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Effect of Adverse Weather on Air Transport: Port Harcourt International Airport in Focus

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Abstract

This work focuses on the effect of adverse weather on air transport in Port Harcourt International Airport, Omagwa. Among the weather elements considered in this article are, rainfall, cloudage, relative humidity, sunshine duration and intensity, wind speed, temperature and other weather-related variables like thunderstorm, clear air turbulent etc. These conditions are diurnal and temporally checked in the airport. In an attempt to understand the effect of adverse weather on air transport, a questionnaire that covers all stakeholders was designed and administered to the relevant stakeholders. The study among other things observed that adverse weather is a challenge to aviation industry. It causes low visibility, can increase the rate of plane crash and can even lead to damages of plane parts. The study shows that the effect of adverse weather in the study area is seasonal. It was also observed that adverse weather leads to flight delay, diversions and cancellations, which cause passengers to spend more money. Finally, the study discovered that announcement of sudden adverse weather condition triggers health issues among passengers. This work used tables' graphs and simple % for analysis. This work suggests the installation of latest weather monitoring devices in the airport, construction of paved runway and reliable weather forecast report should be made available to passengers' days and hours before travelling to minimize flight delay and cancellations.

Keywords: adverse weather, airport, flight delay and cancellation, passengers, travel, seasonality, weather forecast

1. Introduction

Air transport is a modern means of transport when compared to other means of transports, it began after the Montgolfier brothers in November 21, 1783, invented hot air balloon, which was launched on 27th December, 1783. By 1785 two men flew over the English Channel in a hydrogen balloon signalling air transportation.

The modern-day air transport started with the invention of airplane by Orville and Wilbur Wright in 1903; Paul Cornu invented helicopter in 1907. However, it was in 1919 that planes began carrying passengers between London and Paris. Airplanes were also deployed during First World War (Alexander, 2022). The first passenger jet service began in 1952 and the first hovercraft passenger service began in 1962 (Alexander, 2022).

Air transport is the movement of passengers and cargos by air through the use of aircrafts such as airplanes and helicopters. Air transport has become a major means of travelling, especially intercontinentally. It is the fastest and safest mode of transport and therefore suitable for carriage of passengers' freight and delicate goods over a long distance. It provides comfort, efficiency and it is also quick transport of sensitive goods and on emergencies. It is a mode used in terms of national defence and security, to convey troops easily and logistics (Janic, 2000).

One of the greatest challenges to aviation (Air transport) is adverse weather (Heavy rainfall, Sandstorm, Haze or Fog). When evaluating air accidents related with adverse weather and other related effects, it is apparent that the dangers associated with adverse weather were not always recognized by aviators. Weather and its vagaries significantly influence the safety and operational efficiency of air traffic, particularly at the terminal areas. The unavoidable consequences of weather variables are delays, diversions and cancellations of flights (Onyejiri, 2019).

The effect of weather variation brought about by climate change is a great concern to the aviation industry. Kulesa, (2002) stated that several airlines have been inactive and workers on redundancy, while some offer skeletal services as a result of extreme weather events. Adverse weather is an abnormal atmospheric condition or situation that is not very suitable for normal human activities. This condition is a natural phenomenon that might ordinarily be useful to man and the environment. Adverse weather condition is common in the tropical region than any other region of the world. For instance, thunderstorm activity is intense in the tropic than any other region of the world. It has been observed that thunderstorm is inimical to aviation (Pawar & et al, 2010).

Thunderstorm is defined as a thermodynamic mechanics whose potential energy of latent heat of condensation in moist unsuitable air is converted into kinetic energy of violent vertical air current, characterized by thunder, lightning, gusty wind and sometimes hail. It is one of the climatological phenomena that causes problem to man; material losses caused by thunderstorms follow primarily from high intensity electrical discharges, strong winds that accompany cumulus clouds and intense precipitation which leads to local floods and hail (Alexander, 2015; Kolendowicz, 1998).

Ayoade (2004) revealed that poor visibility is the single most important weather hazard to all forms of transportation especially air transportation. Poor visibility can be caused by thick fog, snow, rain, thunderstorm, harmattan, sandstorm, dust, mist, volcanic ash or dust, urban smoke, low ceiling and even smog. Studies show that rainfall can reduce visibility up to zero, making it very difficult for a pilot to see the runway clearly. It will amount to monumental disaster if a pilot should decide to take off or land under such condition.

A study of factors responsible for air crash in Port Harcourt International Airport reveals that adverse weather, particularly due to rainfall and thunderstorm at the time of crash are the major causes of crash (Remi, 1987).

It is important to note that severe rainfall is as destructive as a whirl wind, or a tornado. Similarly, a single severe thunderstorm can cause untold havoc and wreckage between 1- 8 km areas round about it.

The International Air Transport Association (IATA) reported that 71% of air accidents in Nigeria air space can be accounted to by adverse weather condition. The National Oceanic Atmospheric Administration (NOAA), 2004 stated that adverse weather influences flight operation in Nigeria significantly.

Other weather variables outside rainfall can also affect air transport. For instance, Air Traffic Control (ATC) may delay take-off or landing as a result of cloudage or when cloud ceiling is reduced, leading to low acceptance of airplane. Similarly, strong surface winds which produce too much cross factor also leads to low acceptance of aircraft to the airport. NTSB, (2012) said that low-level wind (Shear wind) conditions can cause the cessation or cancellation take-off and landing.

The effect of weather on air transport is not just limited to landing and take-off. During flight, jet streams winds, clear air turbulent and temperature inversions have a significant impact on fuel burn and on-time performance. Furthermore, related weather variables like thunderstorm are capable of shutting down air route for many kilometres away.

Generally speaking, in the tropics weather conditions can change or evolve so unpredictably over a sizable spatial demission. These rapid changes affect air transport (Houle, 2015).

Weather is the single largest contributor of delays in the efficiency of flight operation. In fact, it is becoming the dominant cause of delay in Nigeria. It is important to note that aeroplane can incur delay while on air or on the ground before take-off. This happens for many reasons; however, adverse weather is most often the cause, especially in Nigeria (Schaefer & Millner, 2001).

Adverse weather can create conditions leading to poor visibility. Any of these weather conditions can cause poor visibility such as fog, snow, rain, thunderstorm, sandstorm, shear wind, haze, volcanic ash or smoke, urban smoke; smog, etc. can impact heavily on transport.

Innovation in the field of science and technology has actually check mate and minimized the impact of weather on transport. Human experience has also helped in security and safety of aviation industry from adverse weather.

Aviation is sensitive to the weather; therefore, no decision is taken without first putting the weather into consideration (Ewent Consortium, 2012; Eze, 2015; Pan African News, 2016). The vagaries of weather have made air safety somewhat subtle in the world, especially in the tropics. Similarly, the National Transportation Safety Board (NTSB) of the United State of America stated that adverse weather condition is a major cause of

air accident in air transport industry (NTSB, 2012).

It has been observed in Nigeria that the commonest defining cause of air accident as regulated by part 121 law in 2010 is Clear Air Turbulence (CAT). Klein (2009) opined that adverse weather is the most important source of unavoidable delays in the aviation industry.

Improvement in science and technology has provided latest accurate weather information. This latest weather information has helped the pilots avoid CAT during flight, thereby reducing incidence of air accident, especially those ones that emanating from weather.

A better understanding of weather enhances flight operations because issue of unplanned flight deviation that is connected with bad weather are subsequently reduced. Ahlstorm (2005) stated that an improved communication between the office and the Pilots is vital and can help aviation managers to schedule arrival and departure of flight while minimizing re-routing caused by weather.

Weather is the most reason why flight is cancelled, reason been that no person would like to risk his life flying through squall cells or thunderstorm. Sometimes planes are grounded for safety reasons to avoid encounter with inclement weather such as snowstorms, hurricanes, fog, gusty wind, or as a result of high temperature, since aircraft are not suitable to fly when the temperature is extremely high (Enete & et al, 2015).

Despite the known problems associated with weather in air transport, especially in the tropic regions of the world. Not even the technological improvement in weather forecasting and understanding of weather could eliminate the adverse weather condition or the challenges that come with it. Many scholars have worked on accident due to weather, some looked at effect on passengers. But this work seeks to analyse the effect of adverse weather on both the aviation industry and passengers. It observes human attitude with regards to weather of a place. This work will tend to investigate the relationship between atmospheric weather vagaries and activities within transport sectors (Air transport), especially in Port Harcourt International Airport, Omagwa.

2. Study Area

Port Harcourt International Airport is situated at Omagwa in Ikwerre Local Government Area of Rivers State. It is a suburb of Port Harcourt City in Rivers State, Nigeria.

Port Harcourt and its environs lie very close to the ocean but have no orographic advantage, which by far outweighs the moderating influence of the sea. Consequently, mean annual temperature is only high but has a spatial sequence of slight increase with latitude. For instance, Port Harcourt records a mean annual temperature of 28^0C. Onne, which is further inland, records at temperature of 28.2^0C, while Bonny, on the coast records a mean annual temperature of 27^0C. This is a very important aspect of temperature distribution as it affects tourism. It shows the daily temperature rhythm, which coincides nicely with the net radiation within the 24 hours of the day. In the Port Harcourt region, the morning hours are cold. Temperature rises gradually and peaks around 2pm; between 4pm and 5pm, it becomes warm and peters to a cold situation again at night. The months of February, March and April record the highest temperatures. This gradually slopes down through May, June and more deeply in July and August. Consequently, July and August record the lowest mean monthly temperatures. Again, temperature rises through September, October and November. These months are periods of weather instability, with November marking the end of the rainy season. At this period cloud cover also reduces. The value of temperature is considerably reduced in the months of November and December (26.5^0C – 26.2^0C) because of the influence of the hamattarn. The seasonal variations in relative humidity are mainly due to the seasonal variation in the amount of insolation received at any given location on the globe. The apparent movement of the sun through the region creates two periods of low relative humidity separated by a period of high relative humidity. Generally, relative humidity is high over the entire region with mean annual figures at 85%. The rainy season months of June, July, August, September and October record the highest values. These months are very cloudy due to the strong presence of the south-westerly wind. Comparatively, the more northerly town of Onne, taking lower values both in annual amounts and seasonal march, revealing spatial variation even within short distances because of the nearness of the region to the sea. Like temperatures, monthly and annual relative humidity variations are very low.

Hamattarn, which is a dry cold wind, embedded in the Northeast trade wind blows over the Port Harcourt region from December to February. A study of hamattarn characteristics revealed that February has the highest intensity (5.68%) followed by January and December with (5.50%). Generally speaking, these intensities are very low, mainly due to the nearness of the area to the moderating influence of the sea. Another plausible reason is the fact that after its long trajectory, the hamattarn weakens as it reaches Port Harcourt. Its persistence, duration and reliability are very low with values at 12.48% for the month of January (Ede, 1999). It is erroneous to believe that the hamattarn has a moderating and soothing effect on the sultry weather conditions of Port Harcourt as per human comfort. Ede (1999) calculated the effective temperature index (ET) and wind chill index for the hamattarn months. No month had less than 27^0C (mean ET). Consequently, Port Harcourt is uncomfortable and

stressful during the hamattarn months. The mean wind chill figures viz: (20.29k, 33.45k, 63.21k and 68.94k) in January, February, November and December respectively, reveal relatively low wind chill which has a small soothing effect on the high ET., of December to February which shows slightly higher variations. This low temporal variation is consistent with the low seasonality and low variability in most climatic elements of the humid tropics.

The monthly rainfall in Port Harcourt is almost predictable and follows a temporal sequence of increase towards July-August before decreasing in the dry season months of November to February. Port Harcourt rainfall exhibits a double maxima regime. Rainfall is at its peak in July and September with a little dry season occurring in August. The highest monthly rainfall in July and September are 3496.1mm and 3578.4mm respectively. Port Harcourt experiences the July/August break otherwise known as the little dry season.

The little dry season, even though the actual time of occurrence varies. Many reasons have been advanced for the occurrence of the July/August break in the literature. These are the following among others: (1) the existence of well-marked anti-cyclonic flow coupled with marked in inversion; (2) coldness of the sea in mind summer, derived from eddies of cold water from the cold Benguela current; and (3) speed, direction and moisture divergence stemming from the high-pressure belt in the southern hemisphere moving towards the equator. These three factors they argued, act to reinforce each other in producing the July/August break.

It needs to be stated that the factor, which controls the temporal pattern of rainfall in Port Harcourt is the position of the Inter Tropical Discontinuity (ITD) at various locations during the course of the year. For example, the ITD is in its maximum location of 22^0N during July-August, and Port Harcourt during this period is completely under the strong influence of the ITD. During the months of January and February, the ITD is right inside the Atlantic Ocean with the dominance of the Northeast trades. Though there might be rain during the months of December, January and February, most of the rains received are unreliable and spotty due to the convective overturning of the southwest wind. Generally speaking, rainfall starts early in Port Harcourt and ends late. The mean onset date for Port Harcourt is 27th February. This temporal situation falls in line with the situation of the rain belt at this period.

The retreat of the rains begins generally from the middle of November. By this time, the maximum location of the ITD is about 16^0N at which time, most of the northern and middle belt parts of the country are already under the influence of the dry subsiding northeast trade winds. It should be noted that the southward retreat of the rains is faster than their northward advance. The mean decadal end of the rains in Port Harcourt is 26th November. In terms of the length of the rainy season which is also taken as the length of the period (in days) between the date of onset and date of end of the rainy season, the literature shows that there is no year when the length of the rainy season falls below 250 days. The mean length of the rainy season in the Port Harcourt region is 272 days.

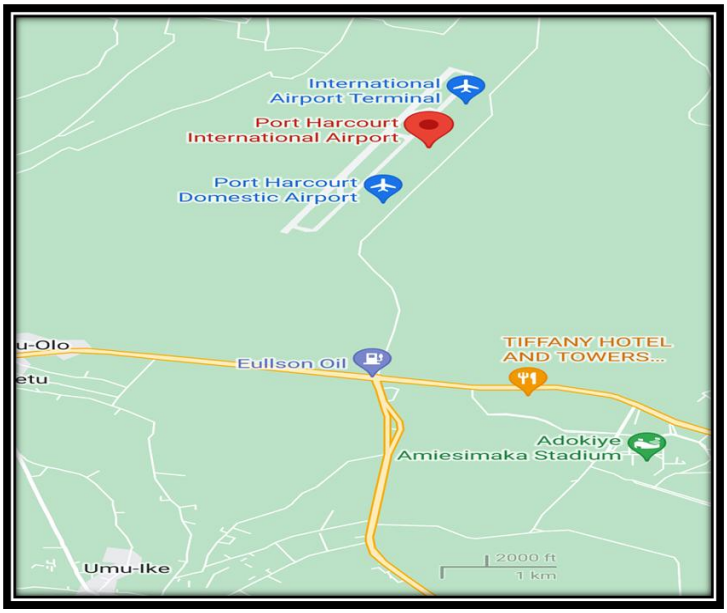

Figure 1. Map showing Port Harcourt International Airport

Source: Google Map, 2022.

3. Methodology

This work will make use of descriptive statistics like simple percentage and graphs for analysis. The research instrument used for the work includes among others, a well-structured questionnaire. The research developed a set of a questionnaire containing fifteen (15) items which was administered to respondents. The questionnaire was constructed based on a five-point likert scale.

The target population is the Port Harcourt International Airport, Omagwa. The crucial point of study is the causes of delay, cancellation and diversion of plane, and its consequences on passengers.

500 persons were selected for this work. Therefore 500 questionnaires were distributed to respondents. However, only 480 of the questionnaires were retrieved. This represents 96% of the respondents.

This work is set out in sections due to the technicalities of the subject matter. For instance, Section A deals with direct effect of adverse weather on air transport. In this section only 100 persons were interviewed based on their experience over time.

Among those interviewed, 280 were male and 200 were female. These represent 58.3% and 41.6% respectively. Those interviewed are shown in table 1 below.

Table 1. Respondents' classification and characteristics

Gender	480		%
Male		280	58.3%
Female		200	41.7%
Origin – P. H			
Destination			
Abuja	100		20.8%
Calabar	80		16.7%
Lagos	120		25%
International	100		20.8%
Others	80		16.7%
Total			100%
Section A	100		
Pilots		10	10%
Administrative Staff		50	50%
Air Host/ress		40	40%
Total		100	100%
Section B	480		
Staff		100	20.8%
Passengers		300	62.5%
Drivers		80	16.7%
Total		480	100%
Section C			
Passengers	300	300	100%

Source: Field survey, 2022

Section B, deal with the seasonality effect of adverse weather condition on air transport in the study area, while Section C, is concerned with the impact of adverse weather on the customer (Passenger).

It is important to note that different number of respondents is used in different sections of this work for analysis. The decision is based on technical knowledge of the respondents not just on the number of respondents available.

Table 2. The questions for the study

Section A: Question and response (100 respondents)	SA	A	DA	SDA	UD
Is adverse weather a challenge to air transport?	36	42	12	6	4
Are planes cancelled, delayed or diverted due to adverse weather?	43	51	0	0	6
Does adverse weather cause poor visibility for flight operators?	40	48	6	1	5
Do weather vagaries increase the rate of air accident?	35	25	20	16	4
Does travelling under adverse weather cause damage to airplane and equipment?	28	32	15	23	2
Section B: Question and responses (480)					
Does adverse weather occur throughout the year	0	42	260	170	8
Does heavy Rainfall/Thunderstorm occur seasonally?	183	245	28	24	0
Does low visibility occur seasonally?	336	96	24	0	24
Does sandstorm and dust storm affect air transport in the study area?	95	101	154	125	5
Does adverse weather-related flight cancellation occur more during extreme weathers?	192	182	72	34	0
Section C: Questions and response (300)					
Does flight cancellation, diversion or delay incur extra cost on passengers?	108	156	24	6	6
Does delay or cancellation of flight affect customers' patronage?	84	54	90	66	6
Does flight delay or cancellation affect customer's schedule?	157	128	0	0	15
Does cancellation of flight lead to making of alternative arrangement by passengers?	54	78	90	78	0
Does announcement of sudden weather change affect passenger's health?	126	129	30	15	0

Source: Field survey, 2022

4. Result and Discussions

The first question in Section A is "Is adverse weather a challenge to air transport?" 36 of the respondents (36%) strongly agreed that adverse weather is a challenge to air transport. Similarly, 42 respondents (42%) agreed that adverse weather is a challenge to air transport. But 12 of those interviewed (12%) disagreed that adverse weather can be a challenge to air transport. Further, 6 respondents (6%) strongly disagreed that adverse weather is a challenge to air transport. 4 of the respondents (4) were undecided in the matter as they did not answer the question.

The response shows that 78% of those interviewed are of the view that adverse weather is a challenge to air transport in the study area. However, 18% of the respondents are of the opinion that adverse weather is not a challenge to air transport. 4% were undecided in this question.

Figure 2 shows the graphic response of the respondents in pie chart. Based on the response of the majority, this study assert that adverse weather is inimical to air transport.

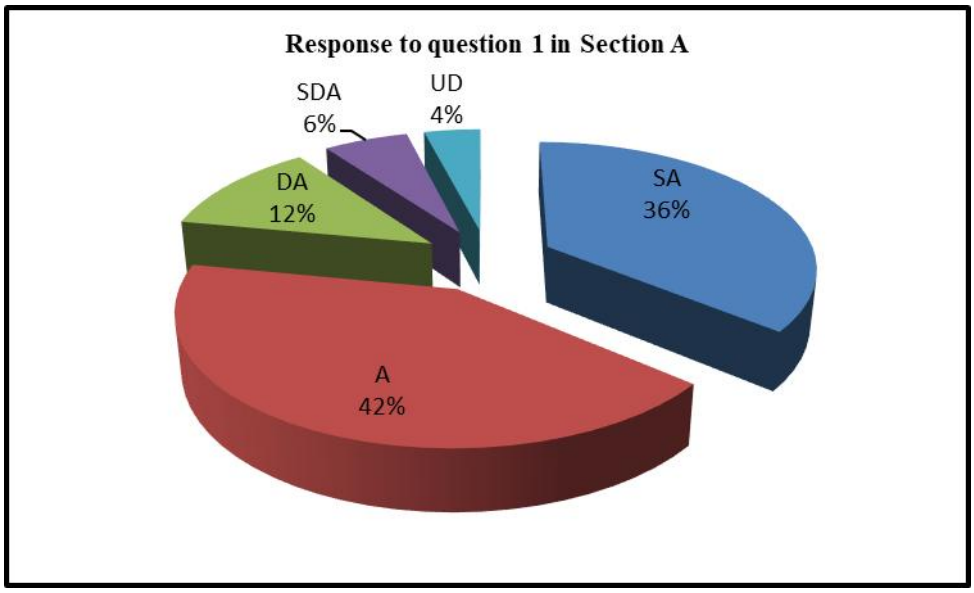

Figure 2. Response on relationship of adverse weather on air transport

The respondents' reaction on question 2 of Section (A) which is "Are plane cancelled, delayed or diverted as a result of adverse weather?" The response is shown in figure 3 of this work.

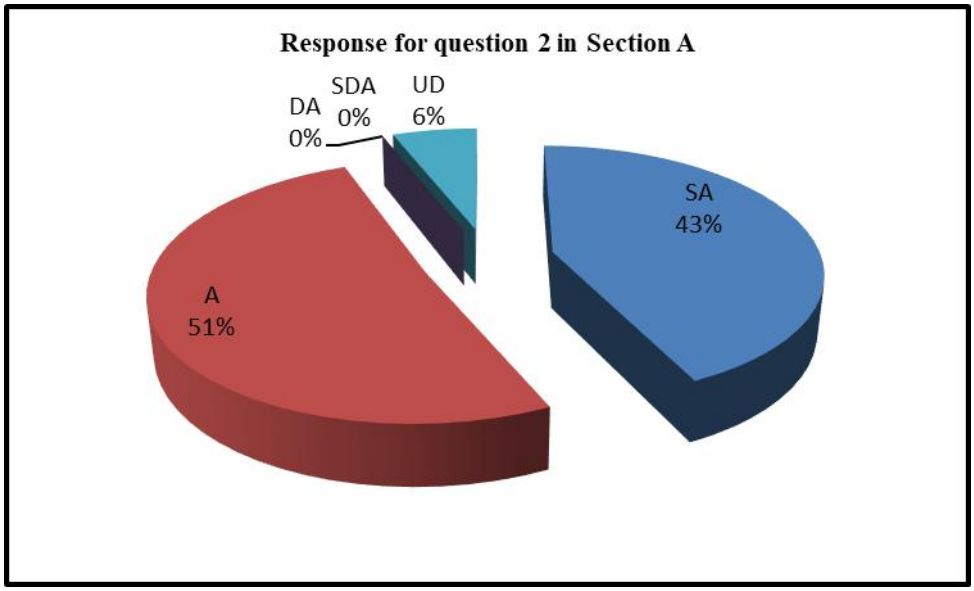

Figure 3. Response on effect of adverse weather on flight cancellation and delay

From figure 3, it is observed that 43% of the respondents strongly agreed that adverse weather can cause cancellation, delay and diversion of flight. 51% also agreed that adverse weather can lead to cancellation, delay or diversion of flight. From figure 3, it is observed that no person strongly disagreed or disagree the statement. This implies that adverse weather is obviously responsible to most of the delays, cancellations and diversions of airplane. Figure 3 shows that 6% of the respondents were undecided as to whether adverse weather is responsible to some cancellations of flight or not. The statistics available shows that adverse weather play key role in flight cancellation; delay in take-off and in landing and diversion of flight. In considering similarity in responses, the result shows that 94% of those interviewed are aware that adverse weather is a key factor in flight delay, either in take-off or in landing. It is also responsible to most of the cancellations or diversions of airplane in the study area. The negligible 6% that are undecided in the matter could be newly employed staff that lack experiences. This work assumed that if responses are regarded as data in figures, then adverse weather account for 94% of delay, cancellation or diversion of planes in the study area.

In responding to question 3 of Section A which states "Does adverse weather cause poor visibility for flight operators?" The response among other things shows that 40% of the respondents (40 persons) strongly agreed that adverse weather triggers poor visibility for operators of airplanes, and 48% of those interviewed (48 persons) agreed that it does affect operators' visibility. To the contrary 6 persons (6%) of the respondents disagreed that adverse weather could affect the operators' visibility. Similarly, I person (1%) of the respondents strongly disagree that adverse weather can impair operator's vision. Finally, it was observed that 5 persons representing 5% of those interviewed were indecisive.

The graphic response of respondents on question 3 of Section A is shown in figure 4.

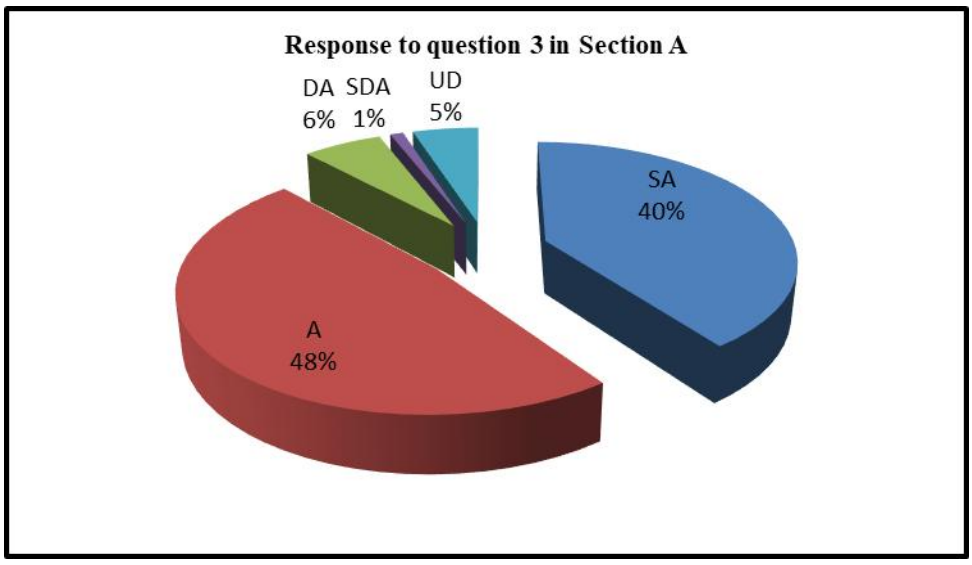

Figure 4. Response on effect of adverse weather on operator vision

The response of the respondents is an indication that inclement weather can affect the visibility of flight operators.

This work observed that 88% of the respondents either strongly agreed or agree that adverse weather affects operator vision. This implies that adverse weather is accountable or responsible for 88% of operators (Pilots) poor visibility while on air.

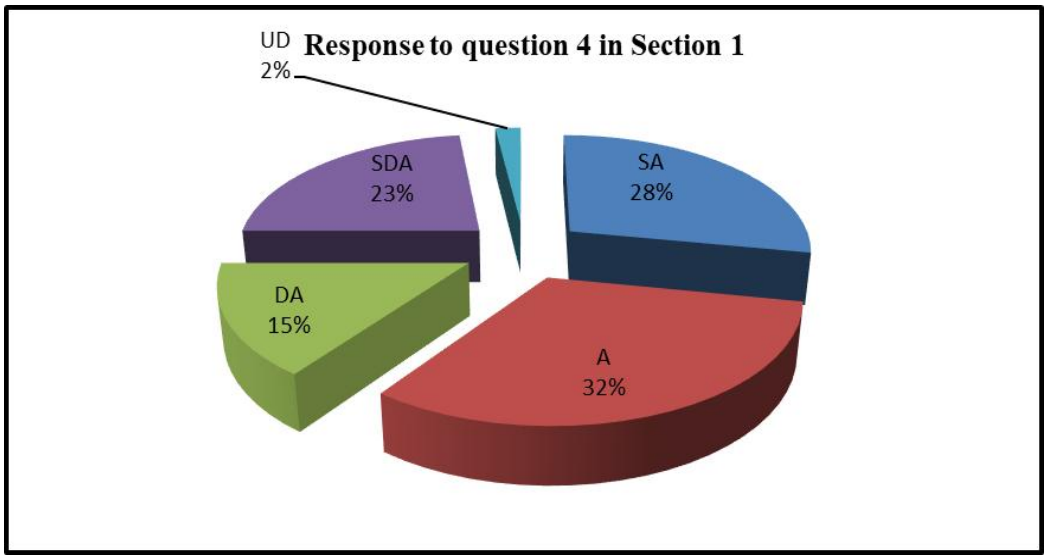

Figure 5. Response to if adverse weather instigates airplane accidents

Figure 5 shows the respondents' response on the question 4 of Section A "Do weather vagaries increase the rate of air accident?" 28 of the respondents (28%) strongly agree that it does, while 32 of the (32%) agree that adverse weather vagaries increase the rate of air accident. However, 15 respondents disagreed that adverse weather could increase rate of air accident. Similarly, 23persons (23%) of the respondents strongly disagree that adverse weather vagaries can increase the rate of air accident. Only 2 respondents (2%) were undecided on the issue.

From the foregoing, it shows that 60% of the respondents agree that adverse weather vagaries can increase the rate of air accident. Contrarily, 38% of the respondents are of the view that adverse weather vagaries do not increase the rate of air accident.

The analysis of the response in figure 5 showed that adverse weather can increase the rate of air accident. Adverse weather is beyond rainfall or high relative humidity. It includes all types of unpleasant weather condition. From the aforementioned, it is obvious that the situation can lead to poor visibility a situation that can accentuate air accident.

This work, therefore, agrees that adverse weather in the study area and indeed all over the globe increases the rate of accident. About 60% of air accident, in air transport is accountable by adverse weather. This position is based on the response of the respondents.

The question "Does travelling under adverse weather cause damage to airplane and equipment?" which is the number 5th question in Section A. The response of the respondents includes 28 respondents that strongly agree that travelling under adverse weather causes damage to planes and equipment. 32 persons representing 32% of the respondents agree that travelling under adverse weather can lead to plane accident and equipment damage. On the other hand, 15% of the respondents disagree that travelling in adverse weather can cause air crash or equipment damage. Similarly, 23% of the respondents strongly disagreed that adverse weather can lead to air accident or damage in equipment of airplane. Just 2% of those interviewed are naïve on the impact of adverse weather on travelling through it.

From figure 6 we observed that 60% of the respondents either strongly agree or agree that that travelling under adverse weather leads to air accident and damage of plane equipment. This implies that about 60% of plane equipment failures and accidents can be attributed to bad or adverse weather condition.

This view is supported by abundant literatures available for readers and researchers. Figure 6 shows the respondents' response on the question that has to do with the impact of weather on travelling under adverse weather.

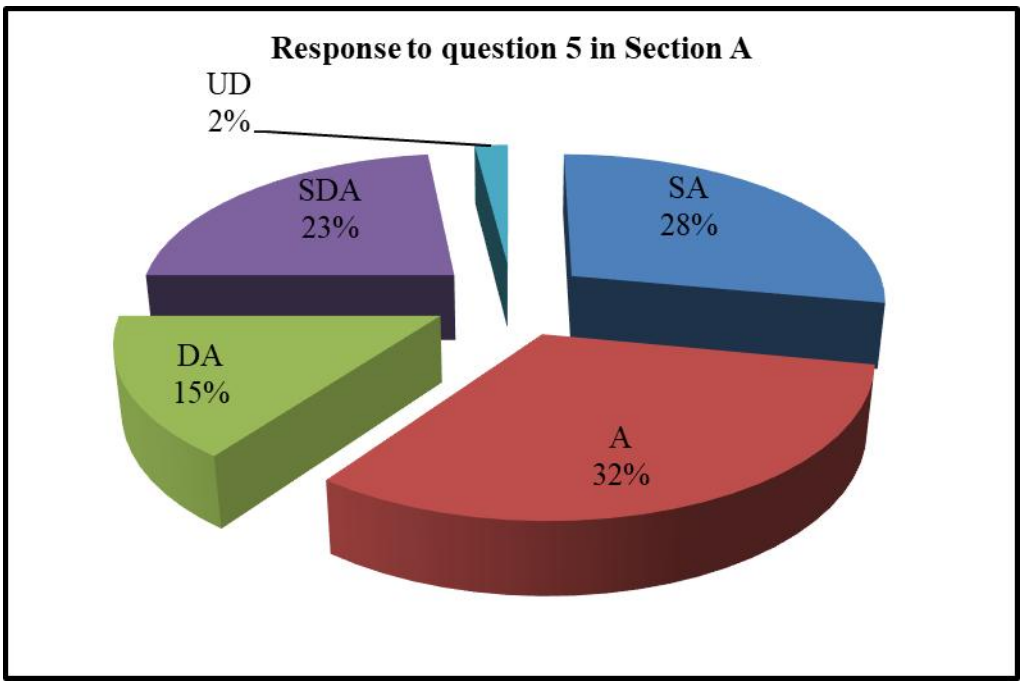

Figure 6. Response on the impact of adverse weather on Section B

480 persons were interviewed in Section B of the work. The responses from the interviewee are used for analysis.

The response to the first question in Section B is "Does adverse weather occur throughout the year" shows that 9% of the respondents (42) agreed that adverse weather occurs throughout the year, while 54% of the 480 persons (260) interviewed disagree that adverse weather occurs throughout the year. Similarly, 35% of the respondents (170) strongly disagree that adverse weather can occur throughout the year. Of those interviewed 2% (8) were undecided of whether it occurs throughout the year or not. This implies that only 9% of the 480 respondents representing 42 persons agreed that adverse weather condition occurs every month of the year. In the other hand, 430 of the respondents disagreed or strongly disagreed that adverse weather occurred throughout the year, this represents 89% of the respondents. 8 of the respondents (about 2%) were undecided.

The response of the respondents shows that adverse weather is seasonal and not all-time round, therefore the influences of adverse weather are seasonal. Figure 6 shows the characteristics and behaviour of the respondents.

The analysis shows that 89% of adverse weather occurred seasonally. It does not occur throughout the year. This explains why air transport weather-related problems does not occur always in the study area (Port Harcourt International Airport, Omagwa).

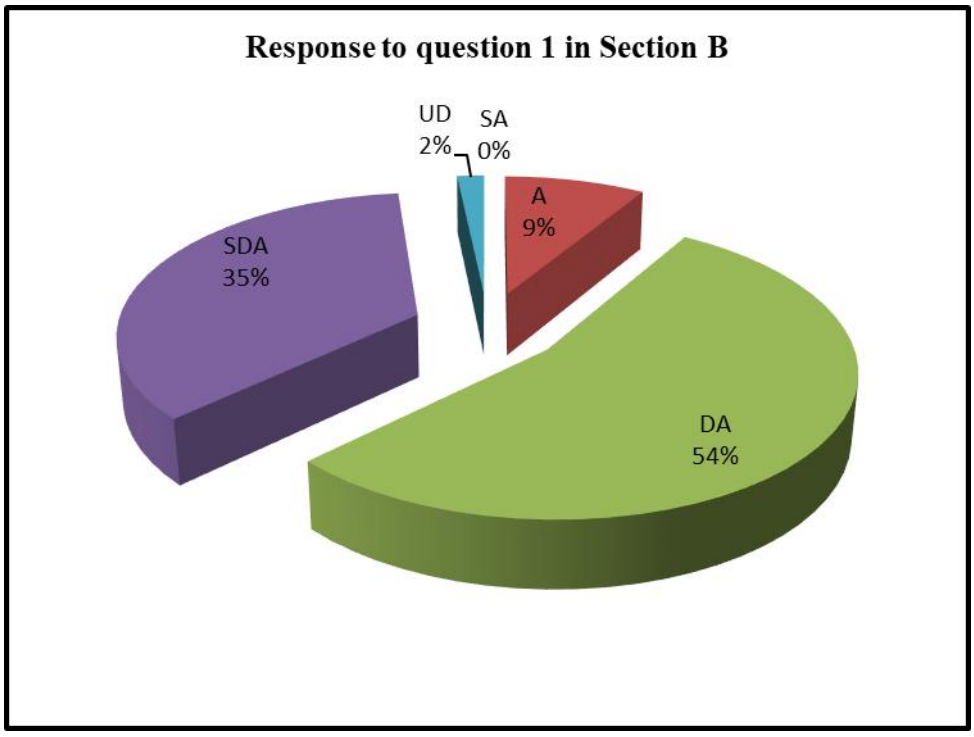

Figure 7. The response on adverse weather occurrence throughout the year

In response to the question "Does heavy Rainfall/Thunderstorm occur seasonally?" this is question 2 in Section B.

183 of the respondents strongly agreed that heavy rainfall and thunderstorm occur seasonally, this represents 38% of the respondents. 245 persons also agree that heavy rainfall and thunderstorm are also seasonal; this represents 51% of the 480 interviewed.

From the analysis as shown in figure 8, 6% of the respondents disagreed that rainfall and thunderstorm are seasonal events; likely, 5% strongly disagree that heavy rainfall and thunderstorm are seasonal; this represents 28 and 24 persons respectively.

This implies that 426 respondents representing 89% either agreed or strongly agreed that adverse weather condition like heavy rainfall and thunderstorm occurs at specific time of the year (seasonal). Only 11% of the respondents (54) disagreed or strongly disagree that the adverse weather conditions are seasonal. To them server weather condition can occur at any time of the year.

This work agrees that adverse weather conditions like heavy rainfall or thunderstorms occur seasonally. The researcher personal observation and documented literatures support the fact that server weather conditions are

seasonal events. In the study area severe rainfall starts during July-September and harmattern starts from December to January.

From the analysis, it was observed that 89% of adverse weather condition (Heavy rainfall and harmttern) is seasonal. The seasons are well documented in literature. Only 11% of adverse weather can occur in the study area by chance.

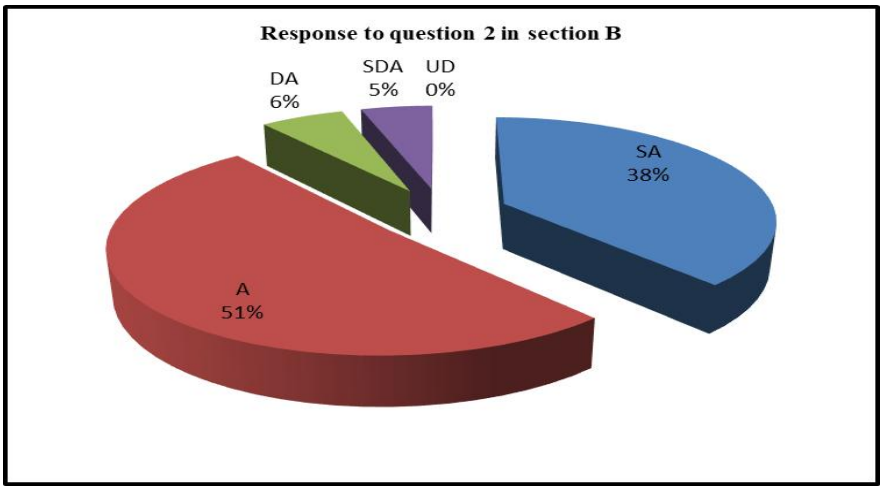

Figure 8. The response on seasonality of weather variables

Of the 480 persons interviewed on "If low visibility occurs seasonally?" which is question 3 of Section B. 336 respondents (70%) strongly agreed that low visibility, as a result of weather condition occurs seasonally. Additional 96 respondents (20%) strongly agree that low visibility issue is seasonal, but 24 of the respondents (5%) think otherwise. However, another 24 persons (5%) interviewed are indecisive on the matter. This implies 5% of those interviewed thinks that visibility issue occurs always, while another 5% does not know if visibility problem is seasonal or not.

Base on the analysis, this paper is of the view that season accounted for 90% of low visibility issues experienced by airplane operators. It is noticed that none of the respondents strongly disagreed that low visibility is seasonal. Meaning that those that disagreed are more likes those that are undecided. It may be that they are newly employed or new in air transport.

Figure 9 shows the respondents' responses on the question of low visibility time of occurrence.

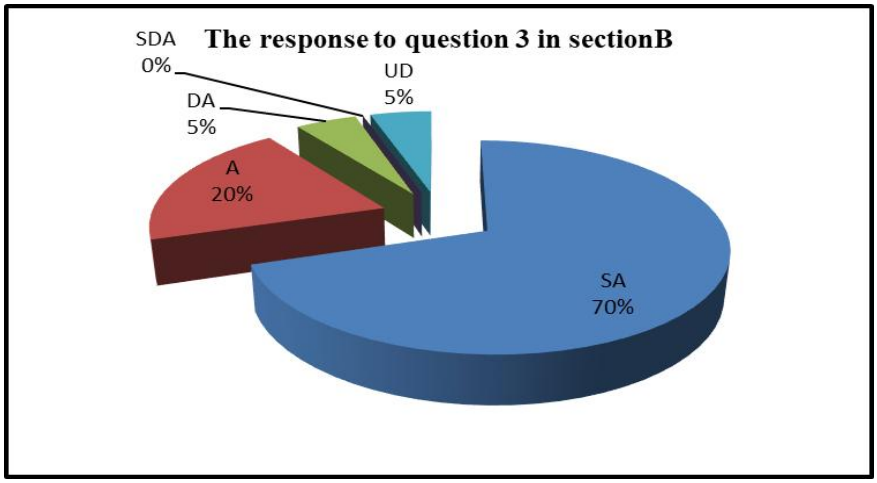

Figure 9. Response on low visibility time of occurrence

The question "Does sandstorm and dust storm affect air transport in the study area?" The analysis shows that 125 and 154 persons disagreed and strongly disagreed respectively, while 101 and 95 respondents strongly agreed or

agreed respectively that sandstorm and dust storm affect air transport in the study area. Of all the respondents only 5 persons were undecided as to whether sandstorm and dust storm affects air transport in the study area or not.

The analysis shows that 26% of the respondents disagreed, that sandstorm and dust storm affect air transport in the study area, similarly 32% strongly disagreed that the aforementioned variable affects air transport in Port Harcourt. This implies that 58% of the respondents representing 279 of the interviewees are sure that dust and sandstorm do not affect air transport in Port Harcourt, Rivers State.

101 representing 21% of the respondents accept that sandstorm or dust storm affects air transport in the study area. 95 of those interviewed which is 20% of the respondents strongly agreed that sandstorm or dust storm affect air transport.

However, 5 of the respondents representing 1% of all the respondents do not know if the aforementioned variables affect air transport or not.

Based on the analysis, it was observed that sandstorm and dust storm does not affect air transport in the study area. This implies that at least 58% of the factors affecting air transport in Port Harcourt have nothing to do with sandstorm or dust storm. This is true because Port Harcourt is a humid tropic region, with rainy months throughout the year.

The closeness between the respondents could be that harmattern is mistaking to sandstorm or dust storm. The only way sandstorm can affect air transport in Port Harcourt is via the incoming planes from areas like Kano, Kaduna, Abuja or International planes passing through the Sahara Desert.

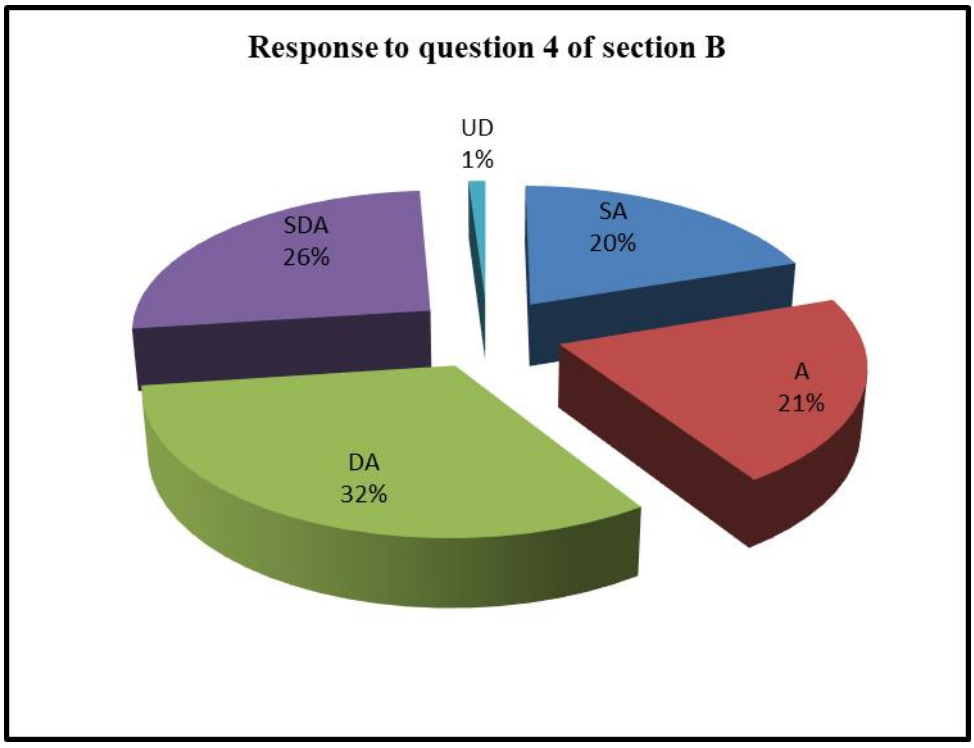

Figure 10. Response on effect of sandstorm/dust storm on air transport

Does adverse weather-related flight cancellation occur more during extreme weather? In response to question 5 of Section B, 192 of the respondents strongly agree that flight cancellations occur more during the extreme weather condition of either rainfall or harmattern. This number represents 40% of those interviewed. Another 182 respondents agreed that most flight cancellation occurs during extreme weather. The number represented 38% of the respondents.

72 of those interviewed (15%) disagreed that cancellation of flight occurs more during the extreme weather period of rainy season and harmattern. Similarly, 34 of the respondents (7%) strongly disagreed, that flight cancellation come more during extreme weather period.

From the analysis, and in taking like terms together it was observed that 78% of flight cancellation relating to adverse weather condition occurs during extreme weather. Therefore, it is deduced that extreme weather

accounted for about 78% of weather-related flight cancellations in Port Harcourt. It is true that other factor can lead to flight cancellation, but observation shows that extreme weather is more responsible to flight cancellation than other causes. Our observation shows that 22% accounted for other factor responsible for flight cancellation. Figure 11 shows the respondents' opinions and reactions to the question.

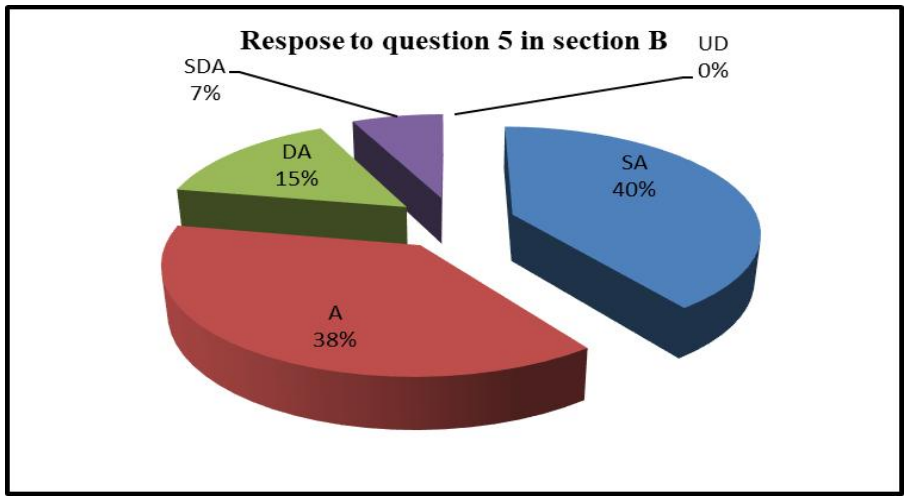

Figure 11. Response to the effect of adverse weather on flight cancellation

In Section C the number of respondents is 300. These 300 persons are just passengers who experience the effect of adverse weather. The responses to the first question, "Does flight cancellation, diversion or delay incur extra cost on passengers?" Has the following reaction.

108 respondents which is (36%) strongly agrees that aircraft cancellation, diversion and delay incur extra cost on passengers. 156 of the respondents representing (52%) agreed that delay, diversion and cancellation of flight, causes the passengers to spend more.

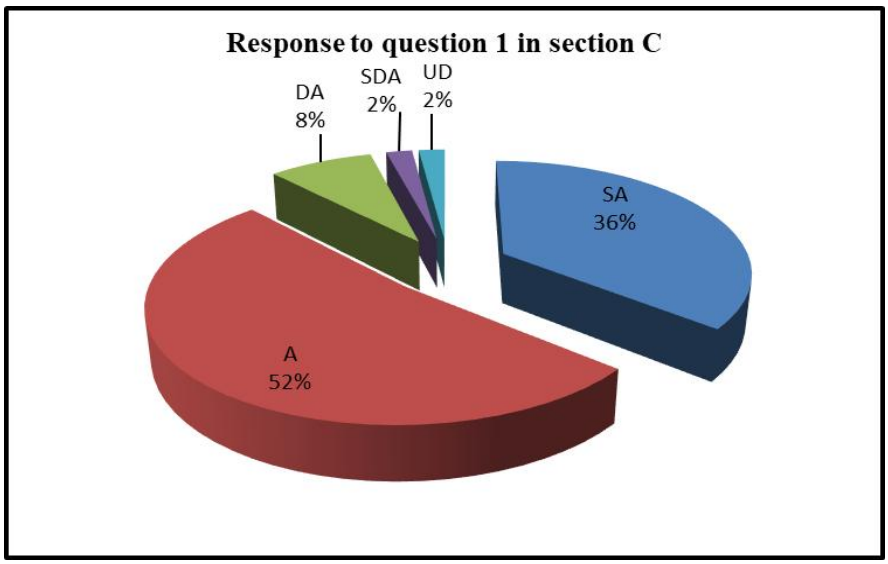

Figure 12. Response to effect of flight cancellation on passenger income

The analysis shows that 24 respondents (8%) of those interviewed are of the view that adverse weather does not affect the passenger's income, similarly 6 respondents (2%) strongly disagree that flight cancellation can affect the passenger's income. 6 persons (2%) are not certain if flight cancellation, delay or diversion can affect the passenger's income.

Based on the analysis, it was observed that 264 respondents representing (88%) of those interviewed stated that

flight cancellation, delay and diversion can incur more expenses on the passengers. 30 of the respondents (10%) were of the view that flight cancellation, delay and diversion does not affect the passenger's expenses or income.

This paper based on the finding from the respondents' reaction is of the view that flight cancellations, flight delay and diversion actually incur more expenses on the passengers. Observation shows that calling, buying of stuff and some other things will cause waiting passengers to spend more which would have been prevented if they are on board.

The 300 respondents' reaction to the question, "Does delay or cancellation of flight affect customers' patronage?" shows that 84 of the respondents strongly agree that delay and flight cancellation affect customers patronage of an airline. Closely to that, 54 respondents agree that flight delay and cancellation does affect customer patronage. But in the other hand, 90 of those interviewed are of the view that flight delay and cancellation does not affect the customers' loyalty or patronage. Similarly, 66 respondents strongly disagree, that flight delay or cancellation can affect the customer's patronage. Only 6 persons were undecided, which imply that they are not sure if flight delay or cancellation can affect customer's patronage.

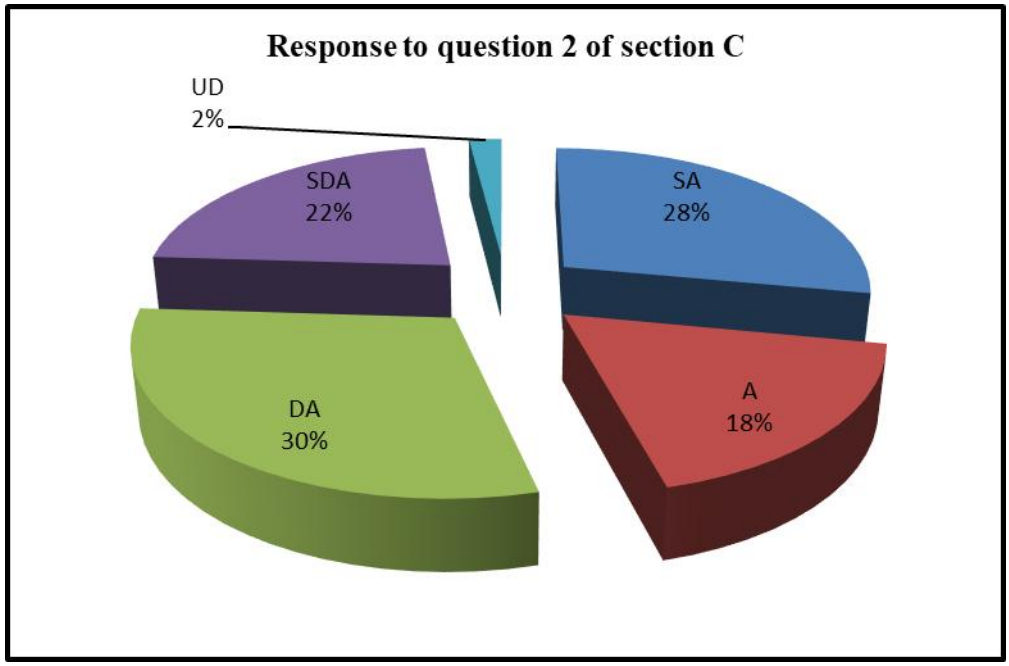

Figure 13. The response on the effect of delay and cancellation on customer patronage

From figure 13 it was observed that 46% which represents 138 respondents are of the view that flight cancellation or delay can affect customer's patronage. 156 respondents (52%) did not agree that flight delay and cancellation will affect customer's patronage. Just 6 of the respondents (2%) of those interviewed are indecisive of the effect of flight delay and cancellation on customer's patronage.

As seen from figure 13, the popular opinion was that 52% of the respondents were sure that flight delay and cancellation does not affect customer's patronage. This implies that customer's loyalty is not affected by flight delay or cancellation.

Does flight delay or cancellation affect customer's schedule? This is the third question for Section B and the response including the following reactions? 157 respondents strongly agree that flight delay and cancellation affect customer's individual schedule.

128 respondents agree that flight delay and cancellation affect passenger's individual schedule. This implies that 285 respondents (95%) are of the opinion that flight delay and cancellation affect individual schedule.

No respondent disagreed, that flight delay and cancellation affect the passengers' schedule.

However, it was observed that 15 persons representing (5%) of those interviewed does not know if flight delay or cancellation affects customer's schedule or not.

Based on the analysis, it is obvious that flight delay and cancellation actually affects individual customer's schedule.

Observation shows that delay flight and cancellation impact on passenger's schedule. The reason for travelling is

to meet up targeted time, and any delay will affect the schedule.

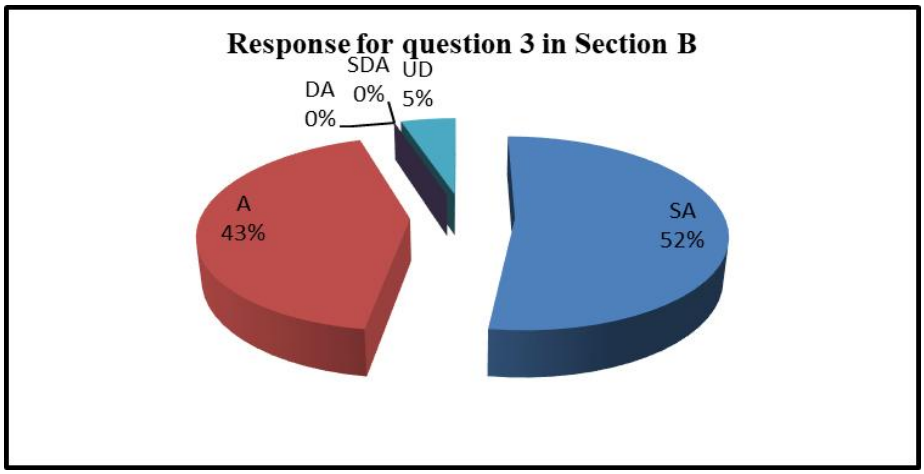

Figure 14. Response on effect of flight delay and cancellation of customer's schedule

54 of those interviewed in an attempt to answer the fourth question of Section B strongly agree that cancellation of flight leads to making of alternative arrangement by passengers. Similarly, 78 respondents agreed that flight cancellation will force passengers to make alternative arrangement. 90 respondents disagreed that flight cancellation will cause the passengers to making alternate arrangement for travelling. Similarly, 78 of the respondents strongly disagree that passengers will make alternative arrangement as a result of flight cancellation. From the analysis, it was observed that 168 respondents either strongly disagree or disagreed that passenger will make alternative arrangement as a result of flight cancellation.

Observation proves that most of the passengers are seen stranded in airports several hours or days after flight cancellations, though negligible numbers based on statues and urgency can make alternative arrangement. This number is very few to warrant a generalization.

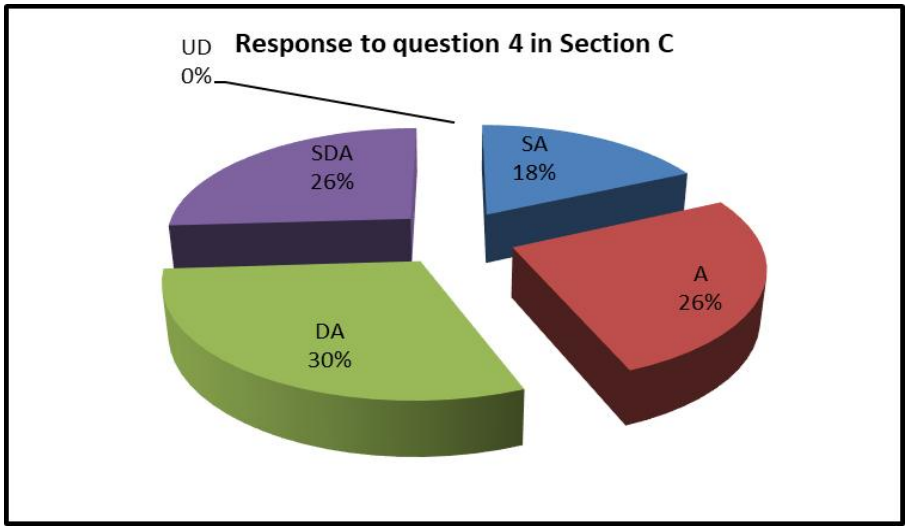

Figure 15. Response on the effect of flight cancellation on alternative arrangement

Analysis base on figure 15 shows that 44% of the respondents strongly or agreed that flight cancellation will lead to passengers making alternative arrangement for travelling. But 56% of the respondents either strongly disagree or disagree to the notion that flight cancellation leads to customers making alternative arrangement.

This work base on observation in airport outside this work agreed that flight cancellation based on adverse weather condition does not allow for customers making alternative flight arrangement. Since the same adverse condition will affect other planes.

Alternative arrangement can be made if the reason for flight cancellation is mechanical or technical in nature. So, 56% of flight cancellation that does not allow passengers opportunity of making alternative arrangement is most likely due to adverse weather. In the study area most of the flight cancellations are due to bad weather condition.

Of interest, none of the respondents were unaware of the impact of weather-related flight cancellation on passengers' alternative arrangement. This work assumed that some of the respondents that presumed that alternative arrangement is a solution to flight cancellation may be thinking of flight cancellation as a result of other causes, not just weather.

The final question "Does announcement of sudden weather change affect passenger's health?" shows that 126 of those interviewed (42%) strongly agree that sudden announcement of bad weather affects passengers' health conditions and 129 of the respondents (43%) just agree that sudden announcement of change to adverse weather affects passengers' health. But 30 of the respondents disagreed that sudden announcement of change in vagaries of weather does not affect passengers' health, similarly, 15 people representing 15 of the respondents stated that the announcement of adverse weather does not affect passengers' health. None of those interviewed were undecided.

From the response as shown in figure 15, it was observed that 85% which represent 255 respondents believes that abrupt announcement of adverse weather affects passengers' health. This implies that sudden announcement of adverse weather can trigger health risk of passengers.

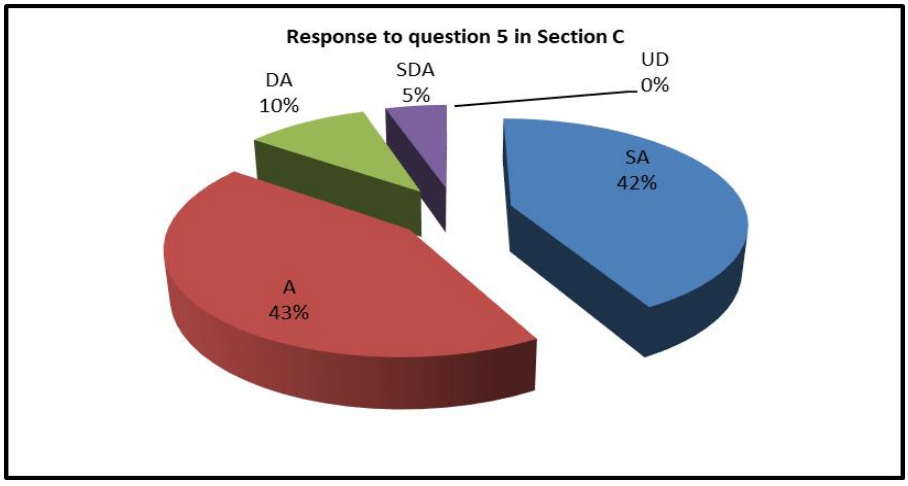

Figure 16. Response on effect of sudden adverse weather announcement on passenger health

5. Conclusion

This work has found among other things that adverse weather is a big challenge to air transport in Nigeria and Port Harcourt International Airport in particular. Air transport suffers delay in take-off or landing, diversion to a different destination and in cancellation of flight as a result of adverse weather.

It has also been noted that operators' visibility is affected by adverse weather. Besides, accidents, and damages are enhanced by bad weather.

Bad weather also affects individual passengers' personal schedules and causes them to spend more. It is also important to note that adverse weather is seasonal and can be predicted.

This work observed that delay as result of poor weather condition does not force passengers to make alternative arrangement of air transport. This implies that adverse weather cannot be manipulated by airlines to gain more customers.

Based on the findings of this work, it is observed that accident and damage resulting from adverse weather can be eliminated or minimised if forecast is spot on, and the forecasting garget is standard.

6. Recommendations

- ✓ Reliable and well-equipped weather station with precise forecast instruments should be established, not only in the airport, but in strategic locations within the State.
- ✓ Passengers must be trained to be patience and more relaxed.
- ✓ Customers with poor health condition should not be allowed to travel during adverse weather prone

period, unless on health ground.

- ✓ Aviation officers should plan flight schedule base on the weather forecast report of the area, especially during the peak adverse weather period.
- ✓ Since flight delay, diversion or cancellation is not caused by customers, se proposed that when it happens, the airlines will offset some of the passenger's cost, by providing them with free data, recharge card and light refreshment.
- ✓ All weather planes should be invented to minimize the impact of weather on air transport.
- ✓ Experts should be saddle with the responsibility of weather forecast and this information should be displayed days before departure.

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