteristics and the use of air transport in diverse industries and different segments of the population. Probabilistic analysis is another decision analysis method that has limited applications in air traffic demand forecasting.

Analytical Hierarchy Process (AHP) is an approach that divides a certain problem into a hierarchy of issues and solves them accordingly. There are numerous applications with AHP because it is a simple and consistent method (Saaty, 1987). It can decompose a problem hierarchically and gives priority weights (Crowe et al.,1998; Lewis et al. 2006). The fundamental theory of AHP is to pairwise compare alternatives and multiple decision criteria hierarchically and derive relative importance weights to decision alternatives. Dožić & Kalić (2014) has used the AHP method to select aircraft types for an identified route network and demand forecasted for air travel for a hypothetical regional airline in Europe. Wang et al., (2009) have investigated a technique to evaluate and analyze human factors in the process of aviation maintenance using the AHP method. They combined with fuzzy theory using expert group survey as data sources which helped to give decision making support for airline management. Moreover, the AHP technique has been used to investigate determinants that affect the efficiency levels of Juanda International Airport terminals, Indonesia by S. U. Park & Lee (2020). Therefore, unstructured, unpredictable, and complicated problems can be evaluated with AHP considering correlated factors (Talib et al. 2011).

3. METHODOLOGY

The main aim of this research is to estimate the level of recovery expected within the international air travel market of Sri Lanka during the phase of responding to the Covid-19 pandemic. The first objective of the research is to conduct an analysis based on literature to identify the main drivers of air travel demand in the pre-Covid-19 scenario. A thorough literature review was conducted to determine the salient drivers considering the macroscopic global level, as well as down to the Sri Lankan context.

The second objective is to decompose the overall air travel market into smaller segments where the pandemic impact can be assessed more precisely. To perform a detailed analysis of the travel market, the entire market was segmented as a two-level hierarchical structure. At the first level market is segmented according to the region of origin or destination of trips and at the second level, each regional market is segmented according to the travel purpose. The covid-19 response is different in different regions in terms of partial or full travel restrictions. These travel restrictions and other demand drivers impact different travel purposes

in diverse ways. Hence the market segmentation was chosen to model the pandemic impact on multiple tiers.

The third objective of the study was to evaluate the level of recovery that can be expected from each market segment during the pandemic response phase. In this study, the level of recovery expected is defined as the probability or the percentage of trips that would be expected to return compared to a baseline demand level. This is a challenging task given no time-series data is available to follow a frequentist approach. Hence it was decided to use the expert judgment method to estimate the expected recovery. AHP method allows a systematic technique of structuring a complex decision problem with multiple decision alternatives. The multiple decision alternatives are compared in a series of systematic pairwise comparisons concerning a set of decision criteria. The key market segments of air travel to Sri Lanka are the decision alternatives to be considered. AHP analysis method was used to obtain an expert opinion to estimate a set of relative weights to depict the expected level of recovery of each market segment. Identified key demand drivers are used as the multiple decision criteria influencing the level of recovery in market segments. AHP analysis was performed for Asia and Middle East regions separately. A two-level decision hierarchy was created with demand drivers at the first level and the market segments at the second level.

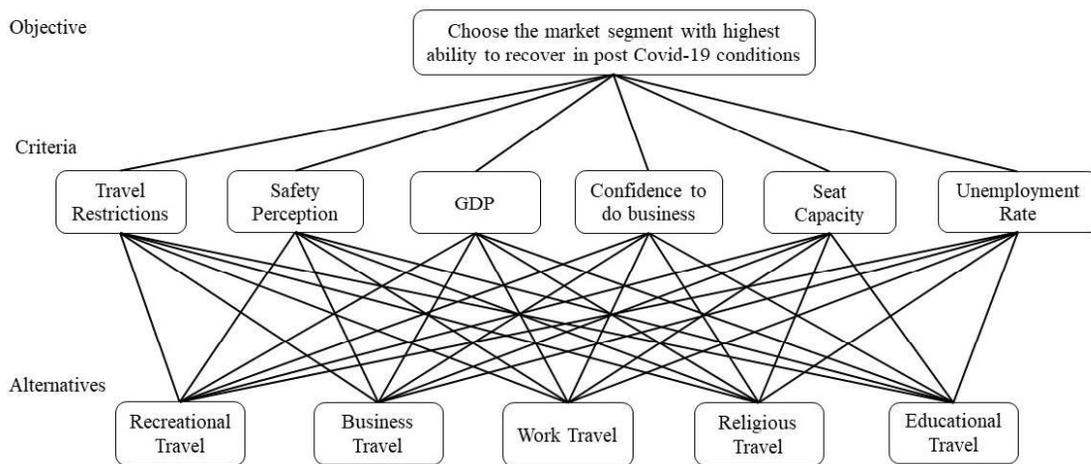


Figure 1: Decision Hierarchy Diagram

Since the final objective of the study is to estimate the level of recovery of each market segment, the recovery level has given as a percentage of the base case scenario (2018 demand level). In 2019, Sri Lankan aviation faced a decrease in demand compared to other regions due to a major terrorism incident. Therefore, it has been assumed that 2019 demand levels are equal to 2018 demand levels. The relative weights obtained by the AHP process cannot be directly used to estimate the percentage recovery. Thus, the percentage recovery of each market segment was defined as the conditional probability of a trip (relative to 2019 level) recovering within the year 2021 given a market segment and it is denoted by $P(Re/W_i)$. The total percentage of recovery is defined as the general probability of a trip recovering within the year 2021 and it is denoted by $P(Re)$. Given the relative weights assigned for level of recovery among each market segment, $P(Re/W_i)$ was estimated with the use of simplifying assumptions and the law of total probability. The estimated probability was used to estimate the expected number of trips that can be recovered compared to the 2019 demand level.

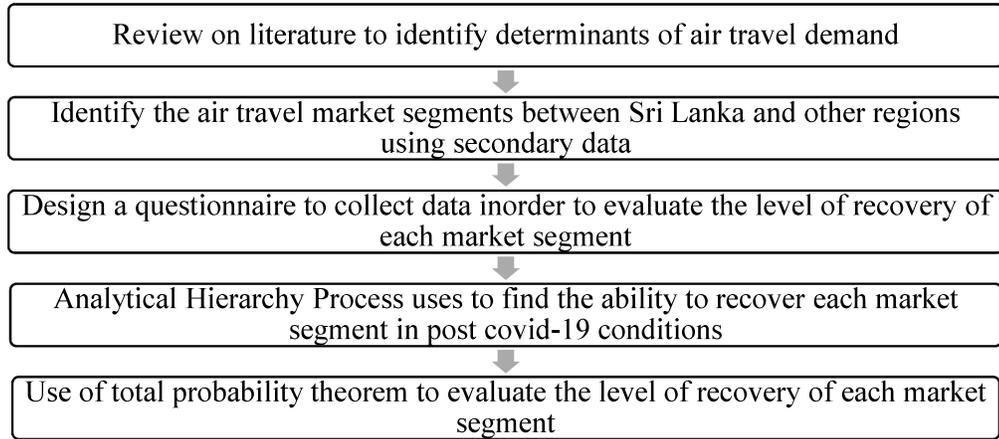


Figure 2: Flow chart of research methodology

3.1 Data Sources

Both primary and secondary data have been used in this research. The hierarchical segmentation of the Sri Lankan air travel market was developed using data from a passenger survey conducted at Bandaranayake International Airport (BIA) in Traffic study for Aerocity 2018, Transportation Engineering Division, Department of Civil engineering, University of Moratuwa. 2018. This database consisted of responses obtained from a random sample of arrival and departure passengers at BIA. Variables collected for each sampled response included destination/origin, trip purposes, age, places visiting, etc. To perform the AHP analysis, a pairwise comparison of the hierarchical decision factors is required. Data for the AHP pairwise comparison was obtained using a questionnaire survey which covered expert group opinions based on Delphi technique. A 12-member panel of local aviation experts was organized to achieve the above objective. Moreover, the forecasted data on regional seat capacity was retrieved by the report on Effects of Novel Coronavirus (COVID-19) on Civil Aviation: Economic Impact Analysis have used as secondary data for estimating the total probability of recovery in the overall travel market.

3.2 Data Sample

The research is focused on expert group opinions based on the Delphi technique. The population for the research is focused on the experts connected with the Sri Lankan aviation industry who are experienced in passenger air travel in their profession. The used methodology, the analytical hierarchy process does not have a specific rule for the sample size of focused group surveys. Hence, in studies of this nature relevance of statistical sampling methods are limited. The panel of experts recruited for the questionnaire survey represents a diverse spectrum of organizations in the aviation industry of Sri Lanka and the region including national and international airlines, airport authority, and the regulator.

4. IDENTIFICATION OF DETERMINANTS OF AIR TRAVEL DEMAND

The first objective has been achieved by analyzing literature to identify the main drivers of air travel demand in Sri Lanka. The results show the determinants of passenger air travel demand focused on the macroscopic global level to the Asian context and then to the Sri Lankan context.

Table 1. Factors affecting air travel demand

No	Factors	Articles
Factors affecting air travel demand - globally		
1	GDP	(Bernstein, 2014), (Abed et al., 2001), (Drago & Ratko, n.d.), (Aderamo, 2010), (Vlieger, 2011), (On, 2013), (Marazzo et al., 2010), (Grosche et al., 2007), (Kopsch, 2012), (Wei & Hansen, 2006), (Dobruszkes et al., 2011), (Chi, 2014)
2	Population	(Bernstein, 2014), (Abed et al., 2001), (Erraitab, 2016), (Vlieger, 2011), (On, 2013), (Bhadra, 2002), (Grosche et al., 2007), (Kopsch, 2012), (Wu et al., 2011), (Phyoe et al., 2017)
3	Distance	(Bernstein, 2014), (Aderamo, 2010), (Grosche et al., 2007), (Kopsch, 2012), (Wei & Hansen, 2006), (Dobruszkes et al., 2011)
4	Per capita Income	(Bernstein, 2014), (Valdes, 2015), (Vlieger, 2011), (Dargay & Hanly, 2001), (Hakim & Merkert, 2017), (Lim, 2004)
5	CPI	(Abed et al., 2001), (Aderamo, 2010), (Vlieger, 2011), (On, 2013)
6	Exchange rate	(Vlieger, 2011), (On, 2013), (Dargay & Hanly, 2001), (Chi, 2014)
7	Total expenditure	(Abed et al., 2001), (Erraitab, 2016), (On, 2013)
8	GDP per capita	(Abed et al., 2001), (Vlieger, 2011), (On, 2013)
9	Airfare	(Dargay & Hanly, 2001), (Grosche et al., 2007), (Wu et al., 2011)
10	Service frequency	(Bernstein, 2014), (Hakim & Merkert, 2017)
11	Travel time	(Abed et al., 2001), (Wu et al., 2011)
12	Import volume	(Abed et al., 2001), (On, 2013)
13	Tourism	(Drago & Ratko, n.d.), (Dobruszkes et al., 2011)
14	Seats being offered	(Valdes, 2015)
Factors affecting air travel demand - Asian countries		
	Population	(Phyoe et al., 2017), (Wu et al., 2011)
	Per capita income	(Hakim & Merkert, 2017), (Lim, 2004)
	FDI, Fuel price, Industrialization, Flight frequency	(Hakim & Merkert, 2017)
	Airfare, Travel time	(Wu et al., 2011)
Factors affecting air travel demand- Sri Lanka		
	GDP, Oil price	(Priyadarshana & Fernando, 2015)
	Growth of tourism industry	(Priyadarshana & Fernando, 2015), (Dias et al., 2009), (Ishara & Wijekoon, 2017)
	Exchange rate, Oil price	(Nisansala & Mudunkotuwa, 2015)

Most of the researches has identified Gross Domestic Product and population as key demand drivers for travel demand. And economic factors like per capita income, consumer price index, exchange rate have contributed to the demand. It can be notified that factors related to the air trip such as distance, airfare, service frequency, travel time are influential in a global context. In Asian countries, the factors are similar compared with the global context. In Sri Lankan context GDP, oil price, exchange rate are some identified factors, and the growth of the tourism industry is also a key factor that is the salient factor for the growth of the economy

as well. The pandemic influenced the change of these factors while it heavily impacted air travel. With the influence of the pandemic, The GDP has been identified as a determinant of passenger demand (Points, 2020). Safety perception is another factor that influences air travel demand with concerns on virus containment, vaccine availability, etc. The air travel restrictions or border closures due to the covid-19 pandemic have deprived the demand for air travel globally (Pere Suau et al.,2020). The strong relationship between Project Managers' Index and air passenger demand has been weakened in 2020 and confidence to do business will be another determinant. The unemployment rate is another determinant that influences the work travel segment in the post-covid-19 condition. Seat capacity is a supplier side factor that expects to recover with the normalization of the industry in the post-covid-19. Therefore, these six factors, are selected drivers that influenced by pandemic.

5. IDENTIFICATION OF AIR TRAVEL MARKET SEGMENTS

The data used to develop the region-wise travel-purpose based air passenger demand segmentation was obtained from the Traffic Study for Aerocity 2018 shown in Figure 3. The Asian and Middle East regions are the most contributing regions for the air passenger travel demand. It is because in Sri Lanka most of the scheduled air network is in the Asian region and more than one million Sri Lankans are employed in Middle East alone which mark foreign employment as major foreign exchange earners.

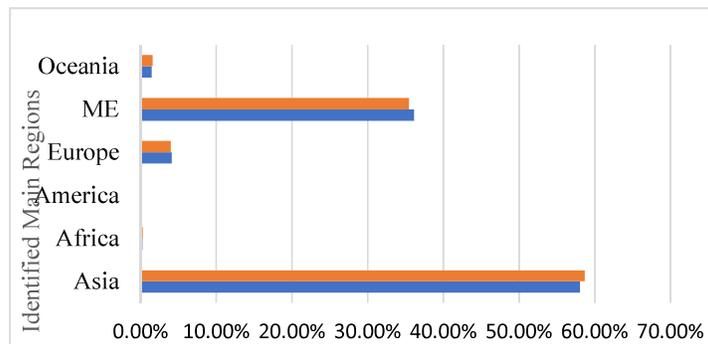


Figure 3. Region wise air passenger demand to Sri Lanka-2018

Using the same data set it was possible to further segment the region-wise segments to subcategories of travel purpose. Figure 4 shows the travel purpose segmentation of the market based on different regions. The distribution of the Sri Lankan air market consists of travel purpose categories like work-related, recreational, business, religious, educational, and others. In the Middle East region, the work travel market contributes highly to the travel demand due to the foreign employment sector. In the Asian region business and recreational travel, markets are comparatively equally contributing to the demand due to the recognition of the country as the best travel destination and the healthy business environment for foreign investors. The recreational segment is the highest contributing sector from Africa, America, Europe, and Oceania regions.

Sri Lankan tourism industry was significantly affected by the disruptions to global travel and air travel restriction due to the pandemic. According to the Tourists Development

Authority, Sri Lanka, tourist arrivals decreased by over 30% compared to 2019 during the first quarter of 2020. The above-mentioned travel sectors were also affected severely. The Middle East work travel has been temporarily halted with the pandemic, and the recreational travel market in other regions has greatly diminished.

Further, it was selected the travel segments that are contributing most to the Sri Lankan air travel market. The countries with a total of 80% trips contribution to the air travel demand have considered for further analysis. In terms of regions, Asia and Middle East regions were selected as a result of continuing the regions that are most influencing the travel market. That will improve the effectiveness of the data collection methods at the next stages of the research. For each of the regions, the main market segments which consist of 80% contribution were filtered using Pareto analysis which is a technique used for the limited number of criteria that create a significant overall effect. In the Asian region, recreational, business, work-related, religious, educational travel markets were selected while in the Middle East region, recreational, work-related, and business travel were selected.

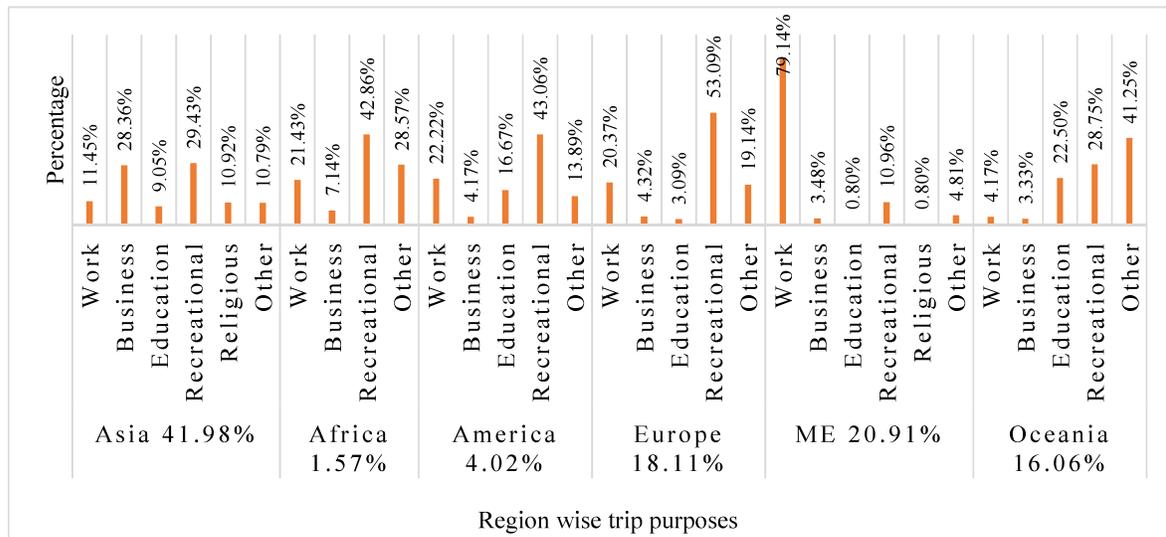


Figure 4. Region wise travel market segments

6. ESTIMATION OF THE LEVEL OF RECOVERY

The objective is to estimate the level of recovery of air travel markets compared to 2018 and the percentage recovery that can be expected. In order to do that, it has chosen the segmentation that has developed in the previous stage and chosen to estimate the percentage level of recovery that can be expected within each market segment that has been derived previously. Rather than considering the entire market as one unit, decomposing it into several market segments allow one to evaluate the impact more precisely. The demand drivers that selected in the first stage are impacting these segments in different ways due to Covid-19. All these differential impacts can be considered methodologically when using market segments. It should be involved with both market segments and drivers in order to estimate the expected level of recovery. This is a challenging task given the context of the study because the frequency data is not available in

order to project trends in the past. Therefore, the experts' judgment technique is a more suitable method. Then it is selected Analytical Hierarchy Process, the multicriteria decision-making tool in order to derive the expert judgment regarding the level of recovery that can be expected in these market segments. AHP allows integrating the decision problem which is the relative weights among different market segments to recover given different regions. This is a complex decision given the multiple decision criteria involves such as demand drivers because they affect different decision alternatives separately. Then AHP is the ideal tool to perform.

Analytical Hierarchy Process (AHP) introduced by Saaty, (1987) has been used as the data analysis method. To use AHP analysis, the data collection was completed using two questionnaire surveys and the second survey was followed by the results of the first questionnaire survey. The questionnaire survey-stage 1 was conducted mainly focusing on the salient factors of air travel demand between Sri Lanka and the two regions Asia and the Middle East. The first questionnaire survey was designed to compare the relative importance designed region wise of 6 demand drivers. The experts did 30 pairwise comparisons for both regions separately. The questionnaires were delivered online and contacted them over the phone to make the process convenient for the respondent.

The questionnaire survey stage 2 is focused to identify the recovery of each air travel market segment in both Asia and Middle East regions in the short-term period 2021 year with the post-Covid-19 condition. It was analyzed the responses of the stage 1 questionnaire survey using the AHP method and identified the relative weights of the factors for both Asian and Middle East regions. The factors which give the highest influence where it sums up to 80% of relative weights have been considered. And given the influence of each determinant, it was asked by the experts to compare two market segments at a time in terms of their ability to recover under the post-Covid-19 conditions in 2021.

At the beginning of the AHP analysis process, the comparison matrix should be built along with the priority vector. The individual responses of each expert may not be consistent in their judgments through each pairwise comparison matrix. Therefore, Consistency ratios (CR) were used to affirm the relevance of responses in decision-making. The responses were adjusted by the researcher with a logical approach in a way to become the responses consistent. Then, the individually given responses were aggregated into one value for each pairwise comparison using the geometric mean aggregation method. The geometric mean method is appropriate because it keeps the first axiom of the AHP method, the reciprocal property alive (Eshtaiwi et al., 2018). Then, comparison matrices were obtained for both regions. The analytical hierarchy process steps were followed accordingly including creating a normalized matrix, eigenvectors, and calculating consistency index and ratios. Finally, the priority weights can be obtained through the process as shown in Table 2 and Table 3. and the adjusted weights for each criterion were calculated. The factors which give the highest influence where it sums up to 80% of relative weights have been chosen and overall composite weights were calculated on each alternative. It is the normalization of weights of multiplication between the respective adjusted weight of criterion and priority weight of each alternative.

Table 2. Priority weights for Asian region

Criteria	Asia
GDP	0.18
Travel Restrictions	0.25
Seat Capacity	0.04
Unemployment rate	0.04
Confidence to do business	0.15
Safety perception	0.34
$\lambda_{\max} = 6.07$	
$CI = \frac{\lambda_{\max} - n}{n - 1} = 0.0144$	
CR = 0.0116 (< 0.1, consistent)	

Table 3. Priority weights for the Middle East region

Criteria	Middle East
GDP	0.06
Travel Restrictions	0.27
Seat Capacity	0.07
Unemployment rate	0.08
Confidence to do business	0.13
Safety perception	0.39
$\lambda_{\max} = 6.09$	
$CI = \frac{\lambda_{\max} - n}{n - 1} = 0.0191$	
CR = 0.0154 (< 0.1, consistent)	

Then the questionnaire survey stage 2 responses were analyzed as the same process conducted for stage 1 survey results. Adjusted weights of determinants of air travel demand (Table 4) and composite weights for travel market segments (Table 5) were calculated and the overall consistency of the hierarchy of each region was checked to confirm the solutions are acceptable.

Table 4. Adjusted weights of criteria in each region

Asian Region	
Safety perception	0.37
Travel restrictions	0.27
GDP	0.19
Confidence to do business	0.17
Middle East Region	
Safety perception	0.45
Travel restrictions	0.31
Confidence to do business	0.15
Unemployment Rate	0.09

Table 5. Composite weights of travel markets in each region

Asian Region	
Recreational travel	0.2513
Business travel	0.2461
Work travel	0.2562
Religious travel	0.1067
Educational travel	0.1663
CR = 0.0252 < 0.1 consistent	
Middle East region	
Recreational travel	0.1762
Business travel	0.4692
Work travel	0.3537
CR = 0.0131 < 0.1 consistent	

7. ESTIMATIONS OF THE PERCENTAGE RECOVERY LEVELS

The objective of this section is to estimate percentage level of recovery of each market segment based on the relative weights obtained in the previous section. Using the AHP method a set of relative weights were estimated for the level of recovery expected in each market segment. However, above relative weights cannot be used directly as estimates of percentage recovery given each market segment. Therefore, the expected percentage of recovery given a market segment is assumed to be proportionate to the relative weight obtained using AHP. Given a market segment, the percentage recovery is defined as the conditional probability of a trip (relative to 2019 level) recovering within the year 2021 (Equation 1).

$$P(RE/W_i) = \text{The probability of a trip being recovered given it is a "i" trip} \quad (1)$$

Where; RE denotes recovery and W_i denotes the i^{th} market segment.

Relative importance weights obtained from experts are assumed to be directly proportional to the probability of recovery given each market segment. The equations (2) and (3) denote the assumption relating to the travel market i and j .

$$P(RE/W_i) \propto \text{Ability to recover}_i \quad (2)$$

$$P(RE/W_j) \propto \text{Ability to recover}_j \quad (3)$$

The two proportionalities can be converted into equations by introducing the constant that is assumed to be common for all the market segments denoted by K . Thus, by taking the ratio between Equation (2) and (3):

$$\frac{[P(RE/W_i)]*k}{[P(RE/W_j)]*k} = \frac{\text{Ability to recover}_i}{\text{Ability to recover}_j} \quad (4)$$

Considering the Asian region as an example, there are five market segments namely recreational, work, business, religious and educational. Then, based on the relationship given by Equation (4), following expressions can be written considering recreational and work travel as an example:

$$\frac{[P(RE/W_{\text{recreational}})]*k=\text{ability to recover}_{(\text{Recreational market})}}{[P(RE/W_{\text{work travel}})]*k=\text{ability to recover}_{(\text{Work travel})}} \quad (5)$$

Let $P(RE)$ denote the total percentage of recovery expected in the overall market. This expected recovery can be estimated using the market predictions published by ICAO, (2020). The total percentage of recovery is defined as the general probability of a trip recovering within the year 2021, the available data of forecast seat capacity change compared with 2019 and predicted 2021 data. Therefore, the seat capacity change is assumed to be equal to the air passenger demand in the post-Covid-19 conditions. The analysis is focused on the first quarter of 2021 and the four scenarios that have been introduced by ICAO on the future air travel recovery forecast.

The four scenarios:

The scenarios are based on forward-looking states with continuous updates and adjustments by ICAO. Firstly it has introduced different shapes of economic recessions and recoveries and based on those, the following scenarios have developed by ICAO, (2020).

Table 6. Scenario by ICAO, (2020)

Scenario	Explanation
Scenario 1: Nike swoosh – and W- shaped	
Path 1	Smooth capacity recovery by picking up pent-up demand but at a diminishing rate of growth
Path 1a	Capacity to start with smooth recovery but then turn back down due to over-capacity
Scenario 2: U and L shaped	
Path 2	Accelerating the return to trend growth after slow progression of capacity recovery
Path 2a	Capacity recovery at diminishing speed due to respite and continuous demand slump

The report has given the seat capacity change of the first quarter of 2021 in each regional international air travel compared to 2019 seat capacities (Table 7). These data are used to retrieve the air travel demand recovery percentages in each region for each scenario.

Table 7.Recovery of travel market according to ICAO (2020)

Asia				
Compared to 2019	Scenario 1	Scenario 1-path a	Scenario 2	Scenario 2- the path a
Q1 capacity change	-56.23%	-75.03%	-64.13%	-75.70%
Q1 recovery P(RE)	43.77%	24.97%	35.87%	24.30%
Middle East				
Q1 capacity change	-53.53%	-63.17%	-60.03%	-66.00%
Q1 recovery P(RE)	46.47%	36.83%	39.97%	34.00%

P(RE) is the total probability of recovery for the overall market, the probability of recovery compared to 2019 air travel demand of an air passenger trip can be represented as in the equation (5) using the total probability rule:

$$P(RE) = \sum_{i=1}^n [P(RE/W_i) * P(W_i)] \quad (6)$$

n= market segments

The probability of each market segment is denoted by $P(W_i)$ which is estimated using the data obtained from the travel survey. From the market segmentation analysis those values can be estimated as follows (Table 8).

Table 8. The probability of trip being in each market segment

Asian Region	$P(W_i)$
Recreational travel market	0.33
Business travel market	0.32
Work travel market	0.13
Religious travel	0.12
Educational travel	0.10
Middle East Region	$P(W_i)$
Recreational travel market	0.12
Business travel market	0.04
Work travel market	0.84

By solving all these equations, the probability of recovery of a given market segment in the post-covid-19 conditions compared to 2019 demand can be estimated and they are given

in Table 9 and Table 10. The equations have solved using the Microsoft Excel Solver function in the research. It was checked whether any multiple solutions did not find any and this is the only feasible solution found given the above constraints. These are considered as the estimates of the probability of recovery given each market segment as the estimate of the level of recovery given the year 2021.

Table 9.Results of probabilities of recovery given each market segment-Asian Region

Probability of demand recovery given each market segment	Scenario 1- path 1	Scenario 1-path 1a	Scenario 2 – path 2	Scenario 2-path 2a
Recreational travel market	0.4912	0.2802	0.4025	0.2727
Business travel market	0.4810	0.2744	0.3942	0.2670
Work travel market	0.5007	0.2857	0.4104	0.2780
Religious travel	0.2085	0.1189	0.1708	0.1157
Educational travel	0.3250	0.1854	0.2663	0.1804

Table 10.Results of probabilities of recovery given each market segment-Middle east Region

Probability of demand recovery given each market segment	Scenario 1- path 1	Scenario 1-path 1a	Scenario 2 – path 2	Scenario 2-path 2a
Recreational travel market	0.2412	0.1924	0.2088	0.1776
Business travel market	0.6425	0.5125	0.5562	0.4731
Work travel market	0.4843	0.3863	0.4193	0.3566

8. DISCUSSION

At the beginning of the study, it was identified the scarcity of researches done in the Sri Lankan context regard to the air travel industry. The determinants of air travel demand can be identified such as population, per capita income, airfare and flight frequency, etc. in the global context. India, UAE, Qatar, China, Maldives, Malaysia, Singapore, Saudi Arabia, and Thailand are the highest contributing countries for demand to Sri Lanka. This passenger demand is defined as both local passengers who visit outside of Sri Lanka and the foreign passengers who travel to Sri Lanka. Asia and the Middle East regions are the highest contributing regions for the air passenger travel demand. Africa and America regions are the least contributing regions for the demand. In the Asian region work travel, business travel, educational travel, recreational travel, and religious travel are the main market segments. In the Middle East region work travel, business travel, and recreational travel markets are the highest contributing market segments for Sri Lankan passenger air travel demand.

The results of the study are subjective to experts' judgments since the primary data collection process has conducted using experts' interviews. Further, the research is subjective to the significant assumptions used in relevant methodologies. The retrieved estimates are reasonable and justifiable, and the estimates can be updated in the future once the industry given wide estimates are updated. Importantly, this methodology allows updating the estimates based on the opinions of the experts on the recovery of a given market segment as well as the

estimate of the total probability of recovery given by ICAO considering future updates. The methodology can incorporate inputs from several sources and can be modified for future usage.

The study assessed how each market segment was influenced by Covid-19 through demand drivers. The work travel market has 33.23% the highest ability of recovery compared to another market segment between Sri Lanka and Asia was given safety perception as the determinant. Given travel restriction as the determinant of demand, it has proved that the business travel market has a 33.79% ability to recover compared to others. The recreational travel market has 32.61% and 35.92% ability to recover given confidence to do business and GDP as the determinants respectively compared with other market segments between Sri Lanka and the Asian region. When considering the air travel markets between Sri Lanka and Asia, in scenario 1-path 1 the probability of recovery given the work travel market is highest among other markets (50.07%). Also, the relative ability to recover in the post-Covid-19 conditions also high in the work travel market's previous AHP output. Further, the least recovery probability is with the religious market segment in all four scenarios. Overall scenario2-path 2a gives less market recovery percentages for all markets compared to other scenarios.

Moreover, when considering the passenger air travel demand between Sri Lanka and the Middle East region, the business travel market has 51% and 45% ability to recover given safety perception and travel restrictions as the determinants respectively compared with other markets. Business travel market and work travel have 44% equal highest ability of recovery compared to other market segment given the confidence to do business as the determinant of the demand. Given the unemployment rate as the determinant of demand, it has proved that the work travel market has 45% the highest ability to recover compared to other segments. Concerning demand recovery scenarios of air travel between Sri Lanka and the Middle East region, scenario 1-path 1, the probability of recovery given the business travel market is highest among other markets (64.25%) and the scene shows the highest recovery among other scenarios. Also, the relative ability to recover in the post-covid-19 conditions also high (46.92%) in the business travel market according to previous AHP output. Further, the least recovery probability is with the recreational market segment in all four scenarios. Also, with the updates of ICAO recovery percentages these values can be updated for the next months of 2021. The recovery estimates levels for each market segment are focused on the first quarter of 2021 and the analysis has carried during the second quarter in 2020. The current context has changed compared to the period the data analysis was undertaken. Therefore, the determinants of air travel demand and forecasted data should be updated accordingly for future usage.

9. CONCLUSION

This research has addressed the problem of how the Covid-19 pandemic has impacted passenger air travel demand to Sri Lanka. The analysis focused on Asia and Middle East regions as highest contributors for travel demand to Sri Lanka. The main passenger travel markets between the country and the regions were identified. Using the Analytical Hierarchy Process (AHP) implemented by R. W. Saaty, (1987) the analysis and the forecasting model were developed. The probabilities of recovery of travel markets were retrieved considering recovery scenarios updated by ICAO for the first three months of 2021. Therefore, the results indicate that the work travel market segment has the highest probability of recovery of demand

following business and recreational travel markets between Sri Lanka and the Asian region in all four scenarios compared to 2019 travel demand. In the Middle East region probability of recovery given the business market segment is the highest compared to 2019 demand. Also, the business travel market segment contributes the least to the overall demand. The probability of recovery in the recreational travel market middle east region has very little compared with business and work market segments.

Industry estimates of demand recovery is available only at aggregate level covering global or regional context. However, a more detailed analysis of demand recovery at the level of different market segments are required for supporting decisions to revive air travel demand affected by the global pandemic. Main challenge faced in this regard is the inability to use data driven forecasting methods. Thus the objective of the research was to systematically integrate the available information such as regional level recovery forecasts given by organizations such as IATA, prior estimates of travel market segmentation and expert judgment on a market segment's potential to recover to derive an estimate of demand recovery at the level of individual travel market segment. The research has focused on Asia and Middle East regions considering the highest demand that manifested and as an improvement it can be considered other regions focusing more on their influential market segments.

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