REAL-TIME WEATHER UPDATES INFORMATION SYSTEM FOR AVIATION:

A CASE OF UGANDA NATIONAL METEOROLOGICAL AUTHORITY (UNMA)

BY

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DECLARATION

I, **Nabada Aisha**, affirm that this is my original report and has never been submitted for any other degree award to any other university before.

…… ……..……

Nabada Aisha Date

APPROVAL

This dissertation was prepared by **Nabada Aisha** under my supervision and is ready for submission to the school of graduate studies and research.

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DEDICATION

To my beloved husband, Mr. Nyamujunga Alex Festus, my children- Mercy, Praise, Faith and Ebenezer for the patience during my study.

I dedicate this work also to my dear late Uncle Tusiime Charles Lwanga (RIP) who passed on September 2018, for his encouragement and the background he laid for my education.

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ABSTRACT

In aviation industry, pilots cannot fly a plane without a weather update. Every pilot must get a weather report termed as a briefing folder. Without a weather report, all flights are cancelled. The process of updating pilots about the weather using briefing folders is done manually; this in many cases delays flight and sometimes leads to cancellation of flights, which hinders the schedule for the users of aircraft. Furthermore, while in transit, pilots could not get instant weather updates in situation of abrupt changes in weather. Therefore, the study developed real time weather updates information system for aviation as a contribution to solve the problem.

The study objectives were to; review the existing system and determine the requirements for the new system; design the prototype of real time weather updates information system for aviation, implement, test and validate the real time information system for aviation to enhance service delivery. The study was carried out at Uganda National Meteorological authority (UNMA) briefing office at Entebbe International Airport. The data was collected using interviews and on site observation.

Findings of the study confirmed the need to develop a real time weather update information system for aviation for briefing officers in UNMA to give timely weather updates to pilots and cut the costs of printing and for effective service delivery to the aviation industry at Entebbe International Airport.

The system was designed, and implemented basing on the study findings, which were used to formulate the system requirements. The real-time weather update information system has been tested and validated and it is now ready for use.

ACRONYMS

BF	Briefing Folder
CCCC	Station Block code
Dddf	Wind Speed and Direction
DFD	Data Flow Diagrams
ERD	Entity Relationship Diagram
F L	Flight Level
FAA	Federal Aviation Administration
IPCC	Inter-Governmental Panel on Climate Change
Metar	Meteorological Aviation Report
MWO	Meteorological Watch Office
NCCH2 NCCHM NCCHH	Low ,Medium and High Clouds
NMC	National Meteorological Centre
PF	Pilot Flying
PNF	Pilot Not to Fly
QAN	Wind speed and direction
QFE	Pressure at station level
QMU	Temperature

QNH	Pressure at mean sea level
RE W^1W^1	Recent Weather
TT/TDTD	Air temperature and dew point temperature
UNMA	Uganda National Meteorological Authority
VFR	Visual Flight Rule
VVV	Visibility
W^1W^1	Present weather
YYGG	Date and Time

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The weather updates information system is a system, which can provide real-time weather information and display it to pilots for flight purposes. (Meteo France international, 2019).
Globally 20% to 30% air accidents result from adverse weather conditions, while 22% of air traffic delays in Europe are due to bad weather, (Christian, 2010)

According to the weather theory by Phak (2008), weather affects the performance and safety of flying. Weather is the state of atmosphere for a short period. The different elements of weather such as Pressure, Temperature, cloud cover wind and others affect the flying activities of an air craft therefore the approach of giving the weather updates to pilots should be done in a convenient way to avoid aircraft accidents.

The basic weather theory offers pilots background knowledge of weather principles.

It is designed to help pilots gain a good understanding of how weather affects daily flying activities, which helps them make sound weather decisions based on the reports and forecasts obtained from a Flight Service Station (FSS) weather specialist and other aviation weather services.

The atmosphere is a blanket of air made up of a mixture of gases that surrounds the Earth and reaches almost 350 miles from the surface of the Earth as stated by (Phak, 2008). This mixture is in constant motion. If the atmosphere were visible, it might look like an ocean with spins and eddies, rising and falling air, and waves that travel for boundless distances.

The atmosphere, solar energy, and the planet's magnetic fields support life on Earth. The atmosphere absorbs energy from the sun, recycles water and other chemicals, and works with the electrical and magnetic forces to provide a moderate climate. The atmosphere also protects life on Earth from high-energy radiation and the frigid vacuum of space. The Atmosphere in any given volume of air is made up of nitrogen 78 percent of the gases that comprise the atmosphere, while oxygen makes up 21 percent. Argon, carbon dioxide, and traces of other gases make up the

remaining one percent. This volume of air also contains some water vapor, varying from zero to about five percent by volume (Phak, 2008)

This small amount of water vapor is responsible for major changes in the weather .The gases surrounding the Earth changes from the ground up. Four distinct layers or spheres of the atmosphere have been identified using thermal characteristics (temperature changes), chemical composition, movement, and density. The massive majority of weather, clouds, storms, and temperature variances occur within this first layer of the atmosphere. Therefore, the Pilot is supposed to get all this information since the flight takes place in all the layers for better decision making before and during the flight.

Uganda National Meteorological Authority (UNMA) is an institution for weather and climate

Services. The Authority promotes and monitors weather and climate as well as offering weather predictions and advisories to the public for use in planning and support the development of the country according to UNMA Act. (UNMA Act, 2012).

The Directorate of forecasting Services (DFS) makes products for different clients such as daily advisories and forecasts for Aviation. It also collects data for weather conditions over the country's airspace and makes daily weather forecasts for the public. The weather advisories for aviation are mainly given to pilots manually in printed form, a process called Pilot briefing, before take-off from Entebbe International Airport. (UNMA, 2019).

Technology is changing so fast in the aviation industry, which necessitates meteorological weather information providers also to advance in new and more efficient services in order to meet the demands of airlines and passengers. (CAA Uganda, 2018).

The National Aviation Master Plan projects 930 incoming travelers and 820 travelers outgoing throughout the busy hours, by 2033 (CAA Uganda, 2018).

UNMA Budget 2016/2017, and 2017/2018 indicated an increase in costs for Printing accessories used to print the pilot briefing information(briefing folder) from UGX14 million to 21.4 million (UNMA, 2019). This was a key indicator of the increasing number of flights and hence increasing printing of the Meteorological flight information.

All the above indicated that the number of flights at Entebbe international airport was increasing day by day, which required an advancement in technology to all Aviation service providers for effective service delivery.

This required a real-time weather updates information system for aviation for effective service delivery and reduction on the costs of printing the weather reports by briefing officers.

The aeronautical Department at NMC Entebbe, receives on daily basis a copy of "MAY FLY LIST" from the airport authorities (UNMA, 2019). The "MAYFLY LIST" encompasses the details of the anticipated aircrafts to land and take off at Entebbe international Airport.

The briefing officer bases on that document to prepare the weather update or a briefing folder for flights indicated in the document.

1.2 Problem Statement

Aviation is one of the most important departments for economic development of any nation. Uganda aviation industry is supported by Uganda National Meteorological Authority weather status updates. With the increasing number of aircrafts using Entebbe international airport, the number of pilots checking weather information for aviation is equally increasing hence requiring efficiency in service delivery (UNMA, 2019).In aviation industry, pilots cannot fly a plane without a weather update. Every pilot must get weather information file termed as briefing folder.

Without this information file, a plane cannot take off since most aviation accidents and incidents are weather related (Prdier-Vabre *et al*,(2008).According to Lester (2012), most aviation accidents are as a result of how the briefing process is conducted.

The processes of updating pilots about the weather using briefing folders by UNMA briefing officers is done manually; this in many cases delays flights and sometimes leads to cancellation of flights, which distresses many users of aircraft. Further, while in transit, pilots could not get instant weather updates in situation of abrupt changes in weather.

Therefore, the study developed real time weather updates information system for aviation as a contribution of solution to the problem.

1.2 Purpose

The purpose of the study was to develop Real-Time weather updates information system for aviation for pilots to view the weather updates.

1.3 Specific objectives

a) To review the existing literature and determine the requirements for the new system.
b) To design the prototype of real time weather updates information system for aviation
c) To implement the real time weather updates information system for aviation.
d) To test and validate the system in terms of service delivery.

1.4 Significance of the study

The real-time system designed if adopted may provide timely weather updates to pilots. This may help them to plan their flights on time, which may enhance the safety of flights.

The pilots may be able to view the briefing folder displays online without physically reaching UNMA briefing office.

This research will help UNMA to eliminate the issuing of printed briefing folder to pilots and cut on costs in terms of money spent on buying toner and papers for printing.

The system designed may create a conducive working environment for the briefing officers since the queues for pilots and Airline Agents may be no more.

The study may provide and add knowledge to existing literature in higher Institutions of learning and may act as a foundation for further research in the same area.

Scope of the study

This section contains what the study covers, where the research was carried out, the sample size from which the data was collected and the period when it was done.

Content Scope: The study was to develop a real-time weather update information system for aviation for Pilots to view the weather updates online. The study considered a sample size of 24 respondents from which the data was collected.

Geographical Scope: The research was carried out at UNMA National Meteorological Centre (NMC) briefing office, Entebbe International Airport Terminal building, 42 kilometres from Kampala capital city's business centre, located 00°02'41"N, 032°26'35"E (Latitude: 0.044721; 32.443055) .

Time Scope: The research focused on the content from UNMA budget 2016/2017, National Aviation Master Plan (CAA Uganda, 2018) and briefing folders for Entebbe international Airport from 2016 to 2019.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviewed and discussed literature related to this study. It discussed information systems, the relevance of weather updates (briefing) to aviation, briefing overview, types of briefing and the technologies used to brief the pilots.

2.1 Information systems.

An Information system is a joined set of components for collecting, storing, processing data and providing information, knowledge, and digital products (Zwaas, 2019).

In a study by Boell & Kecmanovic, 2015, an information system is a work system whose processes and activities are dedicated to processing information, that is, capturing and transmitting, storing, retrieving, manipulating, and displaying information.

The main components of an information system are computer hardware and software, telecommunication, data and databases, human resources and procedures that integrate to perform input, process, output, feedback and control (Juneja, 2019).

Hardware is made up of input/output device, processor, and operating system and media devices. Software comprises of various programs and procedures. Database encompasses data arranged in a required format. Network comprises of hubs, communication media and network devices. The people are device operators, network administrators and system specialist (Juneja, 2019).

Information processing is made up of input, data processing, data storage, output and control. Information systems classification can be based on the usage of the information, therefore, an information system in an organization can be divided into; operations support system and management support system (Management study guide, 2019)

2.1.2 Significance of information systems

The systems deliver the main structures of administering an organization, such as communication, record keeping, decision-making and data analysis, which helps an organization to advance in their business operations and gain a competitive advantage (Picincu, 2018).

Hence, the real-time weather updates information system for Aviation is expected to be of the same value to UNMA.

2.1.3. Types of information systems.

2.1.3.1 Operations support systems

The data input by the end user is handled to generate information used by internal and external users to facilitate business transaction, control production, support internal as well as external communication, and update organization central database for example transaction-processing systems, processing control systems and enterprise collaboration systems. (Management study guide, 2019).

2.1.3.2 Transaction Processing System (TPS)

The system captures and processes information necessary to update data on the important operations of an organization (Zandbergen, 2019).

2.1.3.3 Process Control System

Process control systems are computer systems designed to work without any human intervention for example systems that monitor and control industrial physical processes.

2.1.3.4 Enterprise Collaboration System

These systems facilitate teams to work together without necessarily being in the same place at the same time but able to share data and communicate collectively (Vrounters, 2020) for example video conferencing systems.

2.1.3.5 Management Support System

These are systems, which convert data into information, which can be used at management level to support different decisions. Examples are management information systems, decision support systems, expert systems and accounting information systems.

The real time systems are both process control and enterprise collaboration systems (Kiriger & Feirror, 2019).

A real-time computer system must respond to provocations from the measured purpose by the operator within a period assigned by its situation (Juvva, 1998). Therefore, this research aimed at designing a real-time weather updates information system for aviation to enable Pilots and briefing officers communicate collaboratively.

2.2. The relevance of Weather updates to Aviation

The process of giving weather updates to pilots to prepare for the upcoming flight is called Briefing.

Most aircraft accidents are connected to how the briefing process is conducted since the accidents and incidents are weather related. (Lester, 2012).

Flight Safety Foundation, (1998-1999) discloses that most cases and misfortunes related to aviation are due to inadequate knowledge of current weather conditions, and failure in coordination between Crew and the weather forecasters.

Weather services (briefing) help aviation to reduce the use of fuel and fuel-related operating costs that lead to improved safety since the Pilot can be able to avoid turbulence and severe winds during flight (Kwabena, 2017).
The safety of an aircraft during flights is affected by weather-related hazards such as fog, poor visibility, clear air turbulence, mountain wave turbulence, thunderstorms, microbursts from thunderstorms, and wind shear((Malala; undated).

Weather is also the cause of flight delays and diversions as stated by (Chalk, 1987) (Rose, 1992), (Houle, 2015) and therefore a pilot is not supposed to take any decision without first putting the weather information into consideration" (Consortium, 2012).
Aviation depends on the weather status updates since a plane cannot take off without a weather report for the route to be used (page, 2010). Most aviation accidents are as a result of how the briefing process is conducted (Lester, 2012).

This study aimed at finding out the existing system being used at Entebbe international Airport, its weaknesses and comparing it with the literature reviewed in order to come up with the best alternative that would be used at Entebbe international airport.

In conclusion, accessing weather updates for take-off ,en-route and destination is necessary when a pilot is preparing for the forthcoming flight, otherwise a flight without considering

weather can lead to aircraft accidents, loss of lives, delays and diversions of an aircraft as stated by Consortium (2012).

2.3.1 Briefing Overview

Briefing is a key part of flight research and require weather experts and pilots to work together and select all operating data appropriate to the upcoming flight. The pilots can interact with the system to obtain aviation-specific weather for the entire area or for his specific route and make decisions (Lodha, 2002).

To realize the safety and effective benefits of good flight preparation, all pilots should strive for high quality and timely weather briefing information. (SKYbrary, 2018)

Weather briefing information is very important for the pilots and crewmembers' interaction because often-permanent decisions are made before and during the flight in case there is change of weather (Flight Safety Foundation standard, 2014).

By the end of flight-preparation stage, the pilot and the crew should have a general abstract model of the flight plan and possible difficulties that might arise in normal flights. In addition, the crew should agree upon actions to follow, in case of sudden change in weather that might interrupt the usual plan of flights along the flight route (SKYbrary, 2018).

The pilot should receive takeoff briefing when the aircraft is at the gate or about to take off and the descent preparation should be completed in less than minutes before reaching the top-of-descent (FAA, 2003). This can be achievable with a real-time weather updates information system because pilots will be able to login, and directly view the weather reports for the flight route at their time of convince.

The importance of briefing is often underrated, the style of briefing play an important role (Prinzo, 2007). Collaborative briefings provide the pilots with a chance to communicate and to check and correct each other as necessary for example confirming the use of the correct departure and approach charts.

The pilot flying conducts takeoff briefing, which enables him to inform the Pilot not flying, of the planned course of actions for example expectations, roles and responsibilities, unique requirements for both normal and abnormal conditions during takeoff.

The flight management system guides on the process of take-off briefing internationally through the visualization of paper or electronic charts that indicate the departure route and several data entries, which is not the case for Entebbe International Airport.

Takeoff briefing must be complete and based on thorough situational awareness gained from the available data published on the briefing information system (real-time weather update information system), which is lacking on the side of UNMA.

The briefer is to select relevant information for the flight effectively; briefers need to capture as much information as possible about the proposed flight (Aviation weather Service Guide, 2017). This guided the researcher on designing the system to cater for all the functionalities discussed in this section.

2.3.2 Different types of briefing

The weather specialists to offer suitable weather briefing, they need to know which of the three types of briefings is required, standard, abbreviated, or outlook (Buck, 2013).

2.3.2 .1 Standard Briefing

A standard briefing provides the following information in order as it is valid to the route of flight (Zimmerman, 2016).

1. Adverse conditions—this gives information about adverse conditions that may lead to cancel or alter the route of flight. These conditions include thunderstorms, aircraft icing, and airport closings.
2. Visual flight rule (VFR) flight not recommended-If the weather for the route of the flight is below VFR minimums-the briefer may state that VFR not recommended and therefore the pilot decides to continue or not.
3. Synopsis—this is an overview of the larger weather picture. It involves Fronts and major weather systems that affect the general area provided.
4. Current conditions— the current maximum flight level, visibility, winds, and temperatures.
5. En route, forecast—the weather forecast for the proposed route of flight is the en-route forecast.
6. Destination forecast—the expected weather for the destination airport at the estimated time of arrival.
7. Winds and temperatures upward—A report of winds at specific altitudes for the route of flight.

2.3.2.2 Abbreviated Briefing

Abbreviated briefing is a version of the standard briefing requested when a departure is delayed or when weather information is needed to update the previous briefing.

2.3.2.3 Outlook Briefing

Outlook briefing is an initial forecast given to a pilot at least six hours before the time of departure for flight planning decisions especially the route, altitude and decision for flight to take-off at the scheduled time or to delay.

2.4 Technologies used in Pilot briefing

Different technologies adopted to design briefing systems for aviation according to the literature reviewed by the researcher.

2.4.1 Aero Weather

It is a resourceful integrated system for receiving, processing, and representation of meteorological data for aviation (IBL, 2005-2019). Aero weather system has an in-built interface that enables the access to meteorological data such as forecasts, warnings and automated production of flight information bulletins.

Aero weather was built basing on web portal technology with an in-built content management system. It can be accessed on a desktop and mobile device using a web browser to generate

Pre-Flight Information Bulletin. This is a very important system based on new technology, flexible and convenient for the users since it can be accessed using a web browser even on mobile devices. The researcher based on the same technology to come up with the real time weather update information system for Aviation to be used by briefing officers to enable the pilots view and access the briefing information.

2.4.2 Aero met Web- Pilot Briefing System

The system facilitates Civil Aviation Authorities, airports and airline companies to carry out their operations efficiently. It receives and processes meteorological data from different sources such as-satellite, radar, and operational meteorology (MFI, 2019). Aero met Web –pilot briefing system is the best since it makes total automation. The real-time weather updates information system for Aviation adopted the same technology like fore the AerometWeb –Pilot briefing information system except that the sources of data for the real time weather update information system cannot

allow total automation since part of the data is manually recorded from the observing stations. This makes it difficult to do total automation for the real time weather update information system designed.

2.4.3 Bytron Aviation systems (Sky book)

It is a briefing system and a flight-planning portal that runs briefing packs configured specifically to each operator. Packs are accessed remotely via the Electronic Flight Bag (Bytron, 2019).The system automatically checks and analyses all flight briefing material and logically, delivering flight briefings and narrow route briefings.

The flexibility of the system helps to deliver a structured migration away from paper briefings as the current case in UNMA to digital application.

Therefore, the technologies used to brief the pilots about weather as reviewed by the researcher, have an element of web portal and real-time capabilities. This also guided the researcher during the development of the real time weather update information system for aviation.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter described and discussed the research design, study population and data collection methods, system analysis and design, Implementation, testing and validation and ethical considerations.

3.1 Research design

The study used a case study research design. Yin (2003) defined case study as a practical review that investigates an existing phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not evident. In addition, case study research facilitates the in-depth examination of all variables at play with a view of providing rich data and a more comprehensive understanding of issues and problems applicable in a real-life situation (Soy, 1997).

3.2 Area of study

The study was undertaken at Entebbe International Airport, National Meteorological Centre (NMC), and briefing office.

3.3 Population and Sampling

The study was conducted among NMC employees that work with the briefing office, airline agents and pilots. The study-analysed data from two (2) managers (Forecasting and briefing office), ten (10) briefing officers, ten (10) airline agents and two(2)Pilots making 24, considered as key informants. The selection of respondents was done through purposive and random sampling techniques.The study adopted random sampling techniques because it avoids biasness, as recommended by (Amin, 2005) .The reason for the Sample chosen was to get a clear view from all the system users including management as indicated in the table below.

Category	Population	Sample size	Sampling techniques
Managers	2	2	Purposive
Briefing officers	10	10	Purposive
Airline Agents	10	10	Purposive
Pilots	3	2	Simple random and convenient
Total	**25**	**24**	

Table 3.1: Sampling Frame

The above sample was chosen using sample size determination table by Krejcie, Robert V, Morgan (appendix D)

3.3. Data Collection Methods

The study used interview and observation methods.

3.3.1 Interview

The interview was conducted with the managers, briefing officers, airline agents and pilots at the National Meteorological Centre (NMC) Entebbe International Airport. An interview guide was used with pre-set questions *(*appendix A).

The interview allowed on spot explanations, during data collection process and through respondents' facial and body expressions, tone of voice, gestures, feelings and attitudes the researcher was able to get rich information on the current system being used for briefing.

The study adopted this method because it was the only convenient way of getting information from the respondents due to the nature of their work especially the pilots and airline agents.

3.3.2 Observation

This method was used since it allows the researcher to see what is done directly without relying on what people say. Observation was also used because it provides data which people may hide (Damayanti, 2019).

The researcher physically observed day- today briefing operations for 14 days, which enabled the gathering of the right information from the operations desk. The findings guided the researcher in formulating the system requirements.

3.4. System Analysis and Design

Systems Analysis and Design is a process of studying the business state with an aim of making it more successful by applying better techniques (Dr.Jawahar,2018-2019).It is also defined as procedures for coming up with standard Information Systems where Information technology, people and data support business requirements (Ramakrishna, 2012).The study adopted Software Development Life Cycle, a practice followed by software industries to design, implement and test the software products.

System development life cycle follows a number of steps in a systematic manner where by each phase uses the results of the previous one. The phases are planning, analysis, development and implementation.Several system development life cycle models have been generated for example waterfall, spiral, prototype and rapid application development model (Gajalakshmi 2016).

Each model can be used depending on the type of project. The study adopted rapid application development (RAD) model, which is suitable for system development within the shortest period. RAD allows the changing of requirements to be accommodated, progress can be measured, and interaction time can be short. RAD enables Productivity with fewer people in short time, reduced development time, increases reusability of components, quick initial reviews occur, encourages customer feedback and Integration from very beginning solves many integration issues.

3.4.1 Rapid Application Development

Rapid application development is a methodology that allows organizations to build systems faster while dropping development costs and ensuring quality through a number of processes followed in a methodology (Case Maker, 2000). It is an object-oriented technique to systems development that includes a method of development as well as software tools (Kendall & Kendall, 2005). The Rapid Application Development model is formed on prototyping and repetitive development with no definite planning involved (Tutorial point, 2019).

It aims at gathering customer requirements, early testing of the prototypes by the customer using iterative concept, reuse of the existing prototype components, continuous incorporation and rapid delivery. With RAD model, the functional modules are built in parallel as prototypes and combined to make the whole produce for quick product provision (Tutorial point, 2019).

RAD Model Design uses analysis, design, build, and test stages in short, iterative development cycles. This research adopted the phases of RAD Model as explained below.

3.4.1.1 Business Modeling

It is a model for the product under development designed in terms of flow of information and the distribution of information between various business channels (Tutorial point, 2019).

A full business investigation was carried out to find valuable information for business, how it can be obtained, processed and the factors that can lead to flow of information successfully.

3.4.1.2 Data Modeling

The information gathered in the Business Modeling phase was reviewed and analyzed to form sets of data objects vital for the business (briefing folder information). The characteristics of all data sets was identified and defined at this stage. The relation between these data objects established and defined in detail in applicability to the business model (entity relationship diagram).

3.4.1.3 Process Modeling

The data objects defined in the Data Modeling phase were transformed to create business information flow required to realize business objectives identified in the business model. The procedures ideal for any changes or improvements to the data object sets were defined in this phase.

3.4.1.4 Application Generation

The actual system was built and coding done at this stage using automation tools to convert process and data models into actual prototypes.

3.4.1.5 Testing and Turnover

The overall testing time was short since the prototypes were independently tested during every interaction. Finally, the data flow and the interfaces between all the components were tested using the available data.

3.4.2 System Design Tools

System design is a method of outlining the architecture, components, modules and interfaces for a system that meets the standards of the required system. The study used deferent design tools such as the Dataflow diagram, entity relationship diagrams and the use case diagrams to design the architecture, components, modules and interfaces for the system.

3.4.3 Logical design for the system

The logical design obtained a representation of the data flow input and output for the system as explained above in the RAD phases. The deliverables here were the data flow diagrams (DFD) and the entity relationship diagrams (ERD), UML diagrams such as use case diagrams.

3.4.4 The physical design

The physical design tool generated a pictorial representation (system architecture model) that depicts what a system should do and how to implement it.

3.4.5 System Implementation

The physical design delivered the actual input, output processes as well as storage of the system and how it would interact with the database to give the required information.

The Application development platform used was spring framework. Spring framework is an Open source Java platform used to create high performing, easily testable, and reusable code.

The system was implemented using PostgreSQL an open source object-relational database software. PostgreSQL is an open source database software that relies on SQL for processing data in the database.

3.4.6 System Testing and Validation

The individual modules of the system were tested using the available data to ensure that the system is functional. System Validation was done by corresponding user's questions with the system and using the system validation guide (*Appendix B*).

The system was exposed to the users to test its usability and its usefulness for both the briefing officers and the pilots, results indicated that the system would eliminate the challenges faced currently if adopted (Table 5.1 results for system validation)

3.5 Research Ethical Consideration

Ethics is referred to as the appropriateness of your behaviour in relation to the rights of those who became the subject of your work, or affected by it (Saunders 2009). As regards to research ethics, the researcher exercised integrity, objectivity accountability and confidentiality while conducting this research. The researcher sought written permission from School of Graduate Studies and Research (*appendix* **C**) to access the briefing office at Entebbe International Airport where the data was collected. The exact names of interviewees do not appear anywhere in this report and any information obtained was agreed upon with the interviewees before using it. Before starting the interview, respondents were told that the information recorded would be purely academic and confidential.

CHAPTER FOUR

FIELD STUDY AND SYSTEM DESIGN

4.0 Introduction

This chapter presents the findings of the field study in various sections as follows; section 4.1 is the existing system and its challenges, section 4.2 is the requirement's analysis and finally section 4.3 System design implementation with all its structures.

4.1 Background Information

Uganda National Meteorological Authority (UNMA) is a government organization for weather and climate services (UNMA Act,2012)

UNMA is required to promote, monitor weather and climate as well as provide weather predictions and advisories to Government, Aviation and other stakeholders to support the development of the country (UNMA, 2019).

The study was carried out at the National Meteorological Centre (NMC) Briefing office located at Entebbe International AirPort. The briefing office recieves a list of "MAY FLY" document from the airport authorities on a daily basis.The "MAYFLY" list contains the details of the expected aircrafts to land and take off at Entebbe international Airport. The briefing officer bases on that document to prepare the weather update or a briefing folder for those aircrafts in the document.

4.2 Findings of the study.

Table 4.1 Shows Responses from Managers during the Interview

No	Question	Response	Frequency
1	For how long have you worked with UNMA?	**12 years**	2
2	What systems does UNMA use in briefing office?	• **Print the briefing folder and give to pilots.** • **Face to face interaction with the pilots.** • **email** • **Telephone**	2

3	What challenges are associated with the briefing systems in use?	• **The organization spends a lot on printing.** • **UNMA is not earning much on cost recovery because of using the manual system** • **The organization spends a lot on human resource (two staff) on each shift.**	2
4	What measures has management put in place to minimize such challenges?	**"UNMA has planned to acquire a briefing system if the budget could allow the next financial year."**	2

Table 4.2 Shows Responses from Briefing Officers during the Interview

No	Question	Response	Frequency
1	How long have you worked in this office?	**12 years**	**6**
		4 years	**4**
2	What are the activities performed in this office?	**Preparing, the weather updates for specific routes And brief the pilots**	**10**
3	What systems do you use to brief the pilots?	• **Print the briefing folder and give to pilots.** • **Face to face interaction with the pilots.** • **email** • **Telephone**	**10**
4	What happens in case the pilots do not get the weather information?	**"An air craft cannot take off"**	**2**
		"It's requirement so, it's a must for the pilot to get weather"	**2**
		"An aircraft is affected by strong winds, pressure at landing and taking off, clouds like cumulus-nimbus, which can cause an aircraft accident	**6**

		or crush that can lead to lose of lives".	
5	Which system do you use most in briefing the pilots and why?	**Printing and issuing the briefing folder is used most since all these other systems used to brief the pilots can only apply on local flights only because they are brief.**	**10**
6	Are you facing any challenges using these systems? If yes, what are those challenges?		
		Yes	
		Serving clients on pressure especially when they queue **Shortage of papers for printing a briefing folder sometimes.** **Shortage of toner cartilage some times.** **Printer mechanical problems.**	**8**
		Printing a briefing folder is a slow process.	**2**
7	In case the weather changes, how do you update the pilot.	**We issue another briefing folder, but when the aircraft has already taken off, it is not picked.**	**6**

		We issue briefing folders for the time requested.	**4**
8	How many briefing folders do you issue in a day?	**35 and above**	**4**
		40 sometimes	**3**
		45 some times	**3**

Table 4.3 Showing Responses from Airline agents and Pilots during the Interview

No	**Questions**	**Responses**	**Frequency**
1	**How long have you worked/used Entebbe international Airport?**	**8 years**	**4**
		5 years	**4**
		4years	**6**
2	**What exactly do you do in relation to Aviation?**	**Piloting**	**2**
		Airline agent, Collect a briefing folder on behalf of a pilot	**10**
3	Do you access weather information**?**	**Yes**	**12**
4	How often?	5 to 10 **times a day depending on the type of an airline.**	**12**
5	Are you satisfied with the systems used to provide	**No**	**12**

	the weather information?		
	If no, why are you not satisfied?	• **Time consuming,** • **Risky, because when the weather changes abruptly, there is no way of updating us during the flight** • **Queuing at rush hours when flights are many I hate it.**	**4**
		• **Queuing at rush hours when flights are many is a challenge.** • **Time consuming** • **Not convenient**	**8**
	What happens in case you do not get such weather information	• **Flight can be delayed until you get the weather update.** • **Flight can be cancelled**	**12**

From the above results

On interaction with the managers from UNMA, the following was discovered.

The interviewed managers had worked for the organisation at least for more than 5years which indicated that the manager understood the organisational roles towards the aviation industry. The managers revealed other systems used by the briefing officers to brief the pilots such as telephone, face to face and email other than a briefing folder issued to pilots in hard copy. The interviewed managers explained that all these other systems used to brief the pilots were being used on local flights only because they are brief. They stressed that a briefing folder is more detailed and so it is mostly used on international flights which demand a detailed weather update that cannot be given using a telephone or by face to face explanations. The managers stated that the briefing folder is printed on paper and issued to pilots or their agents.

They further explained that the number of flights landing and taking off from Entebbe international Airport had increased which caused an increase on the reams of papers and toner used on a daily basis which had made briefing budget to increase from the last two years to date. The briefing officers interviewed had worked in the briefing office at least for more than 3years which showed that they had enough working experience to explain how the operations are conducted within the briefing office. The briefing officers gave similar systems as mentioned by the managers used to brief the pilots on weather. About what exactly is done in the briefing office, they clearly explained the type of weather information they give to pilots as follows.

- Take off weather (weather at Entebbe International Airport at the time the aircraft is taking off).
- En-route weather (weather along the route the aircraft is taking)
- Landing weather. (weather at the airport the aircraft from Entebbe airport is going to land)

Briefers explained how important weather briefing is to the aviation industry and stressed that its risky for an aircraft to fly without a weather report with take-off weather information, along the route and the airport where it's going to land.

The interview sessions revealed that an aircraft is affected by strong winds, pressure at landing and taking off, clouds like cumulus- nimbus abbreviated as a CB which can cause an aircraft accident or crush that can lead to lose of lives.

Findings from the Pilots and Airline agents most of them were similar as mentioned by the managers and the briefing officers apart from a few that are captured in challenges faced by using the existing system used in the briefing office.

All these findings confirmed how a real-time weather update information system was ideal for UNMA briefing office to reduce on the costs of printing and to enhance service delivery.

4.2 The Existing System (Observation).

The researcher physically watched out on the day today briefing operations and the findings noted matched with the information that was obtained from the interview sessions, that were conducted by the researcher.

The findings revealed that briefing officers, UNMA managers, pilots and the airline agents have specific challenges caused by the current briefing system as indicated below.

Challenges faced by using the existing briefing system.

UNMA Management

UNMA management revealed that the budget for briefing office was increasing day by day specifically on printing accessories because of an increase in the number of flights at Entebbe International Airport.

Management also revealed that they are earning less on cost recovery from civil Aviation because of using manual systems, therefore they wanted at least to consider acquiring a pilot briefing system the next financial year if the budget would allow since there were no funds to purchase such a system that financial year. Management also revealed that strictly they deploy two briefing officers each shift that work for only six hours with a supervisor and then another shift comes in which indicated that UNMA spends a lot on the human resource for briefing office.

Challenges faced by Briefing officers using the existing briefing system.

The briefing officers highlighted a number of challenges while using the existing system as pointed out below.

- Queues by the airline agent or pilot especially on rush hours. (Printing and issuing of a briefing folder is a slow process.)
- Serving clients on pressure especially when they queue
- Shortage of papers for printing a briefing folder sometimes.
- Shortage of toner cartilage some times.
- Printer mechanical problems.

Challenges faced by Pilots and Airline agents.

The pilots revealed that going to UNMA offices to pick a briefing folder is time consuming since they always have a tight schedule. That is the reason for using an airline agent to pick the folder on their behalf except for the local flights.

Pilots also said that sometimes a briefing folder could be issued to them and then the weather changes abruptly. Pilots went ahead to say that such exposes them to a risk because there is no way a briefing officer could update them once they have left UNMA briefing office.

The pilots pointed out that at rush hours when the flights are many; they find themselves queueing at UNMA briefing office waiting for a briefing folder.

From the mentioned findings, the researcher was able to get rich information and in depth understanding of the existing system and the problems associated with it, which guided in the formulation of the system requirements for a real-time weather update information system.

4.2 Requirements Analysis

Functional requirements (FRs) and non-functional requirements (NFRs) constrain each other and therefore should be treated together (Paech, *et al*, 2002) and must be realized through the architecture.

Basing on the challenges from the user, client and management confirmed that the issuing of a briefing folder in paper form was costly on the side of UNMA management, time consuming for the pilots and there was no way of updating the pilot in case the weather changes.

The findings guided the researcher to formulate the functional and non-functional requirements for the new system that would be a solution to the challenges faced using the existing briefing systems.

4.2.1 Functional requirements.

Functional requirements deal with what the system should do or provide for users and they include description of the required functions, outlines of associated reports or online queries, and details of data held in the system (SQA, 2017). They determine what the system should do.

The following are the functional requirements of a real-time weather update information system for aviation.

a) The system should allow only a registered briefing officer to update briefing folders for different routes.
b) In case of change in weather, the system should issue an alert.
c) The system should allow only a registered pilot to log in and view the weather for the selected route
d) It should allow registered users to log in.

e) It should give the administrator a report of those who log in to the system.
f) The system should enable the Pilot to chart with a briefing officer.
g) The system should allow the briefing officer to upload images that show the weather conditions for the routes.
h) The system should display the images showing weather conditions.

4.2.2 Non-functional requirements

Non-functional requirements detail constraints, targets or control mechanisms for the new system. They describe how well or to what standard a function should be provided (SQA, 2017). For example, levels of required service such as response times; security and access requirements; technical constraints; required interfacing with users' and other systems.

The real-time weather updates information system non-functional requirements include-

a) **Availability** The system is available 24 hours a day and 7days a week since the updating team work day and night.
b) **Reliability** – The system is reliable since it depends on the input information by the briefing officer.
c) **Scalability** –The system can be expanded to allow more functionalities without its performance adversely affected because the application used favors the reuse of the code.
d) **Performance** – The system can support simultaneous users or transactions at the same time.
e) **Security** –To log in to the system, you must be registered by the system administrator as a way of access control to avoid private data processing, and external attacks.
f) **Usability**, the system is easy to use with user-friendly interfaces that allow users to seamlessly interact with the product.

4.3 System design

Requirements highlighted above were used to design the system following RAD approach.

The design flows as follows: system Architecture; data flow diagram, ERD for database and UML design using use case diagram.

4.3.1 The Architecture of the system

System architecture is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system. Whitsett (2019) states that before you build a computer system, you should conceptualize the purpose and the structure. The researcher defined various parts of the system and the roles they play. Below is the layout of a real time weather updates information system.

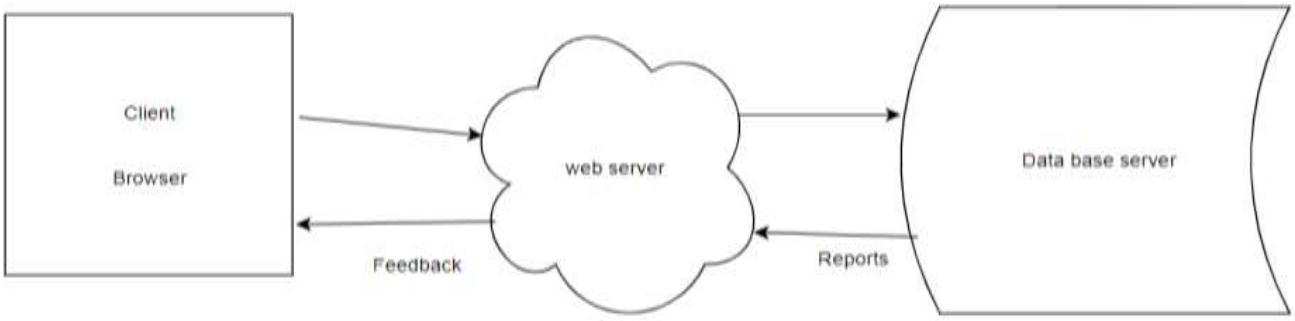

Figure 4. 1 system Architecture

Figure 4.1illustrates the real-time weather update information system three sections;

The client browses the address for the Real-time weather update information system for Aviation through a webserver using a web browser, the webserver displays the home page for the system (Real Time weather Update Information system for Aviation page displays), The client logs in using the username and password, The webserver queries the database for the logins entered. The database server checks in the database and returns the report by either accepting the logins if they

exist in the database or not. Each user of the system interacts with the system as indicated in section 4.3.2.

4.3.2 System Users

The real-time weather update information system has different users as indicated below.

Briefing officer

The briefing officer logs on to the system to update the weather and to make notifications in case the weather changes from what was expected. He also charts with a pilot in case the pilot needs clarification or more information.

Pilot

The pilot who belongs to an airline logs on to the system to view the weather update displays and can download the weather update report (briefing folder). He can also chart with a briefing officer in case he wants some clarification concerning the weather update. The pilot can also check on the alerts (notifications) in case they are available.

The system Administrator

The system administrator has the overall rights to access all the components on the system. The system administrator registers all the users of the system, and assigns access rights to users according to their roles on the system. He or she manages routes, airports and facilities as far as the system is concerned. The system administrator can also view the reports generated by the system concerning those who login and at what time. That helps to keep track of those who access the system and to make them accountable to what they do while using the system.

4.3.3 Context Diagram

The context diagram shows how the system interacts with the outside environmentas indicatedin the diagram below**.**

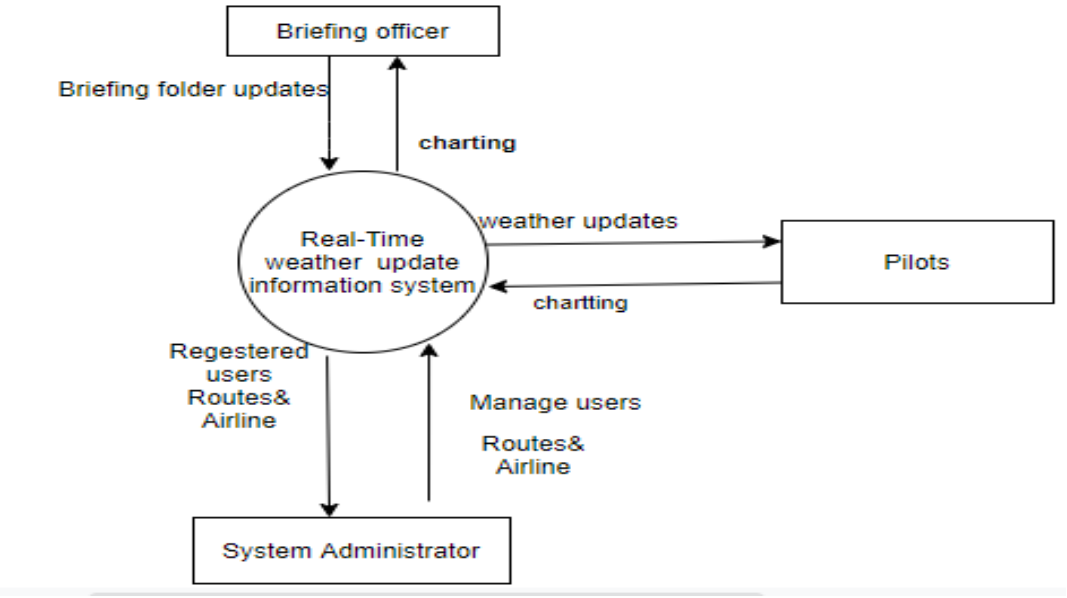

Figure 4.2 Context Diagram

4.3.4 Data Flow Diagram.

Data Flow Diagram describes the processes that are involved in a system to transfer data from the input to the file storage and reports generation. Data flow Diagram shows you the practical process of moving information through a system (Clifford Chi2018).

In the same way, the real time weather updates information system data flow diagram is shown below.

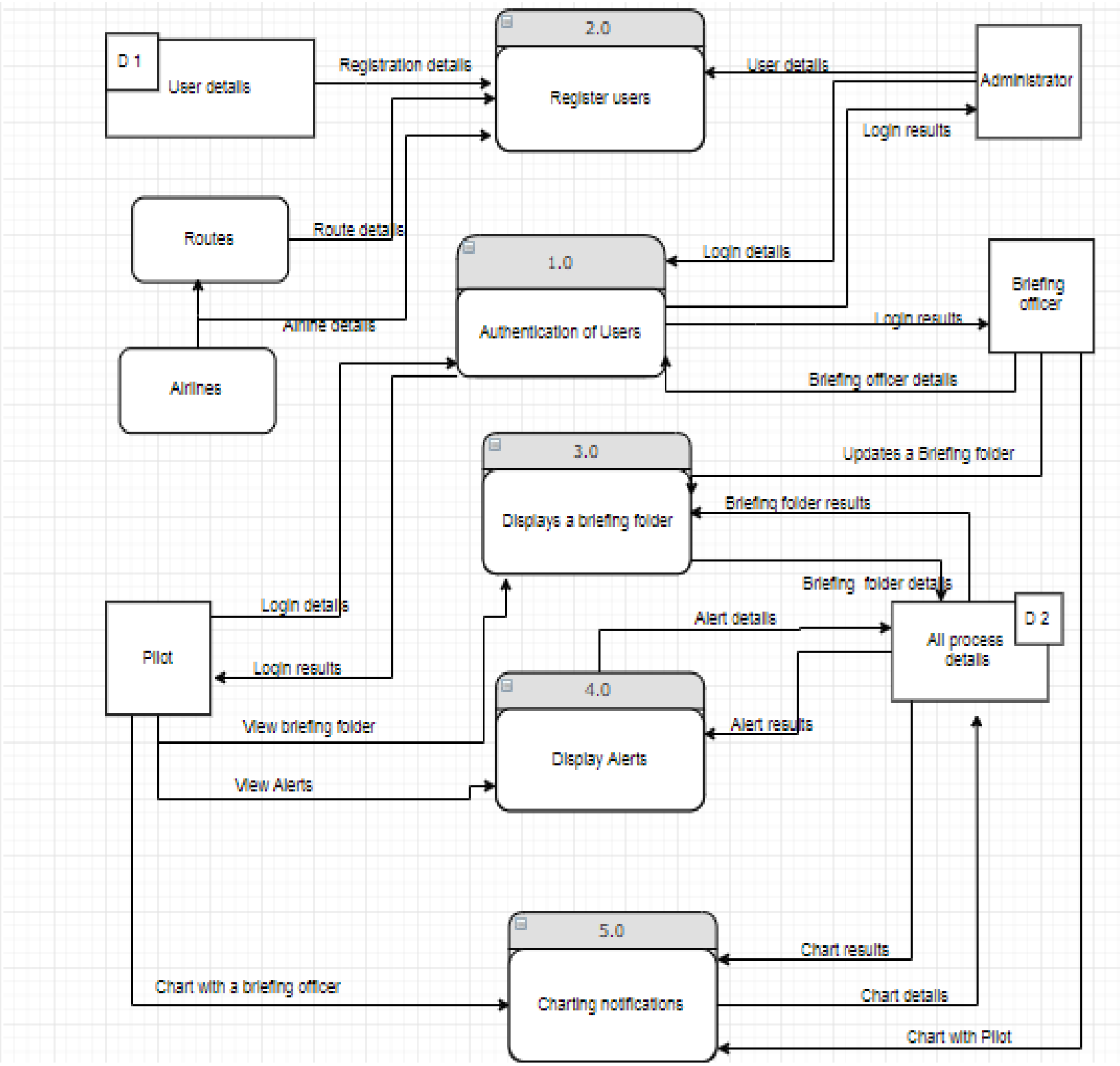

Figure 4.3 Data Flow Diagram

Figure 4.3 is an illustration of how data is processed by a system in terms of inputs and outputs. It shows the flow of information, where data comes from, where it goes and how it gets stored as explained below:

- The first process (1.0) is authentication when a user logs in, the system checks in the database if the login details for the users are correct the process is completed by the system returning the login successful, if the login details are wrong the system returns
  login failure.
- The second process (2.0) is the registration of the system users by an Administrator, where by the user details are stored in the database as well as their user rights. All processes are registered.
- The next process (3.0) is the display of the information or briefing folder as requested by the pilot. The information displayed is retrieved from the database.
- Another functionality of the system is the display of notifications or alerts (4.0) .This process is initiated by the briefing officer.
- The last process (5.0) is for the chart notifications, these can be initiated by a pilot and the system process the information and returns the chart notifications or messages as a result

4.3.5 Database design and Entity relationship Model

An entity relationship diagram is a model that shows relationship between entities in a database (Connoly&Begg 2004).The real-time weather updates information system adopted the entity relationship model approach in the design of database as illustrated in the figure below.

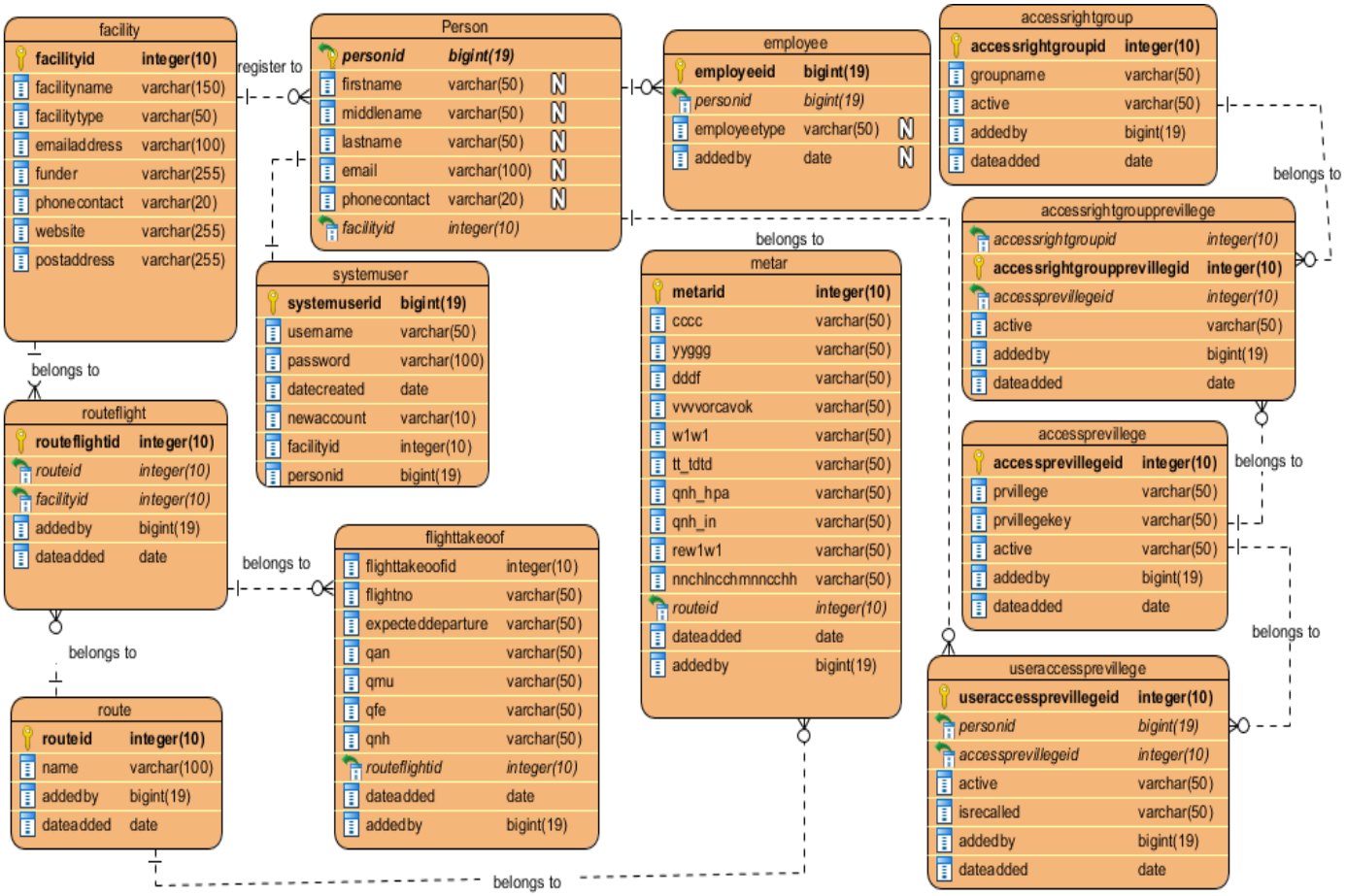

Figure 4.4 Entity Relationship Diagram for the system

The figure above shows the relationship between entities and how they link to perform their roles in the system. The facility is an airline, Person is a Pilot and Employee is UNMAa Briefing officer.

From the entity relationship model above, there are different entities each with its attributes. The entities are Facility, person, employee, access right group, system user, Metar,

flight take off, route, route flight, and user access privilege.A system user can be either a briefing officer or a pilot. Pilot (person) who is registered to a certain facility or an airline.

A facility belongs to a flight route according to the model.

A Metar and flight takeoff (data) also belong to a certain flight route. Finally all system users have different access privilege, which belong to access privilege group.

An entity relationship model for charts and Notifications.

The real-time weather updates information system has a functionality of chatting and notifications that enables a pilot to directly chat with a briefing officer in case there need for any explanations concerning the weather update and a notification or alert in case the weather changes abruptly .

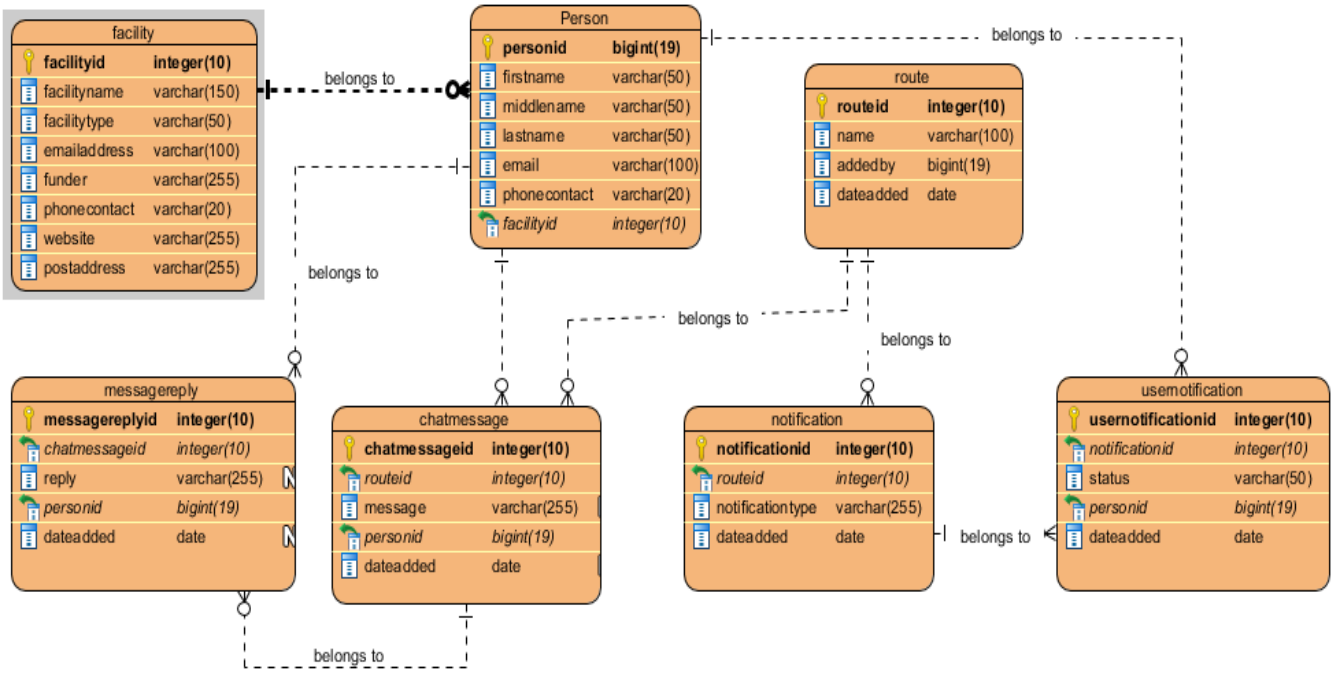

Figure 4.5 ERD for flight chats & notifications (alerts).

From the ERD model above, a person belongs to a facility and a user notification, which belongs to notifications.

Chat messages belong to a certain route and message reply belongs to a person who is either a pilot or a briefing officer.

4.3.5 Use case Diagram.

A use case diagram was used to illustrate how different actors interact with the system according to their roles as shown below.

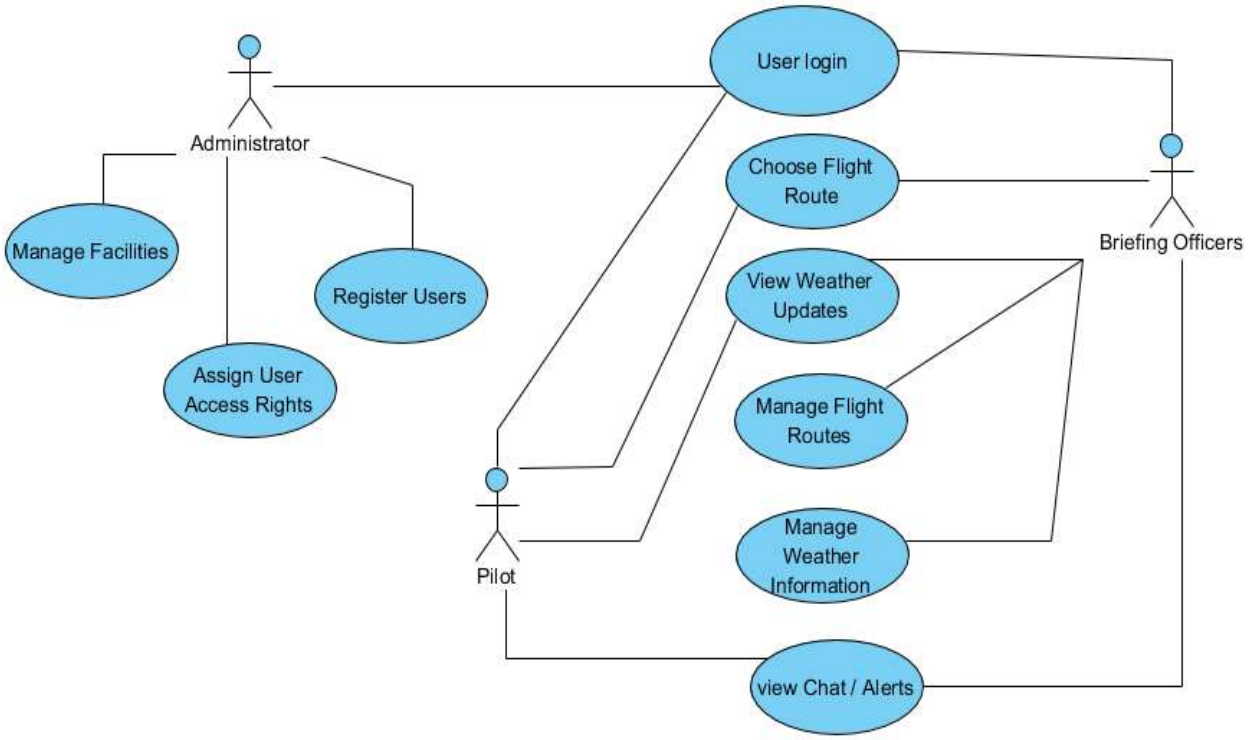

Figure 4.6: Use case diagram

The figure above is a use case diagram, which shows the roles performed by each actor in the system. The system has three actors, an Administrator, Briefing officer and a Pilot.

The administrator can login and register users. Unless the administrator registers one, He or she cannot access the system.

The administrator manages facilities, which are airlines, and he or she can assign access rights. Each user on the system has different access rights to enable them access the system according to their roles.

According to the system, a briefing officer can login, choose flight route, update the weather for a route, manage routes, view weather updates, issue alerts or notifications, view charts and initiate a chat.

The Pilot can also login, choose a flight route, view weather updates, view an alert, chat and initiate a chat.

User	**System**
Login	Authenticates
Choose flight route	Required flight route displays
Browse the page to manage weather information	Interface for updating the weather displays
Browse to manage facility.	Page for managing facility opens
Register users	Users captured in the database
Assign user access rights	Each user assigned a specific access right
Browse the page for weather updates	Updated Weather page opens
Weather update issued	A notification message displays
Initiate a chart	Notification message displays

Table 4.4 shows how the system behaves when a certain role is played.

CHAPTER FIVE

SYSTEM IMPLEMENTATION

5.0 Introduction

This chapter presents the system implementation basing on system design. System implementation describes the different functionalities of the system using the screen shorts for different interfaces. The implementation phase involved the use of the architectural design to make a real system that would meet the user's needs. The software components were constructed, tested and verified at this stage.

5.1 Technologies

The application development platform used was spring framework. Spring framework is an open source Java platform used to create high performing, easily testable, and reusable code.

The system database was implemented using PostgreSQL a powerful, open source object-relational database software that relies on SQL for processing the data in the database.

The database tables were designed as illustrated in chapter four section 4.3 and 4.4 Entity relationship diagrams respectively.

5.2System Interface

5.2.1 Welcome page

The welcome page for the system was implemented as indicated in the screen short below.

Figure 5.1 Welcome interface

Figure 5.1 shows the welcome interface, the interface shows the representation of the system and, how it can be accessed.

5.2.2 The login interface.

The fact that the system is for aviation purposes, it is not open for everyone to use. The general public can only see the home page and access about us and weather which is very brief. It's only the pilot and a briefing officer already registered that can login through the login interface as shown below.

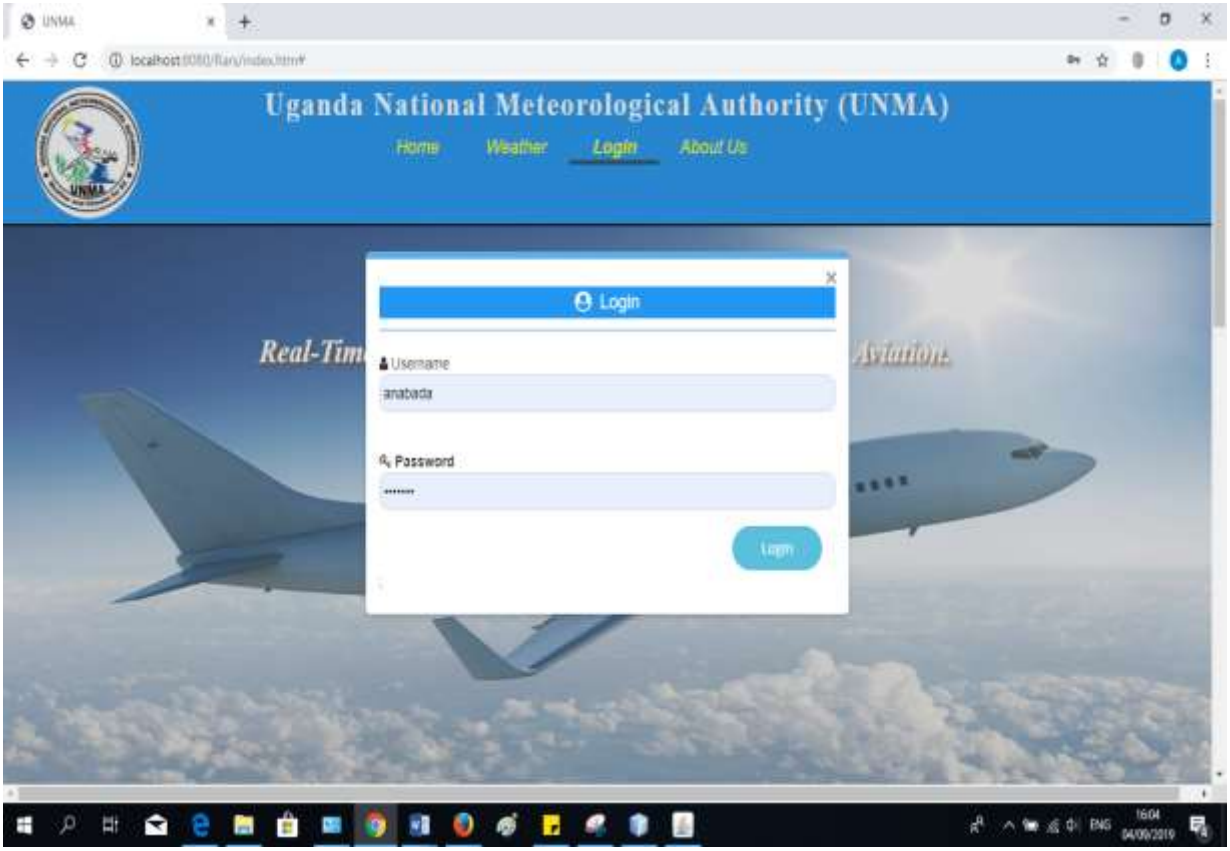

Figure 5.2 Login interface for the system users.

Figure 5.2 is a page that is displayed by the system when you click on login.

5.2.3 Interface for updating take off data.

Depending on the access rights given to each user, when a briefing officer logs in success fully, he or she selects the route and the interface below is displayed for updating the take-off data.

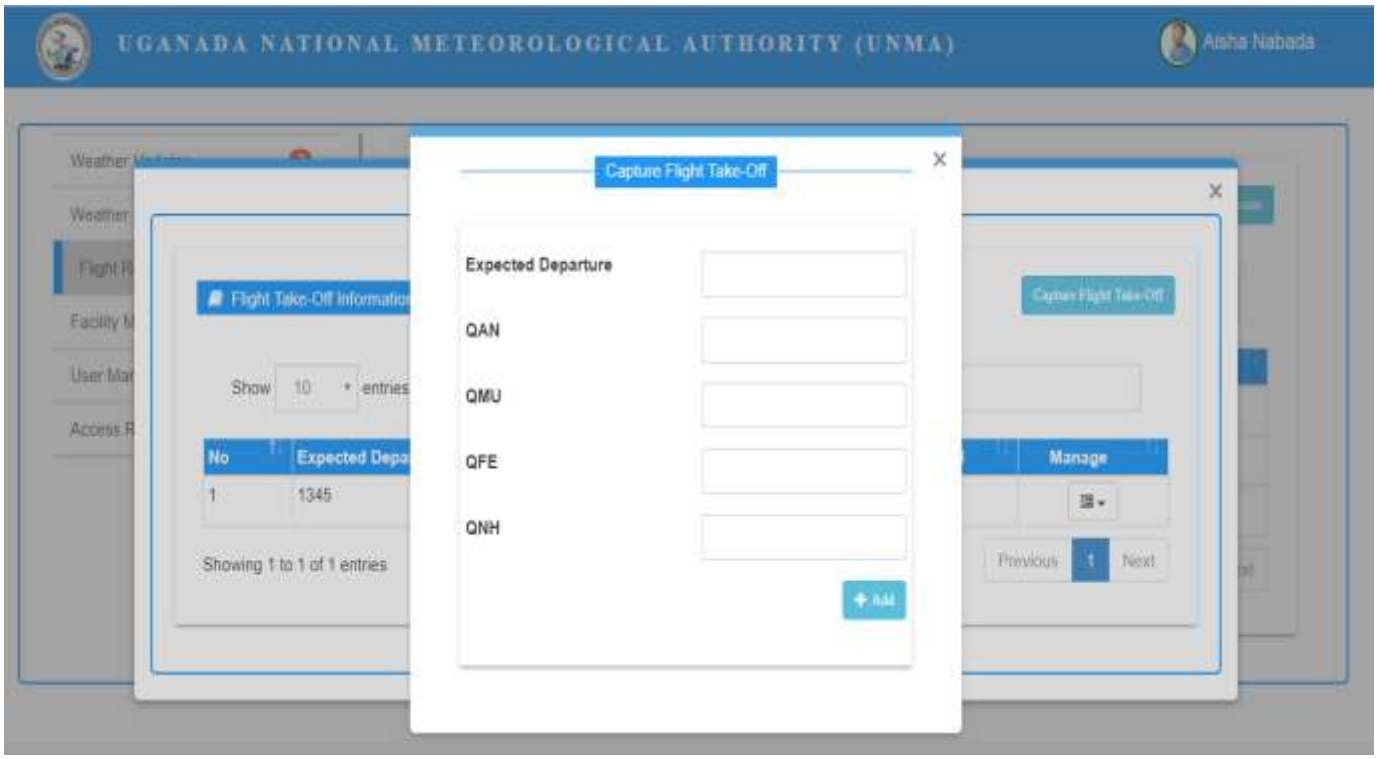

Figure 5.3 Interface to update the take-off data by the briefing officer.

Figure 5.3 shows an interface, which is accessed by the briefing officer to update the take-off data. The take-off data is part of the briefing folder or part of the weather update that a pilot uses in preparation to take off.

The page shows information on expected conditions over the runway in regard to surface wind direction and speed (QAN) , temperature (QMU), pressure
(QNH) and any other information as may be requested by a pilot.

5.2.4 Metar interface.

A Metar is an aviation weather report that is valid for only one hour. It involves the update of several weather parameters along the route for the aircraft as indicated in the screen short below.

The metar interface is in coded form, because it is the standard way of reporting meteorological information for Aviation according to the briefing officers who interacted with the researcher. The pilot understands the format in which a metar is reported for example;**CCCC** is the station code**,yyggg**is the date and time at which the metar is made,Dddf is the wind speed and

Direction,www or cavok visibility,NCCH2NCCmNCCHH low, medium and high clouds,TT/Td air and due point temperature,QNH(hpa) Pressure in hectopascols,W1W1 present weatherand REW1W1 the past weather.

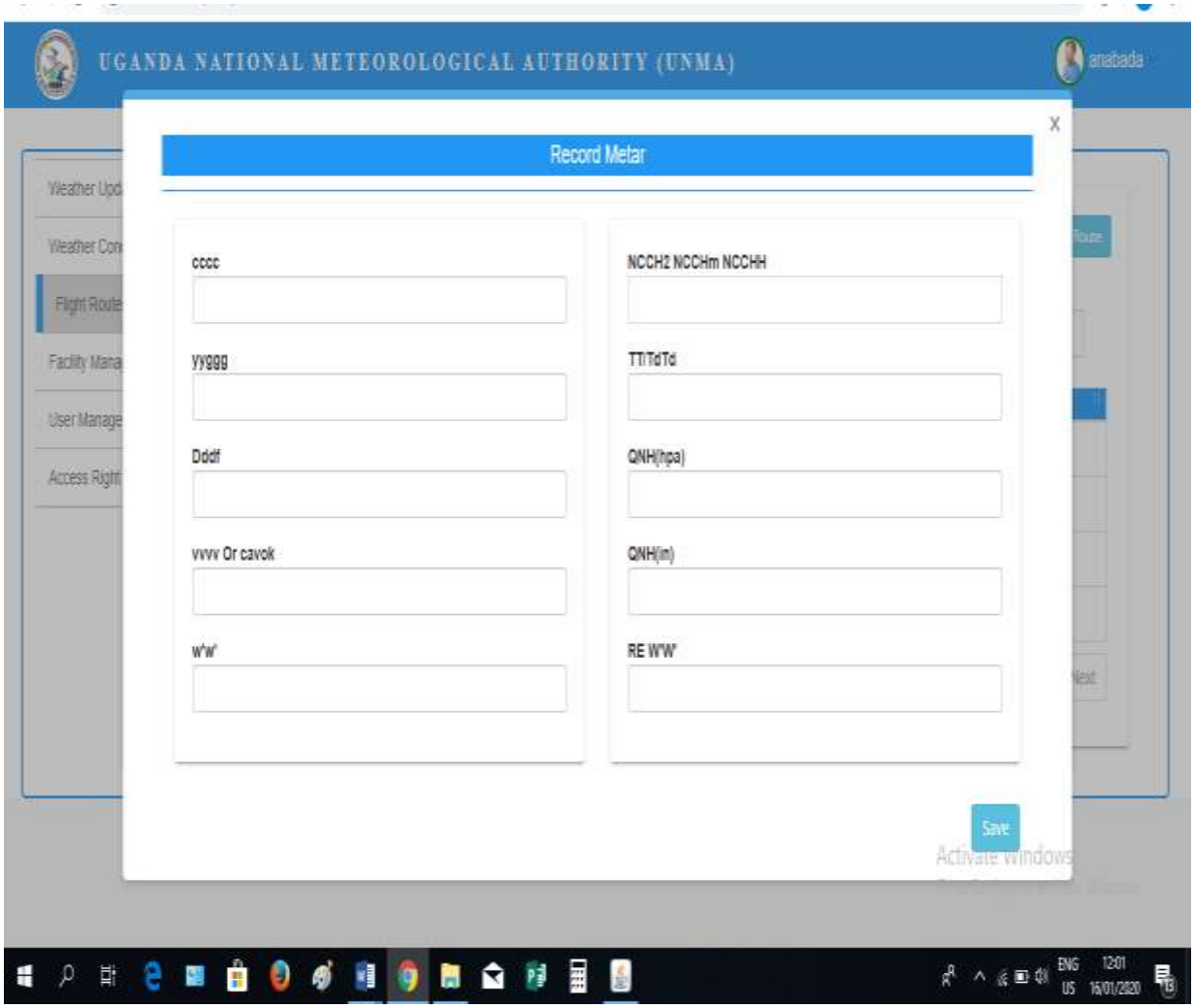

Figure 5.4 Metar updating interface.

The interface is accessed by clicking on the weather update button under weather, which allows the briefing officer to add or update metar data along a specific route. The metar is made up of

several weather parameters such as wind speed and direction, visibility, cloud cover, pressure, date and time as well as the location of the station in coded form.

5.2.5 Manage the weather conditions interface.

A briefing folder has a section that describes the weather conditions in form of weather images captured by satellite describing different weather parameters using standard symbols as shown below.

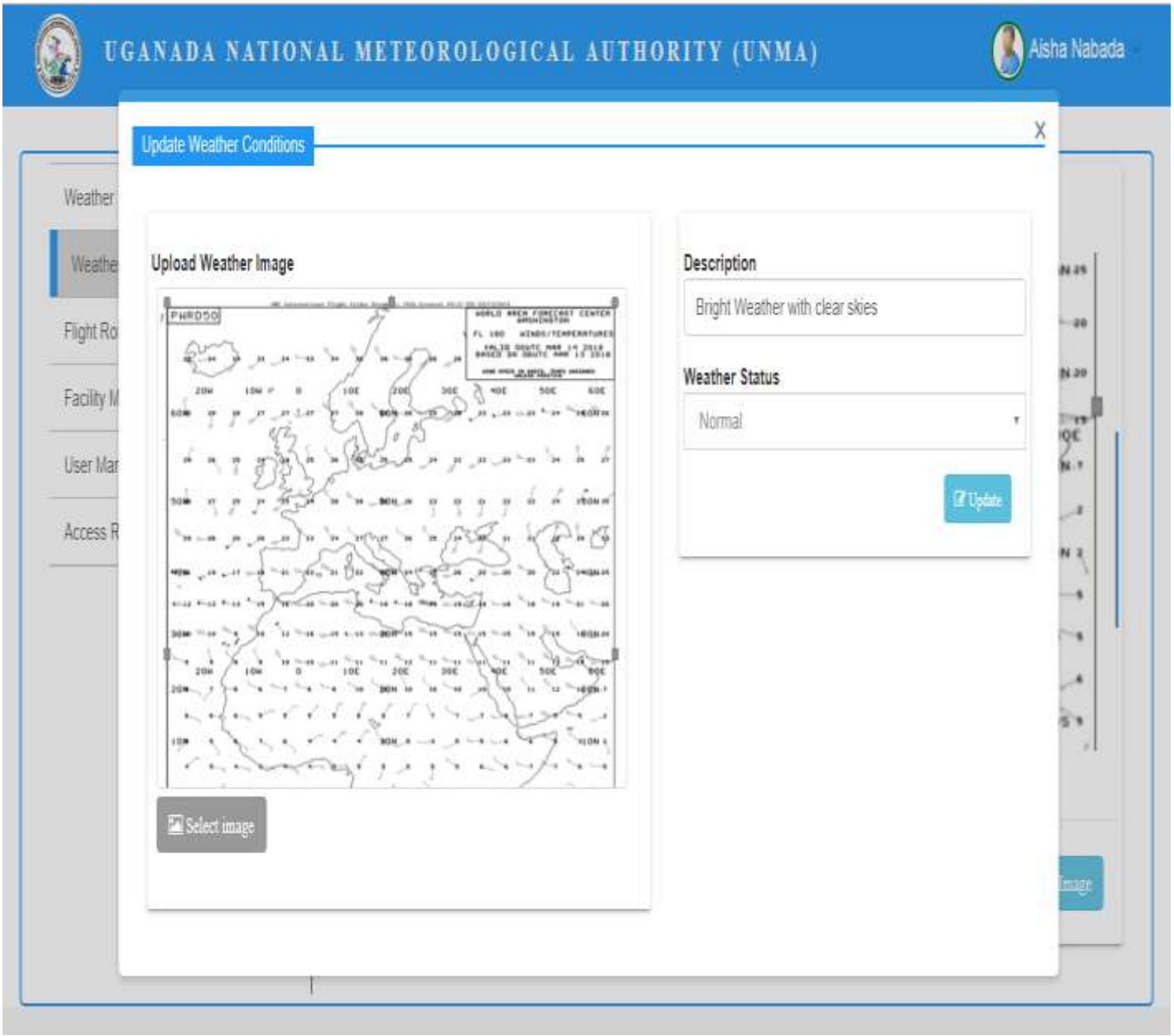

Figure 5.5 Update weather condition's interface

The above interface is for updating the weather, such as wind, temperature at different flight levels captured in form of symbols and represented as an image. That image is termed as a weather chart. The weather charts are always part of the weather update, therefore every briefing weather update, has to be accompanied by a weather chart that shows the weather at different flight levels. The image is updated by clicking on select image icon at the left bottom coner.That will take you to a page with several folders and there you select the folder with an updated image and upload.

5.2.6Briefing folder Interface

A pilot accesses the briefing folder interface when he or she logs in, selects the flight route wanted and then the flight folder for that route is displayed as shown below.

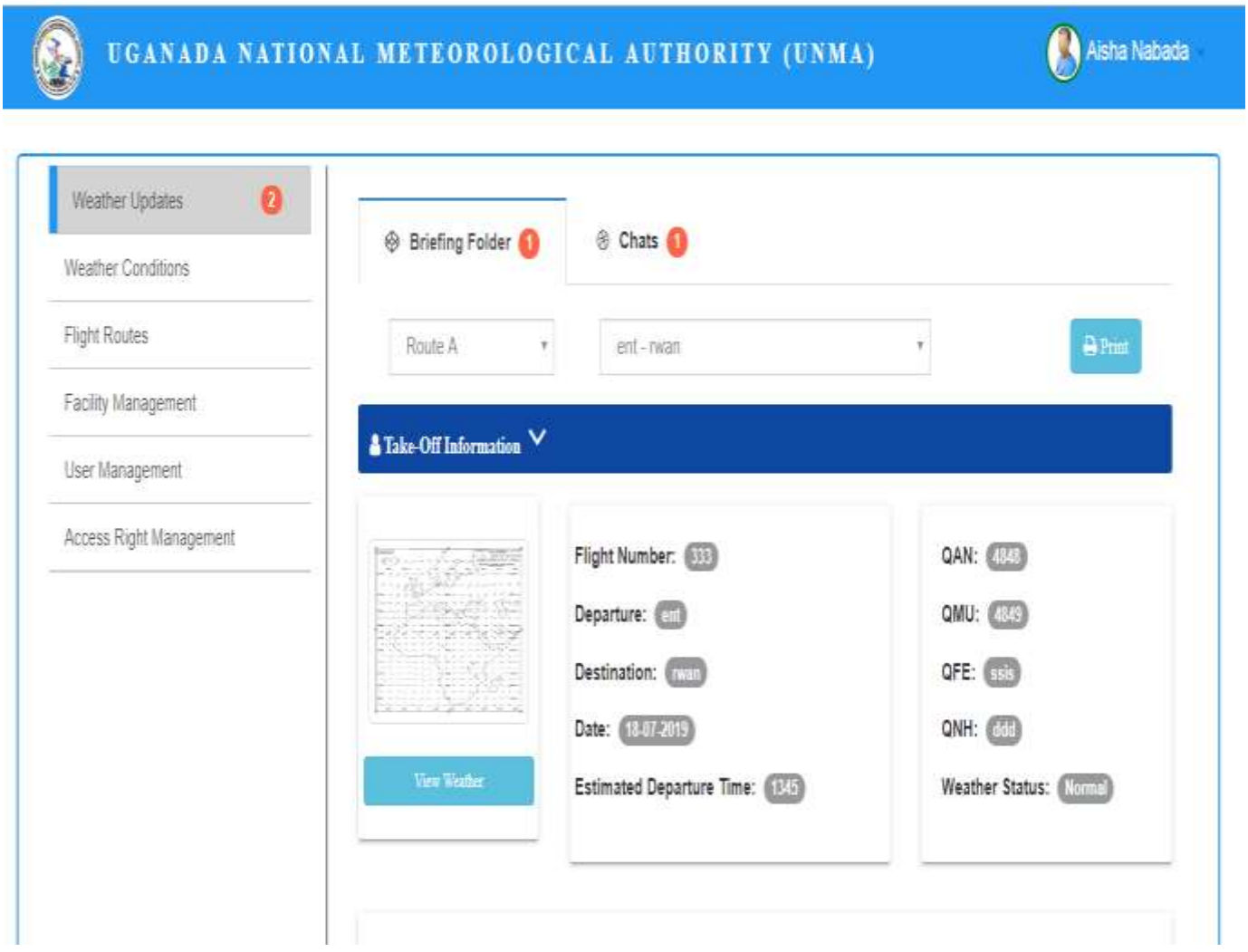

Figure 5.6 Briefing folder Interface. (Accessed by a pilot)

The pilot gets the above interface after log in. He or she can view weather updates along the flight routes and can initiate a chart with the briefing officer by clicking on chart. User can view take-off information and a metar information for a given route. The user can also view weather statusbyclicking on the view weather button on the above interface. User can also print a briefing folder if necessary.

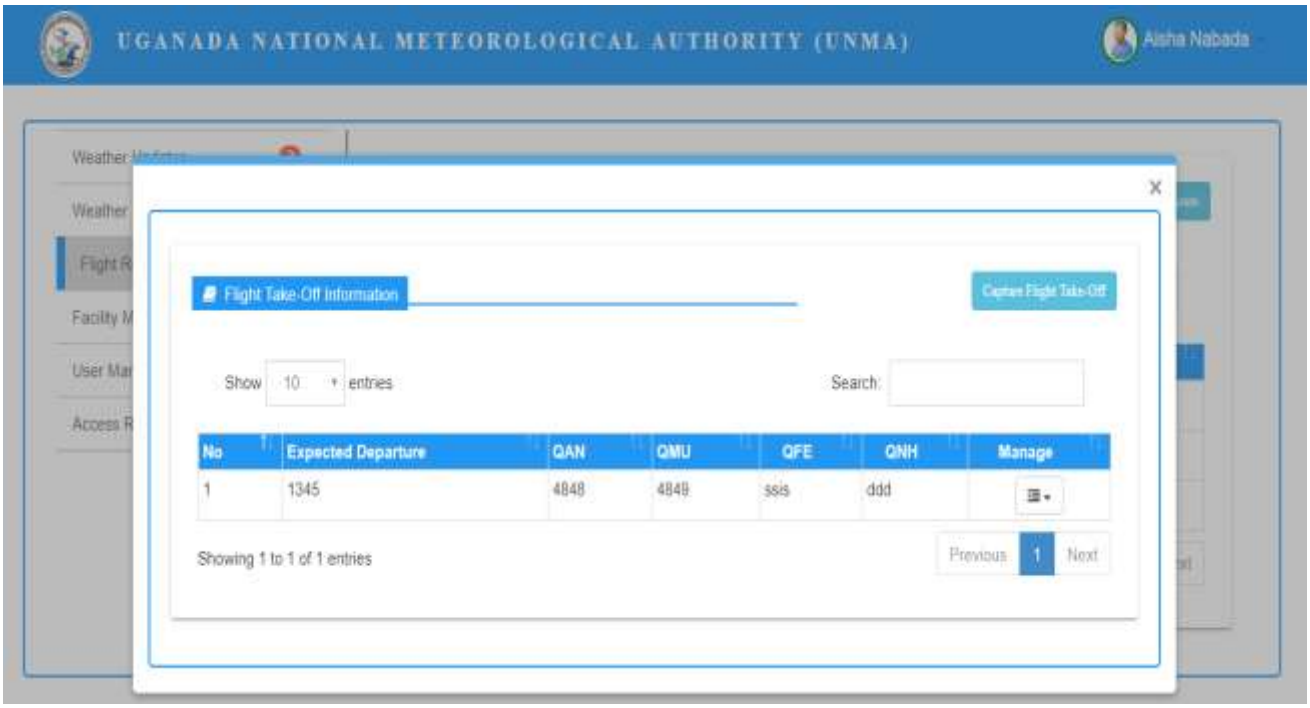

Figure 5.7 Take off data as viewed by the pilot

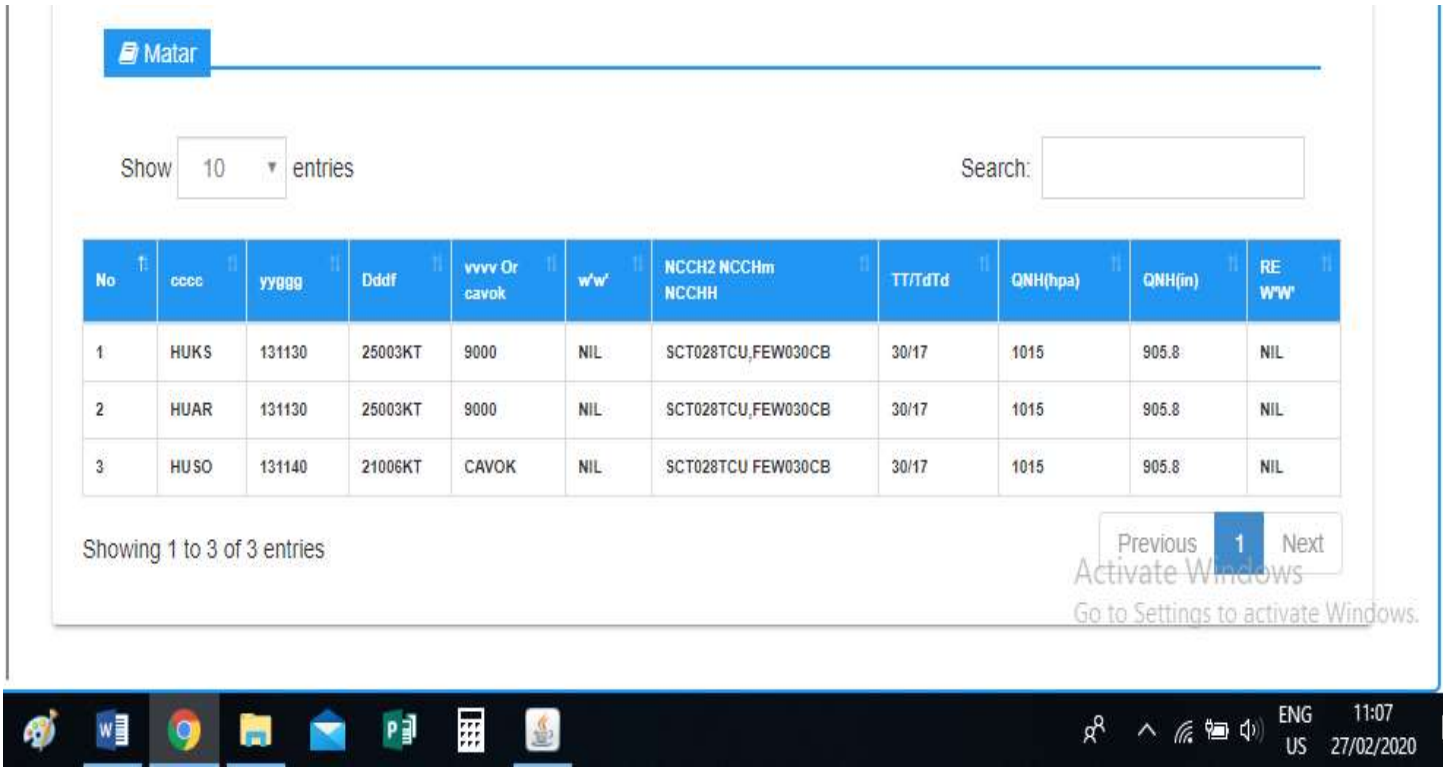

Figure 5.8 Mater interface as viewed by a pilot

5.2.9 The Chart interface

The chart interface is accessed by both a briefing officer and a pilot. The pilot can initiate the chart in case he wants any clarification from the briefing officer as shown in the figure below.

Figure 5.9 Chat interface

5.3 System security

To ensure the security of the system, different users have different access rights; each user has an account, which cannot be accessed without a correct user name and password. The system administrator must register all the users of the system. Therefore, the system cannot be accessed by unauthorized users who could either alter the information or deny users access.

5.4 System testing

The system was tested to ensure that all the system functional and nonfunctional requirements were achieved using the available data and to confirm that the system has no errors.

5.5 System Validation

Validation of the system was subjected to two managers,four briefing officers and four pilots who confirmed that the system performance can fulfil the user's needs.

The validation guide was used during the testing of the systemand subjected to ten users of the system ,the results are indicated below.

Requirement description	**User Rating Frequency**			
	Agree	**Strongly Agree**	**Disagree**	**Strongly disagree**
The system allows only an administrator to create user accounts for the system users.	5	5	0	0
The system administrator should assign different system users different access rights.	5	5	0	0
The system should allow the briefing officer to update all the details of a flight folder.	5	5	0	0

The system should allow a pilot who is registered to view the weather update /briefing folder details	5	4	1	0
The pilot should be able to chart with a briefing officer.	5	4	1	0
The system should givenotifications or alerts in case the weather changes for specific routes.	5	5	0	0
Is the system serving the purpose for which it was developed?	5	5	0	0

Table 4.5 Validation guide.

The above table shows the results from the ten users who interacted with the system .Each participant gave their rating basing on the functional and non-functional requirements to confirm whether the system meets the requirements and reliability. The agree and strongly agree scored 68 0ut of 70 and the disagree and strongly disagree scored 2 out of 70.

68/70 x100 =97.14 % 2/70x 100 =2.85%=3%

The disagree scored 3% while strongly disagree scored 0%.Therefore the overall acceptance test was 97% .This confirmed that the system can perform according to the user's needs and its reliable.

CHAPTER SIX

DISCUSSION, CONCLUSION, RECOMMENDATION AND FUTURE WORK

6.0 Introduction

This chapter presents the discussion, conclusion, recommendation and future work.

6.1 Discussion.

The purpose of this study was to developed real-time weather updates information system for aviation. Four themes were derived from the study following four objectives namely:

1). To review the existing literature and determine the requirements for the new system.

In this study, the requirements were acquired from both the literature and field study. From literature, the following requirements were determined basing on other briefing systems reviewed.

a. **Availability** The system is available 24 hours a day and 7days a week since the updating team work day and night.
b. **Reliability** – The system is reliable since it depends on the input information by the briefing officer.
c. **Scalability** –The system can be expanded to allow more functionalities without its performance adversely affected since the application used favors the code to be reused.
d. **Performance** – The system can support simultaneous users or transactions at the same time.
e. **Security** –To log in to the system, you must be registered by the system administrator as a way of access control to avoid private data processing, and external attack.
g) **Usability**, the system is easy to use with user-friendly interfaces that allow users to seamlessly interact with the product.

From the field study, the following requirements were also determined.

i. The system should allow only a registered briefing officer to update briefing folders for different routes.
ii. In case of change in weather, the system should issue an alert.
iii. The system should allow only a registered pilot to log in and view the weather for the selected route

iv. It should allow registered users to log in.
v. It should give the administrator a report of those who log in to the system.
vi. The system should enable the Pilot to chart with a briefing officer.
vii. The system should allow the briefing officer to upload images that show the weather conditions for the routes.

All the above lead to both functional and non-functional requirements, which were used to determine the design of the system.

2). To design the prototype of real time weather updates information system for aviation.

The design followed in this study was RAD prototype design. In software development, rapid application development (RAD) is a concept, which emphasizes working on software and being more adaptive. Rapid Application development focuses on gathering customer requirements through workshops or focus groups, early testing of the prototypes by the customer using iterative concept, reuse of the existing prototypes components, continuous integration and rapid delivery.

All the stages of RAD design as explained in chapter three were followed, in both the logical and physical design .These are; Business Modeling. Data Modeling. Process Modeling. Application Generation. Testing and Turnover.

3). To implement the real time information system for aviation.

The real-time weather update information system was developed using spring framework development platform and it was implemented using PostgreSQL a powerful, open source object-relational database system that relies on SQL for processing the data in the database. The new system has several advantages compared to the existing system being used now as discussed below.

The real-time system designed will provide timely weather updates to pilots accessible at any time and from anywhere. This will help them to plan their flights on time, which will enhance the safety of flights unlike the current system where the pilot has to specifically go to UNMA briefing office to pick the weather update printed on a paper. The system can put a notification in case the weather for a certain route changes unlike the existing system where the update is given once for a route and that is all. The system will help UNMA management to eliminate the issuing of paper briefing folder to pilots and reduce on costs in terms of money spent on buying toner and papers for printing. The system designed will create a conducive working environment for the briefing officer

since the queues for pilots and Airline Agents waiting for a briefing officer to print a briefing folder will be no more as for the existing system now. The real-time weather update information system will help a briefing officer serve very many clients (pilots) with in the shortest time or even at ago which is not possible with the existing system.

4). To test and validate the system in terms of service delivery.

The system was tested using the available data and it was found to perform without errors.

The system was also validated using the validation guide, which was subjected to two managers and eight briefing officers from UNMA.

The results proved that 98% of the system requirements and its usefulness was achieved.

6.2 Conclusion

The aviation industry is supported by weather status updates. Every pilot must get a weather report termed as a briefing folder before flying. Without a weather report, all flights are cancelled. The process of updating pilots about the weather using briefing folders is done manually which in many cases delays flight and sometimes leads to cancellation of flights, which hinders the schedule for the users of aircraft. Furthermore, while in transit, pilots could not get instant weather updates in situation of abrupt changes in weather. Therefore, the study developed real time weather updates information system for aviation as a contribution to solve the problem.

The study objectives were to; review the existing system and determine the requirements for the new system; design the prototype of real time weather updates information system for aviation, implement, test and validate the real time information system for aviation to enhance service delivery. The study was carried out at Uganda National Meteorological authority (UNMA) briefing office at Entebbe International Airport. The data was collected using interviews and onsite observation.

Findings of the study confirmed the need to develop a real time system for aviation for briefing officers in UNMA to give timely weather updates to pilots and reduce on the costs of printing on the side of UNMA and for effective service delivery to the aviation industry at Entebbe International Airport.

The system was designed, and implemented basing on the study findings, which were used to formulate the system requirements. The real-time weather update information system has been tested and validated and it is now ready for use.

It can be used to enable the pilot view the briefing folder displays as per their request online without physically going to briefing office to pick a printed copy. This will help UNMA to reduce on the costs for printing, reduce the queues of airline agents and pilots waiting for a briefing officer to print and give them a hard copy of a briefing folder. From the study, we can learn that information systems can help improve service delivery, reduce on the costs of production and ease communication.

6.3 Recommendations

The information in a briefing folder is extracted from other systems, such as automatic weather stations, satellite systems and other manual systems like a metar observed physically sent to briefing office by email.

I would highly recommend all these systems to be integrated with the real-time weather update information system, for total automation if UNMA can be given full authority over these systems.

6.4 Future work

1. Integration with other aviation systems was not done because it was not part of the objectives therefore, future research can be conducted along that line.

2. The system can be modified to accommodate and update another product such as Marine forecasts. This was left out because it was not part of the scope.

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APPENDICES

Appendix A: Interview Guide for Briefing officers.

1. How long have you worked in this office?
2. What are the activities performed in this office?
3. What systems do you use to brief the pilots?
4. What happens in case the pilots do not get the weather information?
5. Which system do you use most in briefing the pilots and why?
6. Are you facing any challenges using these systems? If yes, what are those challenges?
7. In case the weather changes, how do you update the pilot?
8. How many briefing folders do you issue in a day?

Interview Guide for Managers UNMA briefing office.

1. For how long have you worked with UNMA?
2. What systems does UNMA use in briefing office?
3. What challenges are associated with the briefing systems in use?
4. What measures has management put in place to minimize such challenges

Interview Guide for Airline agents or Pilots

1. How long have you worked/used Entebbe international Airport?
2. What exactly do you do in relation to Aviation?
3. Do you access weather information ?
4. How often?
5. If yes, are you satisfied with the systems used to provide the weather information?
6. What happens in case you do not get such weather information

7. If no, why are you not satisfied?

Appendix B: Validation guide.

Requirement description	**User Rating**			
	Agree	**Strongly Agree**	**Disagree**	**Strongly disagree**
The system allows only an administrator to create user accounts for the system users.				
The system administrator should assign different system users different access rights.				
The system should allow the briefing officer to update all the details of a flight folder.				
The system should allow a pilot who is registered to view the weather update /briefing folder details				
The pilot should be able to chart with a briefing officer.				
The system should give notifications or alerts in case the weather changes for specific routes.				
Is the system serving the purpose for which it was developed?				

Appendix C: Letter of authorization to carry out the research.

UNIVERSITY OF KISUBI

(Formerly known as Kisubi Brothers University College)

In Virtue We Educate

10th July, 2019

TO WHOM IT MAY CONCERN

Dear Sir/Madam.

RE: INTRODUCING NABADA AISHA

I wish to introduce to you **Nabada Aisha (17MIT023)**. She is our student on the **Master of Information Technology (MIT) of Uganda Martyrs University** programme that is being offered at the **University of Kisubi.**

She is carrying out a study on the topic: **"Real – Time Weather Updates Information System for Aviation: Case of Uganda National Meteorological Authority (UNMA)"**

The purpose of this letter is to kindly request you to accord her such assistance as may be necessary to enable her access and obtain the data she might need for her study.

It is my hope that her findings will not only be useful for academic purposes but will also be of much benefit to the general public.

Thank you in advance.

Yours faithfully,

UNIVERSITY OF KISUBI
19 JUL 2019
PO Box 182
Graduate Studies and Research

Dr. Ankwasiize G. Evarist

Ag. Director, School of Graduate Studies and Research

Appendix D:Sample size determination table as recommended by Morgan and Krejcie.

TABLE FOR DETERMINING SAMPLE SIZE FROM A GIVEN POPULATION

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	181	1200	291	6000	361
45	40	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Note: N the population size

S sample size

Appendix E: Sample of an existing briefing folder at Entebbe international Airport UNMA briefing officein coded form.

Head Office:
Plot 67 – 75
Port bell road
Luzira

E-mail:info@unma.go.ug

Tel: +256 414 251798
Fax:+256 414 251797

P.O. Box 7025
Kampala

Website: www.unma.go.ug

UGANDA NATIONAL METEOROLOGICAL AUTHORITY

FCT 112F: TAKE – OFF INFORMATION

FLIGHT NUMBER: **ET357**

DEPARTURE: **ENTEBBE**

DESTINATION: **JUBA/ADDIS ABABA**

DATE: **24TH September, 2019**

ESTIMATED TIME OF DEPARTURE: 1425Z

QAN: 27006KT

QMU: 23°C

QFE: 884hPa

QNH: 1015hPa

Prepared by:

Signature…… Time: 1317Z

MET-BRIEFING OFFICE ENTEBBE INTERNATIONAL AIRPORT

E-mail: *metbriefing@yahoo.co.uk*

Data at: 1317 UTC 13 Mar 2018

HUEN 131200Z 18010KT 9999 SCT022 FEW024CB BKN130 24/20 Q1017 NOSIG

TAF HUEN 131100Z 1312/1418 20007KT 9999 FEW023 FEW025CB SCT140 FM 131600 23006KT FEW022 FEW024CB SCT130 BECMG 1321/1324 35004KT 9000 -TS SCT019 FEW021CB SCT130 TEMPO 1401/1406 VRB11KT 7000 TSRA BKN017 FEW019CB OVC100 BECMG 1407/1412 18010KT 9000 -TS SCT022 FEW024CB SCT160 FM 141600 22006KT 9999 FEW021 FEW023CB SCT130

No METAR found for HUAR

No TAF found for HUAR

No METAR found for HSSJ

TAF HSSJ 130500Z 1306/1412 18003KT 9999 SCT030 BKN140 TEMPO 1309/1312 21005KT 9999 FEW040 BKN140

PROB30

TEMPO 1312/1318 22005G15KT 6000 TSRA FEW045CB BKN120

HSSS 131300Z 33012KT CAVOK 34/M04 Q1010 NOSIG

TAF HSSS 131100Z 1312/1418 02008G18KT CAVOK TEMPO 1316/1320 6000

HSOB 131300Z 36004KT CAVOK 33/M05 Q1012

No TAF found for HSOB

HAAB 131300Z 19006KT 9999 BKN025 24/07 Q1023

TAF HAAB 131000Z 1312/1418 12012KT 9999 SCT025 SCT080
BECMG 1312/1315 16012KT SCT030
BECMG 1318/1321 18010KT FEW030 FEW080

No METAR found for HADR

TAF HADR 131000Z 1312/1418 36008KT 9999 SCT030 FEW080
BECMG 1312/1315 35008KT SCT025
BECMG 1315/1318 36010KT FEW030 FEW080

HDAM 131100Z 07013KT 9999 FEW023 30/23 Q1012

HDAM 131100Z 1312/1412 08012KT 9999 FEW023
BECMG 1315/1318 VRB03KT CAVOK
BECMG 1400/1403 00000KT SCT020
BECMG 1403/1406 VRB03KT SCT020

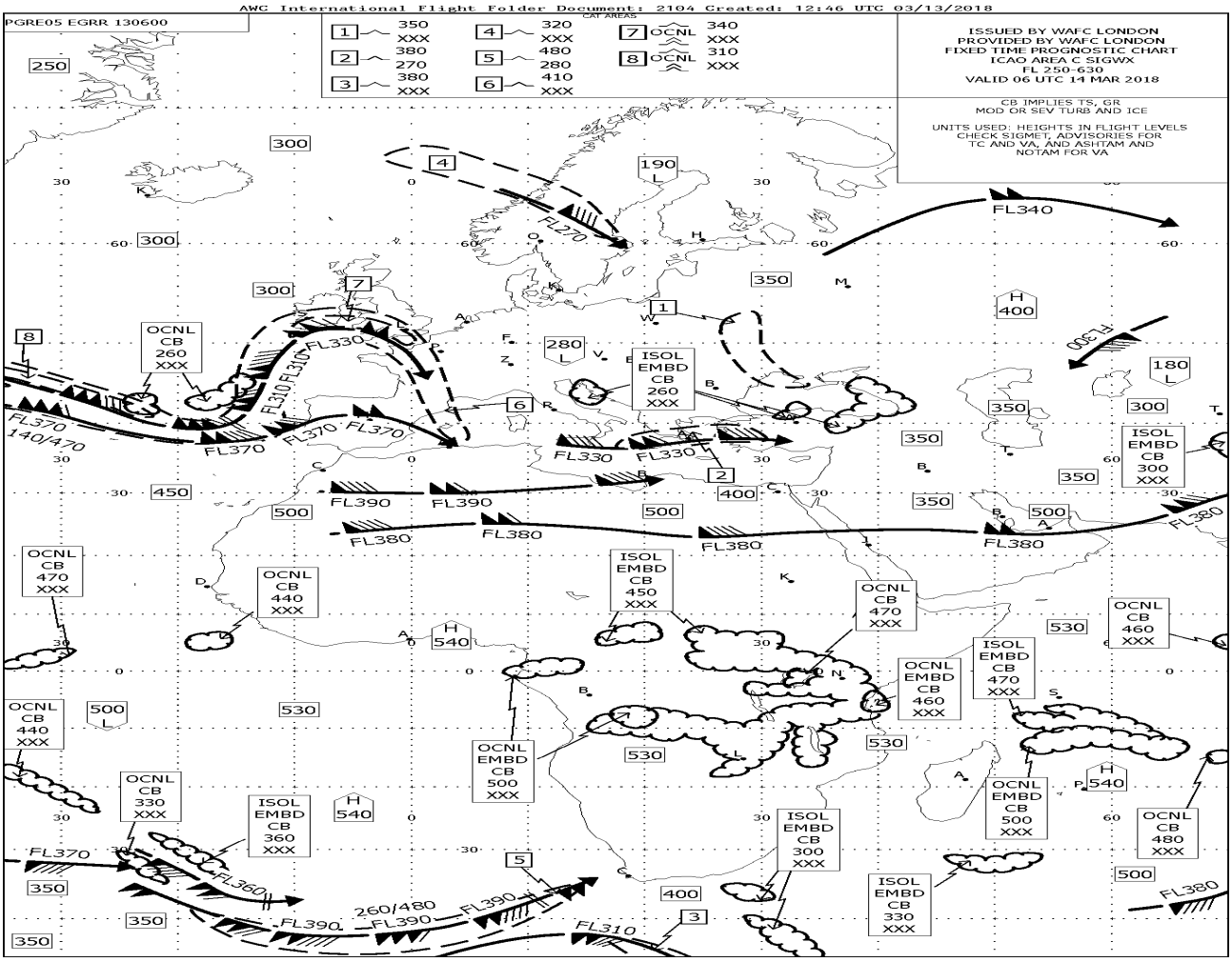

Chart showing hazardous weather to the aircraft along the route

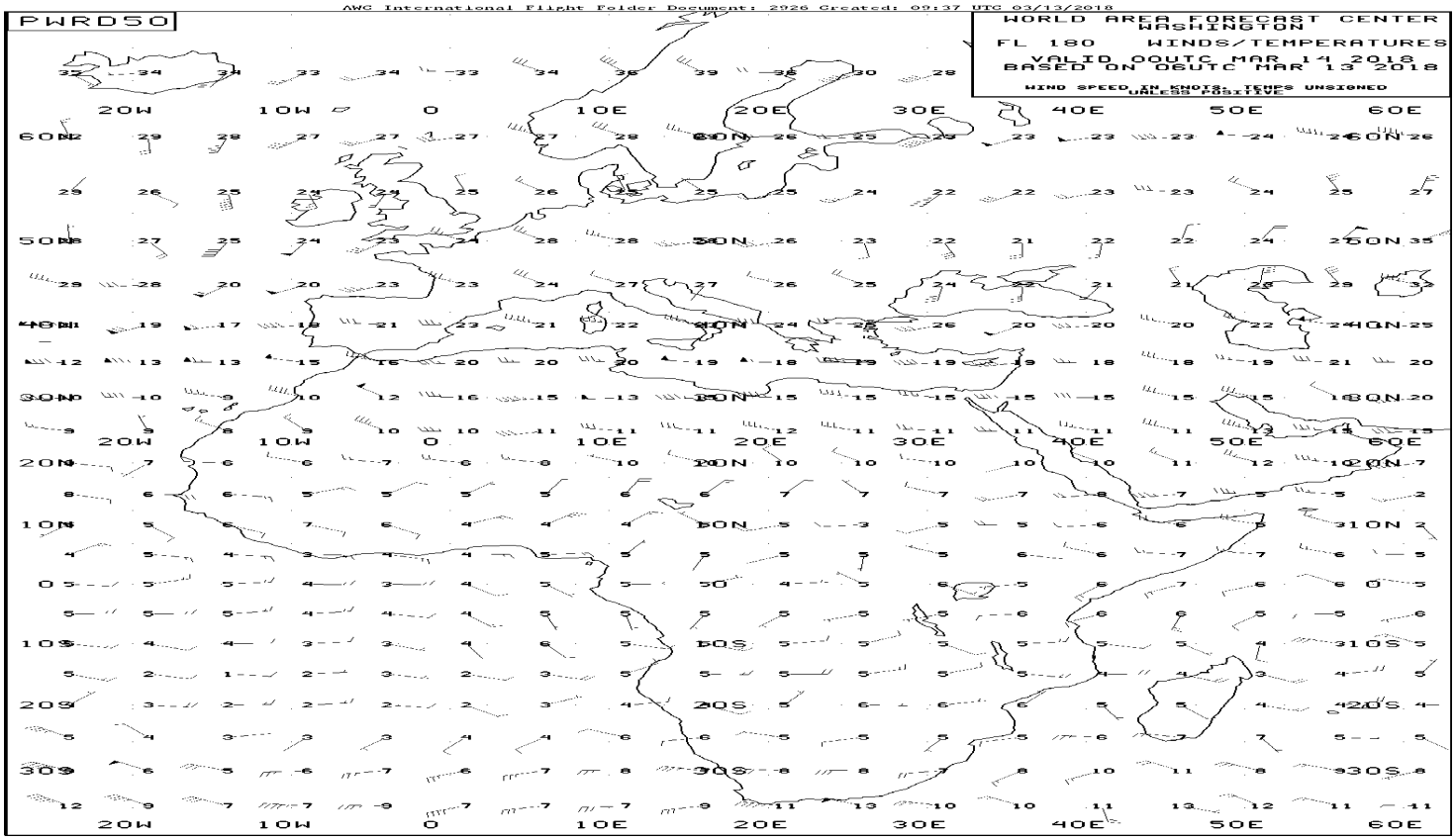

Chart showing winds and temperature at Flight level180

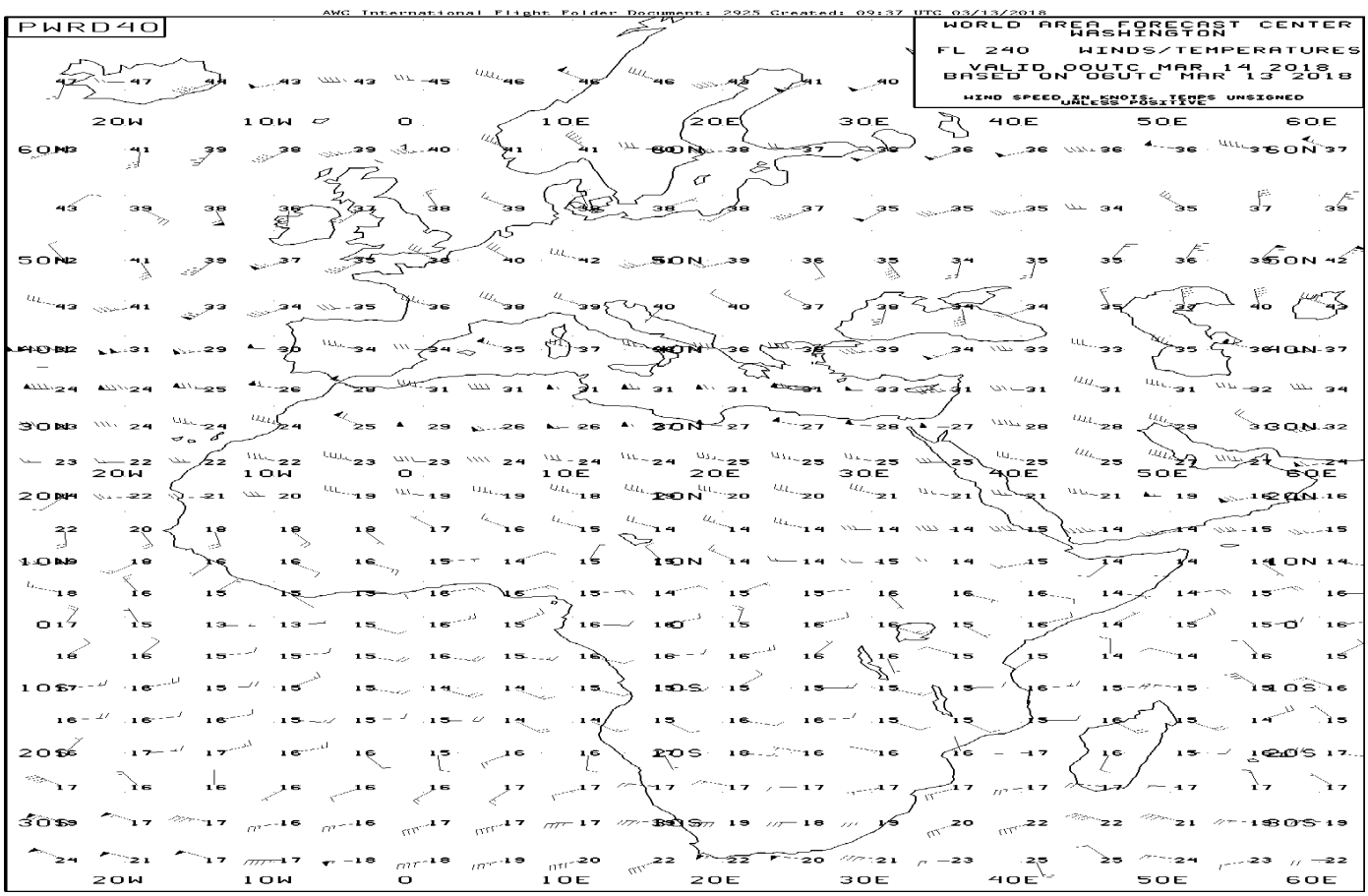

Chart showing winds and temperature at Flight Level 240

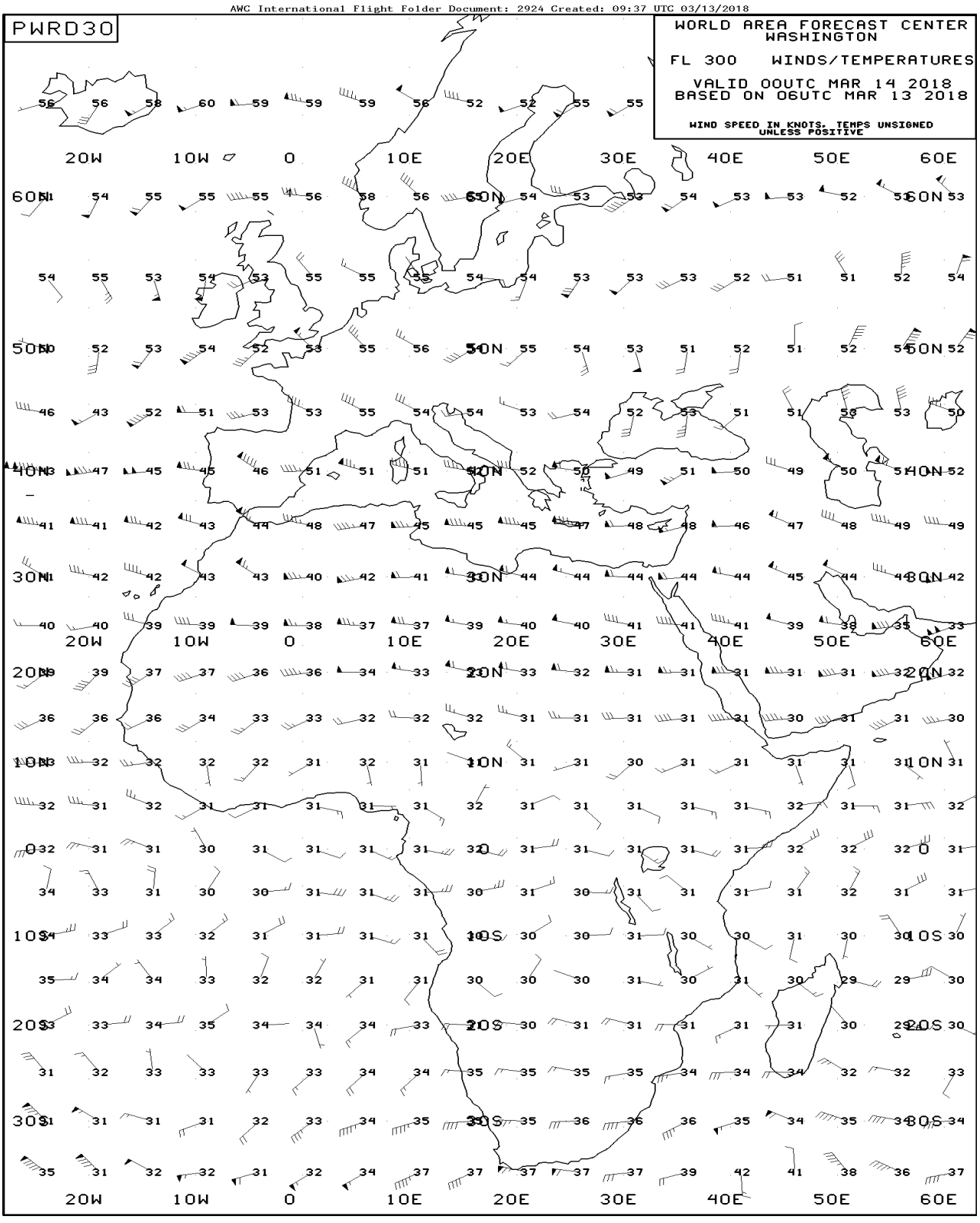

Chart showing winds and Temperature at Flight level 300

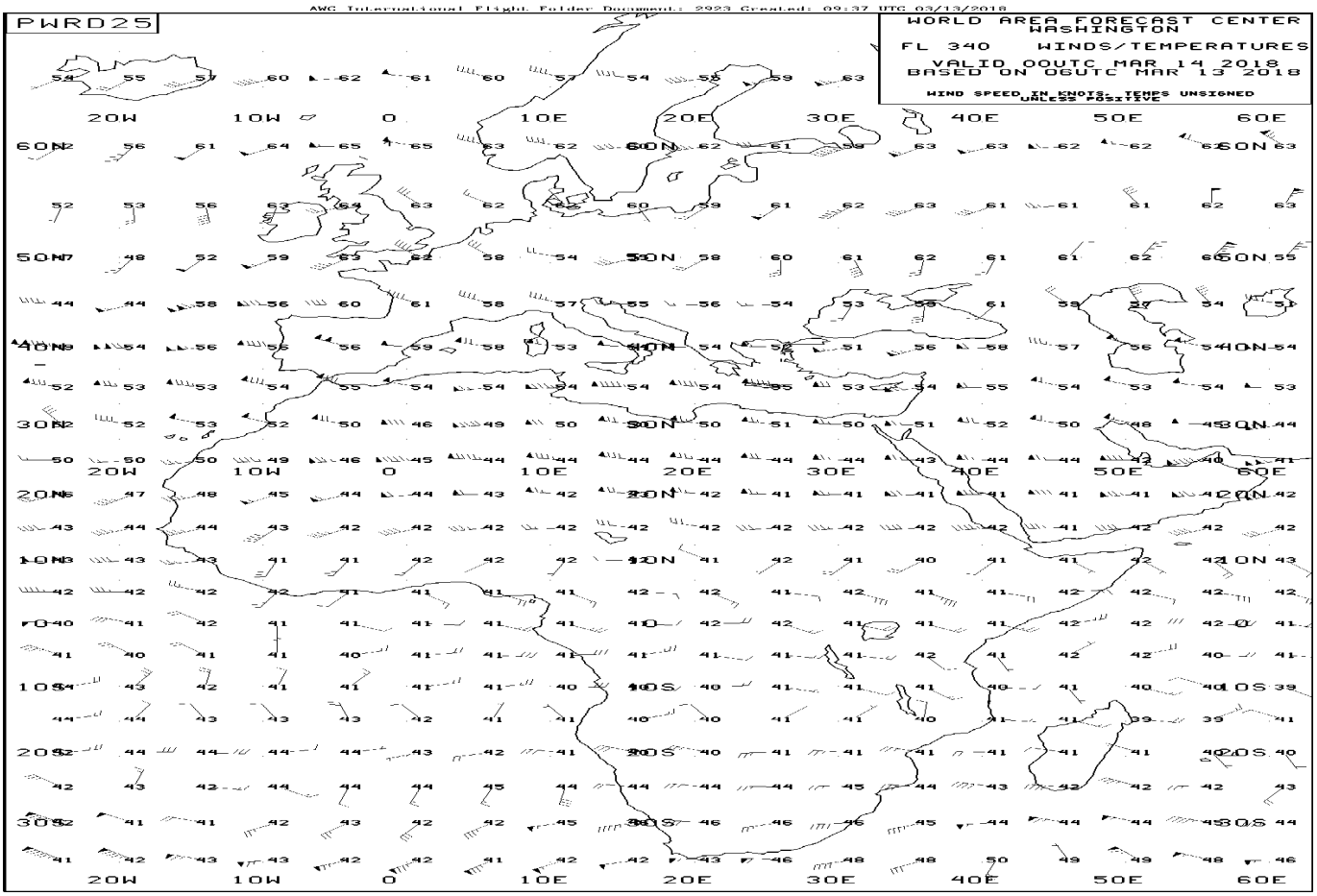

Chart showing winds and Temperature at Flight Level 340