EMERGENCY DISEASE RESPONSE SYSTEM CASE STUDY: MBALE REGIONAL HOSPITAL MBALE CITY

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S21/MUC/BSIT/006

A DISSERTATION Submitted TO THE FACULTY OF SCIENCE AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A DEGREE OF BACHELOR OF INFORMATION TECHNOLOGY OF UGANDA CHRISTIAN UNIVERSITY

August, 2024

UGANDA CHRISTIAN UNIVERSITY

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DECLARATION

I, Mukite Jesca, declare that the content of this research report is my original work. To the best of my knowledge and belief, this work has never been submitted anywhere for any award. It is a testament to my dedication, effort, and commitment to contributing valuable insights to the academic community.

Signature: ……  **……** **Date: 15th August, 2024**

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APPROVAL

I hereby certify that this research, conducted by Mukite Jesca, is an original work that has been thoroughly developed and reviewed under my supervision. It is now ready for submission to the Department of Computing, Technology, Engineering and Design for further consideration and academic evaluation.

Signature: …… Date: 01/10/2024

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CHAPTER ONE

This chapter explains the background information to the study with the view of the problem statement, objectives, scope and significance of the study

1.1 Introduction

In the wake of increasing global health emergencies, the need for robust, real-time response systems is paramount. Mbale Regional Hospital, a key healthcare provider in Eastern Uganda, faces number of challenges in managing immediate outbreaks of diseases such as Ebola, COVID- 19, and cholera. This concept paper proposes the development of an Emergency Disease Response Platform (EDRP) to enhance the hospital's capacity to respond swiftly and effectively to health crises.

1.2 Background to the Study

Mbale Regional Hospital, a referral hospital in Eastern Uganda, faces challenges in responding to public health emergencies and as well serves a large and diverse population, making it a critical node in Uganda's healthcare network. Historically, the hospital has encountered various health emergencies, each highlighting gaps in communication, resource allocation, and data management. The 2019 Ebola outbreak and the COVID-19 pandemic underscored the urgent need for a coordinated emergency response system. Despite efforts to bolster emergency preparedness, systemic challenges persist, necessitating an integrated digital solution.

1.3 Problem Statement

Mbale Regional Hospital currently is facing a lot of challenges when it comes to anti outbreak of immediate diseases. The hospital lacks a comprehensive, real-time emergency disease response system resulting in delayed response times, inefficient resource management, and poor coordination during health emergencies. These deficiencies undermine the hospital's ability to contain outbreaks, leading to higher morbidity and mortality rates.

1.4 Main Objectives

The general objective is to develop an emergency disease response platform (EDRP) tailored for Mbale Regional Hospital that will enable health professionals to communicate with people about disease out breaks by integrating data management, communication, and resource allocation functionalities.

1.4.1 Specific Objectives

i. To study the current system used to manage the emergency response programs at Mbale Regional Hospital in order to note system requirements.
ii. To design an emergency disease response platform for Mbale Regional Hospital using the identified requirements.
iii. To implement the designed emergency Response Platform using various programming languages like php, Mysql among others.
iv. To test and evaluate the emergency disease response platform so as to check for any errors and to see whether it meets the user requirements.

1.5 Scope

The scope of this study encompasses the development, implementation, and evaluation of the Emergence Disease Response Platform at Mbale Regional Hospital. The project will involve collaboration with healthcare professionals, IT experts, and public health officials. The platform will be designed to handle various types of health emergencies, with scalability to potentially integrate with regional and national health systems.

1.6 Significance

i. Implementing the Emergency Disease Response Platform at Mbale Regional Hospital will significantly enhance the hospital's emergency response capabilities. The platform's real-time data analytics will enable timely identification and containment of disease outbreaks, thereby reducing transmission rates and saving lives.
ii. Improved communication and resource management will ensure that the hospital can effectively mobilize and deploy its resources during health crises. Ultimately, the EDRP will serve as a model for other regional hospitals, contributing to a stronger, more resilient healthcare system across Uganda.
iii. Improve public health emergency response times and efficiency
iv. Enhance disease surveillance and monitoring capabilities.
v. Reduce the impact of public health emergencies on patients and the community.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Chapter One presented the Background information to the study explaining the objectives, scope and significance to the study. This chapter is about the Literature review of the Emergency Disease Response Systems. It specifies what an Emergency disease response platform is, what it needs and how it operates for its enhancements

2.1 Emergency Disease Response Platform

Emergency Disease Response Platforms (EDRPs) are integrated systems designed to manage and mitigate the impact of infectious disease outbreaks, pandemics, and other health emergencies. These platforms facilitate rapid data collection, analysis, and dissemination, enabling health authorities to make informed decisions and implement effective response strategies. EDRPs combine technology, data science, and public health principles to enhance preparedness, response, and recovery efforts during health crises.

Emergency disease response platforms are essential tools in the management and mitigation of disease outbreaks. These platforms integrate various technologies and methodologies to provide real-time data collection, analysis, and dissemination, facilitating prompt and effective public health responses. The rapid identification and reporting of infectious diseases are crucial in preventing their spread and minimizing their impact on public health and economies. By leveraging electronic health records, mobile health applications, and geospatial data, these platforms enhance situational awareness and support decision-making processes (World Health Organization [WHO], 2020).

2.2 Types of emergency response Systems.

Emergency response platforms are critical in managing and coordinating responses to various emergencies, including natural disasters, industrial accidents, and terrorist attacks. These platforms vary in functionality, scope, and the specific needs they address. Here are the main types of emergency response platforms, along with detailed explanations and references:

Here are the various types of emergency response systems, including their examples

2.2.1 Early Warning Systems (EWS)

According to the United Nations International Strategy for Disaster Reduction (UNISDR, 2012), early warning systems are designed to detect and provide timely information about potential hazards, allowing for preventive measures to be taken. In Uganda, the Uganda National Meteorological Authority (UNMA) provides weather forecasts and warnings about impending natural hazards such as floods and droughts.

2.2.2 Emergency Operations Centers (EOC)

According to the Federal Emergency Management Agency (FEMA, 2013), Emergency Operations Centers are centralized locations where government agencies and emergency responders coordinate efforts during an emergency. The National Emergency Coordination and Operations Centre (NECOC) in Uganda coordinates disaster response activities and resources during emergencies, such as during the floods in Kasese District.

2.2.3 Incident Command System (ICS)

According to the National Incident Management System (NIMS, 2017), the Incident Command System is a standardized approach to the command, control, and coordination of emergency response, providing a common hierarchy within which responders from multiple agencies can be effective. The Uganda Red Cross Society (URCS) uses the Incident Command System to manage large-scale emergency responses, such as during the Ebola outbreaks in Western Uganda.

2.3 Public Alert Systems

According to the National Oceanic and Atmospheric Administration (NOAA, 2018), public alert systems are designed to disseminate critical information to the public in a timely manner through various channels such as sirens, text messages, and broadcast media. In Uganda, the Uganda Communications Commission (UCC) uses community radios and SMS alerts to disseminate information about emergencies and disasters, such as the mudslides in Bududa District.

2.4 Healthcare Emergency Response Systems

According to the Centers for Disease Control and Prevention (CDC, 2019), healthcare emergency response systems are designed to coordinate medical resources and personnel in response to health emergencies, including pandemics and bioterrorism incidents. Uganda's Ministry of Health coordinates health emergency responses, including the establishment of isolation centers and distribution of medical supplies during the COVID-19 pandemic.

2.5 Community-Based Disaster Response

According to the International Federation of Red Cross and Red Crescent Societies (IFRC, 2014), community-based disaster response systems involve local communities in the planning and execution of emergency response strategies, ensuring that the unique needs of the community are addressed. In Uganda, Community Disaster Preparedness Committees (CDPCs) train local communities in disaster risk reduction and response techniques, such as in the landslide prone areas of Eastern Uganda.

2.5.1 Search and Rescue (SAR)

According to the International Search and Rescue Advisory Group (INSARAG, 2015), search and rescue systems are specialized in locating and providing aid to people in distress or imminent danger, including those lost, isolated, or injured. The Uganda Police Force has specialized SAR units that conduct operations during natural disasters such as floods and landslides, like those that occurred in the Mount Elgon region.

2.6.1 Uganda Red Cross Society (URCS) Emergency Response System in Uganda

According to Businge (2021), The Uganda Red Cross Society (URCS) operates an emergency response system designed to provide humanitarian assistance during various disasters and crises, including natural disasters, health emergencies, and conflict situations. URCS plays a pivotal role in disaster management and relief efforts in Uganda, leveraging its network of volunteers and resources to respond effectively to emergencies.

There are number of modules that this system runs including the following:-

i. **Emergency Preparedness module:** This module involves training volunteers, conducting drills, and stockpiling resources (food, medical supplies, and shelter materials) to ensure readiness for potential disasters.
ii. **Disaster Response module:** This module mobilizes resources and volunteers immediately following a disaster. This includes setting up emergency shelters, distributing relief supplies, and providing first aid and medical care.
iii. **Community Engagement module**: This module educates and involves communities in disaster preparedness and response activities. This module aims to build local capacity and resilience through community-based programs.

iv. **Reporting and Evaluation module:** This module provides documents response efforts, assesses the effectiveness of interventions, and provides feedback for continuous improvement. This involves collecting data, analyzing outcomes, and compiling reports for stakeholders and donors.

2.6.1 How the System Works.

According to Businge (2021), Uganda Red Cross Society prepares for emergencies by training a vast network of volunteers and stockpiling essential resources.

When a disaster occurs, the organization swiftly mobilizes its resources and volunteers to the affected areas. The response includes setting up temporary shelters, distributing emergency supplies (food, water, medical supplies), and providing psychosocial support and first aid.

URCS also works closely with local communities, engaging them in preparedness activities and building their capacity to respond to emergencies. All activities are meticulously documented and evaluated to ensure transparency, accountability, and continuous improvement in disaster response practices.

2.6.1.2 Benefits/Strengths

According to Businge (2021), the benefits or strengths of URCS Emergency response system are;

i **Rapid Mobilization:** The ability to quickly deploy resources and volunteers to disaster-affected areas ensures timely humanitarian assistance.

ii **Community Involvement:** Engaging local communities in disaster preparedness and response enhances community resilience and self-reliance.

iii **Humanitarian Focus**: URCS's primary focus on humanitarian aid ensures that vulnerable populations receive the necessary support during crises.

iv **Network of Volunteers**: A robust volunteer network enables widespread coverage and effective response in various regions of Uganda.

2.6.1.3 Weaknesses/Problems

According to Businge (2021), the weaknesses or problems of URCS Emergency Response System are;

i **Funding Limitations**: URCS relies heavily on donations and external funding, which can be unpredictable and may limit the scope and scale of its operations.

ii **Volunteer Management:** Coordinating and managing a large number of volunteers, especially during large-scale emergencies, can be challenging.

iii **Sustainability Issues:** Ensuring long-term sustainability of preparedness and response efforts requires continuous funding and support, which can be difficult to maintain.

2.6.1.4 Conclusion

According to Businge (2021), The Uganda Red Cross Society's Emergency Response System is a critical component of Uganda's disaster management framework. Its strengths lie in rapid mobilization, community involvement, and a strong humanitarian focus, which together ensure effective and timely response to emergencies. However, the system faces challenges related to funding, volunteer management, and sustainability. Addressing these challenges is essential for enhancing the effectiveness and resilience of Uganda's emergency response capabilities.

2.6.2 Integrated Public Alert and Warning System (IPAWS)

According to Cossin (2020), IPAWS is a system designed to provide emergency alerts and warnings to the public through multiple communication channels. In Uganda, it plays a crucial role in disseminating information about natural disasters, health emergencies, and security threats.

The Integrated Public Alert and Warning System (IPAWS) is a unified emergency alert system designed to improve public safety by providing timely and effective alerts and warnings.

Here are the key components and features of IPAWS:

i. **Multi-Channel Alert:** IPAWS allows authorities to disseminate emergency messages through multiple channels, including radio, television, mobile phones, internet services, and other communication networks. It integrates existing public alert

systems, such as the Emergency Alert System (EAS), Wireless Emergency Alerts (WEA), and the NOAA Weather Radio.

ii. **Interoperability:** IPAWS ensures that different communication platforms and alerting authorities can work together seamlessly. It uses the Common Alerting Protocol (CAP), an open standard that allows messages to be consistently formatted and easily shared across various systems.

iii. **Geotargeting:** IPAWS can send location-specific alerts to ensure that only those in the affected areas receive the warnings. This feature helps to prevent unnecessary panic and ensures that the right people receive the right information at the right time.

iv. **Accessibility**: The system is designed to be accessible to people with disabilities, ensuring that alerts are delivered in formats that can be received by all, including audio, visual, and text formats. IPAWS also supports multiple languages to reach a broader audience.

v. **Authorized Alert Originators:** Only authorized federal, state, local, tribal, and territorial authorities can send alerts through IPAWS. These authorities are trained and certified to use the system to ensure accurate and appropriate use.

vi. **Public Safety and Non-Weather Emergencies:** In addition to weather-related warnings, IPAWS can be used for a wide range of public safety emergencies, including natural disasters, terrorist attacks, AMBER alerts, and other critical incidents.

vii. **Reliability and Redundancy:** IPAWS is designed to be highly reliable with redundant systems to ensure continuous operation during emergencies. The system undergoes regular testing and updates to maintain its effectiveness and efficiency.

viii. **Community Engagement and Education:** Public education campaigns are conducted to inform citizens about the system and how to respond to alerts. Communities are encouraged to participate in preparedness activities and to understand the importance of following emergency alerts.

ix. **Integration with Local Systems:** IPAWS can be integrated with local alerting systems, allowing for a more coordinated and comprehensive approach to emergency communication. Local authorities can customize alerts to address specific needs and conditions within their jurisdictions.

IPAWS represents a significant advancement in emergency communication, enhancing the ability to quickly and effectively warn the public about imminent dangers and helping to save lives and protect property.

2.6.3.1 How the System Works

According to Cossin (2020), Integrated Public Alert and Warning System (IPAWS) Authorized agencies generate alerts based on the type and severity of the emergency. These alerts are authenticated and then disseminated through various channels to reach the maximum number of people. The system collects feedback to improve future alerting efforts

2.6.3.2 Benefits/Strengths

According to Cossin (2020), Integrated Public Alert and Warning System (IPAWS)

i. **Wide Reach**: Utilizes multiple channels to ensure broad dissemination of alerts.
ii. **Real-Time Information**: Provides timely warnings to help the public take protective
iii. **Improved Public Safety**: Enhances awareness and preparedness for emergencies.

2.6.2.3 Weaknesses/Problems

According to Cossin (2020), Integrated Public Alert and Warning System (IPAWS)

i. **Dependency on Communication Infrastructure:** Effectiveness can be compromised by infrastructure failures.
ii. **Potential for Misinformation:** Risk of unauthorized or false alerts if the system is not properly secured.
iii. **Limited Accessibility**: Some remote or rural areas may have limited access to communication channels.

2.6.2.4 Conclusion

According to Cossin (2020), The Integrated Public Alert and Warning System (IPAWS) is highly effective in disseminating wide-reaching public alerts through multiple communication channels, enhancing public safety and awareness.

However, it relies heavily on communication infrastructure and faces risks of misinformation and limited accessibility in remote areas.

2.6.3 Uganda Police Force Emergency Response System

According to Kirunda (2021), The Uganda Police Force (UPF) operates an emergency response system to handle security related emergencies, including crimes, accidents, and public disturbances. NECOC**: The Uganda Police Force (UPF) plays a critical role in maintaining public order and safety in Uganda. Their emergency response system is an

integral part of their operations, designed to handle a variety of emergencies, including crimes, accidents, natural disasters, and other incidents requiring immediate attention.

Modules of the Emergency Response System

i. **Command and Control Center**: Centralized hub for receiving and dispatching emergency calls. Equipped with advanced communication technology to coordinate responses.
ii. **Patrol Units:** Mobile units that are strategically deployed across various regions. Ready to respond to emergencies within a short time frame.
iii. **Specialized Response Teams:** Units such as the Counter-Terrorism Unit, Fire and Rescue Services, and Traffic Police. Each team has specific training and equipment for particular types of emergencies.
iv. **Community Policing**: Engagement with local communities to build trust and gather intelligence. Establishment of local emergency committees and volunteer groups to assist in response efforts.
v. **Training and Capacity Building**: Regular training programs for officers in first aid, disaster management, and crisis intervention. Simulation exercises to enhance preparedness and response efficiency.
vi. **Technology and Infrastructure**: Use of Geographic Information Systems (GIS) for mapping and planning. Deployment of surveillance cameras and other monitoring tools.

2.6.3.1 How it Works

According to Kirunda (2021), Uganda Police Force (UPF) Emergency Response System operates in the following ways;

i. **Incident Reporting**: Emergencies are reported via a centralized emergency number (usually 999 or 112). Information is logged and assessed at the Command and Control Center.
ii. **Dispatch**: Based on the nature and location of the incident, appropriate response units are dispatched.
Real time communication is maintained between the control center and field units.
iii. **On-Scene Response**: First responders secure the scene, provide immediate assistance, and gather information Specialized teams are called in if necessary, depending on the complexity of the situation.

iv. **Coordination with Other Agencies**: Collaboration with other emergency services such as medical, fire, and disaster management agencies. Integration of efforts to ensure a comprehensive response.

v. **Follow-Up:** Continuous monitoring and support are provided until the situation is resolved. Investigations and after-action reviews are conducted to improve future responses.

2.6.3.2Benefits/Strengths

According to Kirunda (2021), Uganda Police Force (UPF) system has the benefits or strengths as listed below;

i. **Rapid Response:** Aids in quick mobilization of resources and personnel ensures timely intervention in emergencies that has broken out.

ii. **Specialized Units**: Availability of trained teams for specific types of emergencies enhances effectiveness.

iii. **Community Involvement:** Engagement with the public improves information flow and builds trust.

iv. **Technological Integration:** Use of advanced technologies aids in efficient incident management and resource deployment.

v. **Inter-Agency Collaboration**: Working with other agencies ensures a holistic approach to emergency management.

2.6.3.3Weaknesses/Problems

According to Kirunda (2021), Uganda Police Force (UPF) system has the weaknesses or problems as below mentioned;

i. **Resource Constraints**: There is the case of limited funding and resources that hampers the effectiveness of response efforts.

ii. **Training Gaps:** It has the challenge of inadequate training for some officers that leads to suboptimal handling of certain situations.

iii. **Infrastructure Challenges:** Poor road conditions and lack of adequate communication infrastructure can delay response times during the time of bad weather conditions.

iv. **Corruption and Mismanagement:** Issues within the police force, such as corruption, undermine public trust and response efficiency to such incidences.

v. **Public Awareness:** Low levels of public awareness about emergency procedures can affect the overall effectiveness of the system.

2.6.3.4 Conclusion

According to Kirunda (2021), The Uganda Police Force's emergency response system is a vital component of the country's public safety framework. While it has several strengths, including rapid response capabilities and specialized units, there are also significant challenges that need to be addressed. Improving resources, training, infrastructure, and public awareness can enhance the effectiveness of the system, ensuring better safety and security for all Ugandans.

2.6.4 National Emergency Coordination and Operations Center (NECOC)

According to Mukasa (2020), National Emergency Coordination and Operations Center (NECOC) is responsible for coordinating national responses to various emergencies, including natural disasters, health crises, and security threats. As well for coordinating disaster response and management activities across the country. It serves as the central hub for managing emergencies, ensuring effective communication, coordination, and deployment of resources during disasters and crises.

Modules of NECOC

i. **Command and Control Center:** Centralized facility for monitoring and managing emergency operations. Equipped with advanced communication and information technology systems.
ii. **Early Warning and Monitoring Systems:** Systems in place to detect and monitor potential hazards and threats. Utilization of Geographic Information Systems (GIS) and remote sensing technologies.
iii. **Incident Management Teams:** Teams of trained personnel responsible for on-ground coordination and management of emergency responses. Specialized teams for different types of disasters such as floods, earthquakes, and epidemics.
iv. **Resource Management:** Database and inventory of emergency supplies and resources. Efficient allocation and distribution of resources during emergencies.
v. **Public Information and Communication:** Systems for disseminating timely and accurate information to the public. Use of various media channels to communicate warnings, advisories, and updates.

vi. **Training and Capacity Building:** Regular training programs for staff and volunteers. Simulation exercises to improve preparedness and response capabilities.

vii. **Inter-Agency Collaboration:** Coordination with various government agencies, non-governmental organizations (NGOs), and international partners. Integration of efforts to ensure a unified response to emergencies.

2.6.4.1 How it Works

According to Mukasa (2020), National Emergency Coordination and Operations Center (NECOC) NECOC continuously monitors data from various sources to identify potential emergencies. When an incident occurs, the center coordinates resource allocation and response efforts, ensuring effective communication between involved agencies. All activities are documented for accountability and future improvement.

i. **Detection and Early Warning**: Continuous monitoring of environmental and socio-political conditions to detect potential threats.

   Dissemination of early warnings to relevant authorities and the public.

ii. **Activation of Emergency Operations:** Activation of the command and control center upon detection of an emergency.

   Mobilization of incident management teams and resources.

iii. **Coordination and Communication**: Centralized coordination of response activities, ensuring all stakeholders are informed and aligned.

iv. **Deployment of Resources**: Strategic deployment of personnel, equipment, and supplies to affected areas. Coordination with local authorities and community organizations for effective distribution.

v. **Public Information and Engagement**: Regular updates and advisories to the public through various communication channels.

   Engagement with communities to gather feedback and address concerns.

vi. **Post-Emergency Recovery:** Assessment of damage and needs for recovery and rehabilitation.

   Coordination of recovery efforts and allocation of resources for rebuilding.

2.6.4.2 Benefits/Strengths

According to Mukasa (2020), National Emergency Coordination and Operations Center (NECOC)

i. **Centralized Coordination**: Streamlined management of emergency response activities ensures efficiency and effectiveness.
ii. **Advanced Technology:** Utilization of cutting-edge technology for early warning, monitoring, and resource management enhances response capabilities.
iii. **Trained Personnel:** Well-trained staff and volunteers ensure competent handling of emergencies.
iv. **Public Information Systems:** Effective communication with the public helps in timely dissemination of information and reduces panic.
v. **Collaborative Approach**: Strong collaboration with various agencies and organizations ensures a comprehensive response.

2.6.4.3 Weaknesses/Problems.

According to Mukasa (2020), National Emergency Coordination and Operations Center (NECOC)

i. **Resource Limitations:** Insufficient funding and resources can constrain response efforts.
ii. **Infrastructure Challenges:** Inadequate infrastructure, such as poor road networks and communication systems, can hinder operations.
iii. **Coordination Gaps:** Lack of coordination among different agencies can lead to inefficiencies.
iv. **Public Awareness:** Low levels of public awareness and preparedness can affect the overall effectiveness of emergency responses.
v. **Bureaucratic Delays:** Administrative hurdles and delays can impede timely action.

2.6.4.4 Conclusion

According to Mukasa (2020), The National Emergency Coordination and Operations Center (NECOC) is a vital component of Uganda's disaster management framework. While it has several strengths, such as centralized coordination and advanced technology, there are challenges that need to be addressed. Improving resources, infrastructure, coordination, and public awareness can enhance the effectiveness of NECOC, ensuring better preparedness and response to emergencies in Uganda.

2.6.5 Health Emergency Response System (HERS)

According to Nanyonjo (2021), Uganda's Health Emergency Response System (HERS) is designed for managing public health crises, including epidemics, pandemics, natural disasters, and other health-related emergencies. This system is designed to ensure rapid and effective responses to health threats, minimizing their impact on public health and safety.

Uganda's Health Emergency Response System (HERS) excels in early detection and coordinated responses to public health emergencies. It effectively informs the public about health risks and manages healthcare resources during crises. Despite these strengths, it is constrained by limited healthcare resources, relies on accurate data, and requires continuous training for healthcare workers.

Modules of the Health Emergency Response System

i. **National Health Emergency Operations Center (NHEOC):** Central hub for coordinating health emergency responses.
   Equipped with advanced communication and data management systems.
ii. **Surveillance and detection**: Continuous monitoring of health data to detect early signs of outbreaks. Use of technologies such as Geographic Information Systems (GIS) and electronic health records.
iii. **Rapid Response Teams (RRTs):** Teams of healthcare professionals trained to respond quickly to health emergencies.
   Deployed to affected areas to provide immediate medical care and contain outbreaks.
iv. **Logistics and Supply Chain Management:** Management of medical supplies, vaccines, and other essential resources.
   Ensuring timely distribution to affected areas during emergencies.
v. **Public Health Communication**: Systems for disseminating accurate and timely information to the public. Use of various media channels to educate and inform about health risks and protective measures.
vi. **Training and Capacity Building:** Regular training programs for healthcare workers and volunteers. Simulation exercises to enhance preparedness and response capabilities.
vii. **Inter-Agency and International Collaboration:** Coordination with other government agencies, NGOs, and international organizations.
   Integration of efforts to ensure a comprehensive response to health emergencies.

2.6.5.1 How it Works

According to Nanyonjo (2021), Uganda's Health Emergency Response System (HERS) The system monitors health data to detect potential threats. Upon detection of an outbreak, it coordinates response efforts, including mobilization of healthcare resources and dissemination of public health information. Data collected during the response is analyzed to improve future readiness as explained below;

i. **Detection and Early Warning:** Continuous surveillance of health data to identify potential threats. Dissemination of early warnings to relevant authorities and the public.

ii. **Activation of Emergency Operations**: Activation of the NHEOC upon detection of a health emergency. Mobilization of Rapid Response Teams and resources.

iii. **Coordination and Communication:** Centralized coordination of response activities, ensuring all stakeholders are informed and aligned.

Real-time communication with field teams and other emergency services.

iv. **On-Scene Response:** Rapid Response Teams provide immediate medical care and implement containment measures.

Coordination with local health facilities and community organizations.

v. **Public Health Information:** Regular updates and advisories to the public through various communication channels.

Engagement with communities to gather feedback and address concerns.

vi. **Post-Emergency Recovery**: Assessment of impact and needs for recovery and rehabilitation. Coordination of recovery efforts and allocation of resources for rebuilding health infrastructure.

2.6.5.2 Benefits/Strengths.

According to Nanyonjo (2021), Uganda's Health Emergency Response System (HERS)

Rapid Response Capability: Quick mobilization of resources and personnel ensures timely intervention in health emergencies.

i. **Advanced Surveillance Systems**: Early detection and monitoring of health threats enhance response capabilities.

ii. **Trained Personnel:** Well-trained healthcare professionals ensure competent handling of health emergencies.

iii. **Effective Public Communication:** Timely and accurate information dissemination helps in reducing panic and promoting protective measures.

iv. **Collaborative Approach:** Strong collaboration with various agencies and organizations ensures a comprehensive response.

2.6.5.3 Weaknesses/Problems

According to Nanyonjo (2021), Uganda's Health Emergency Response System (HERS)

i. **Resource Constraints**: Limited funding and resources can constrain response efforts.

ii. **Infrastructure Challenges**: Inadequate health infrastructure, such as poorly equipped facilities and lack of transportation, can hinder operations.

iii. **Coordination Gaps**: Lack of coordination among different agencies can lead to inefficiencies.

iv. **Public Awareness and Compliance:** Low levels of public awareness and compliance with health advisories can affect the overall effectiveness of the response.

v. **Data Management Issues**: Challenges in data collection, management, and sharing can impede early detection and response efforts.

2.6.5.4 Conclusion

According to Nanyonjo (2021), The Health Emergency Response System(HERS) in Uganda is a vital component of the country's public health framework. While it has several strengths, including rapid response capabilities and advanced surveillance systems, there are also significant challenges that need to be addressed. Improving resources, infrastructure, coordination, and public awareness can enhance the effectiveness of the system, ensuring better preparedness and response to health emergencies.

2.6.6 Fire and Rescue Services (FRS) in Uganda

According to Kato (2020), The Fire and Rescue Services in Uganda are essential for responding to fire emergencies, road accidents, building collapses, and other situations requiring rescue operations. Managed primarily by the Uganda Police Force's Fire Brigade, these services are crucial for safeguarding lives and property across the country.

Modules of the Fire and Rescue Services

i. **Emergency Call Handling**: Receives fire and rescue-related emergency calls. Dispatching: Deploys fire and rescue units to emergency scenes.
ii. **Fire Stations and Sub-Stations:** Strategically located across urban and rural areas to ensure quick response times. Equipped with fire engines, ambulances, and rescue equipment.
iii. **Emergency Communication Center**: Centralized hub for receiving emergency calls and dispatching response units. Uses advanced communication systems for coordination and information dissemination.
iv. **Firefighting Units:** Teams of trained firefighters ready to respond to fire emergencies. Equipped with personal protective equipment (PPE) and firefighting tools.
v. **Rescue Units:** Specialized teams trained in rescue operations, including vehicle extrications, building collapses, and water rescues. Equipped with specialized rescue tools and medical kits.
vi. **Fire Prevention and Public Education**: Programs aimed at educating the public about fire safety and prevention. Regular inspections and assessments of buildings to ensure compliance with fire safety regulations.
vii. **Training and Capacity Building**: Continuous training programs for firefighters and rescue personnel. Simulation exercises to improve response efficiency and coordination.
viii. **Inter-Agency Collaboration**: Coordination with other emergency services, such as medical and police units. Integration with local authorities and community organizations.

2.6.6.1 How it Works

According to Kato (2020), The Fire and Rescue Services in Uganda are Emergency calls related to fire or rescue are received and processed. Units are dispatched to the scene, where they manage the incident and coordinate rescue operations. Continuous training ensures personnel are prepared for a variety of emergencies.

Incident Reporting: Emergencies are reported via a centralized emergency number (typically 999 or 112). Information is logged and assessed at the Emergency Communication Center.

Dispatch: Appropriate firefighting and rescue units are dispatched based on the nature and location of the incident. Real-time communication is maintained between the control center and field units.

On-Scene Response: Firefighters and rescue teams secure the scene, provide immediate assistance, and conduct firefighting or rescue operations. Coordination with other emergency services, such as medical teams, for comprehensive support.

Fire Prevention and Safety Checks: Regular inspections of commercial and residential buildings for fire safety compliance. Public education campaigns to promote fire safety awareness.

Post-Incident Recovery: Assessment of damage and needs for recovery and rehabilitation. Coordination of recovery efforts and allocation of resources for rebuilding.

2.6.6.2 Benefits/Strengths

According to Kato (2020), the Fire and Rescue Services in Uganda

i. **Rapid Response Capability**: Quick mobilization of resources and personnel ensures timely intervention in emergencies.
ii. **Specialized Training:** Well-trained personnel equipped to handle a variety of fire and rescue scenarios.
iii. **Public Education:** Ongoing fire safety education reduces the risk of fire incidents.
iv. **Technological Integration:** Use of advanced communication and monitoring systems enhances response efficiency.
v. **Collaborative Approach**: Strong collaboration with other emergency services and community organizations ensures a comprehensive response.

2.6.6.3 Weaknesses/Problems

According to Kato (2020), the Fire and Rescue Services in Uganda

i. **Resource Constraints:** Limited funding and resources can constrain response efforts.
ii. **Infrastructure Challenges:** Inadequate infrastructure, such as poorly equipped stations and lack of proper firefighting equipment, can hinder operations.
iii. **Coordination Gaps:** Lack of coordination among different agencies can lead to inefficiencies.

iv. **Public Awareness:** Low levels of public awareness about fire safety and prevention can affect the overall effectiveness of the system.

v. **Training Gaps:** Inadequate training for some personnel may lead to suboptimal handling of certain situations.

2.6.6.4 Conclusion

According to Kato (2020), The Fire and Rescue Services in Uganda ensure rapid response to fire emergencies and conduct specialized rescue operations, enhancing public safety. Their quick deployment and specialized training are key strengths. However, the system faces challenges with limited resources, high training costs, and potential overload during large-scale emergencies

Aspect	Uganda Red Cross Society	Integrated Public Alert and Warning System (IPAWS)	Uganda Police Force	National Emergency Coordination and Operations	Health Emergency Response System Center (NECOC)	Fire and Rescue Services
Primary Function	Humanitarian assistance and disaster response	Multi-channel public alert and warning dissemination	Law enforcement and emergency response	Coordinating national disaster response and management	Managing public health crises and emergencies	Responding to fire emergencies and rescue operations
Command and Control	Centralized coordination center for disaster response	Centralized hub integrating various public alert systems	Command and Control Center for dispatching and coordinating police response	Centralized facility for monitoring and managing emergency operations	National Health Emergency Operations Center (NHEOC)	Emergency Communication Center for receiving calls and dispatching units
Specialized Units/ Teams	Trained volunteers and rapid response teams	No specialized response units, focuses on alert dissemination	Specialized units (Counter Terrorism, Traffic Police, etc.)	Incident Management Teams for on-ground coordination	Rapid Response Teams (RRTs) for health emergencies	Firefighting units and specialized rescue teams

Public Engagement	Communitybased disaster risk reduction and education	Public education campaigns on emergency alert systems	Community policing and engagement to build trust	Public information dissemination and community engagement	Public health communication and education programs	Fire prevention programs and public education on fire safety
Training and Capacity Building	Regular training for staff and volunteers	No direct training component, focuses on alert dissemination and multichannel alerts	Continuous training programs and simulation exercises surveillance cameras	Regular training and simulation exercises	Continuous training and capacity building for healthcare workers surveillance systems	Regular training and simulation exercises for firefighters and rescue personnel
Coordination with Other Agencies	Collaborates with government agencies, NGOs, and international partners	Integrates existing public alert systems and coordinates with various agencies	Collaborates with other emergency services and government agencies	Coordinates with government agencies, NGOs, and international partners	Interagency and international collaboration for comprehensive response	Coordination with medical, police, and other emergency services
Strengths	Rapid response, community involvement, use of technology	Multi-channel alerts, Geo targeting, accessibility	Rapid response, specialized units, strong community engagement	Centralized coordination, advanced technology, trained personnel	Rapid response, advanced surveillance, effective public communication	Rapid response, specialized training, strong public education
Weaknesses	Resource constraints,	No direct response capability, relies on	Resource limitations, coordination gaps,	Resource constraints,	Resource limitations,	Resource constraints,

	training gaps, infrastructure challenges	other systems for actual response	corruption issues	coordination gaps, public awareness issues	infrastructure challenges, data management issues	infrastructure challenges, coordination gaps
Post-Emergency Activities	Recovery and rehabilitation assistance	No direct post emergency activities, focuses on alert dissemination	Investigations , after-action reviews, community support	Damage assessment, recovery coordination, resource allocation	Impact assessment , recovery and rehabilitation coordination	Damage assessment, recovery efforts, rebuilding fire safety infrastructure

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

The aim of this chapter is to outline the methodologies utilized in the development of an emergency disease response platform. This includes detailed steps and procedures for system study and analysis, data collection approaches, techniques for data analysis, and tools used for designing and implementation of the system.

The methodology in this chapter are in line with the specific objectives of the proposed emergency disease response platform.

3.1 System Study and Analysis

This section involves a comprehensive examination of the current systems used for emergency disease response and fact finding techniques were used in order to determine the system and user requirements. This determined what the system is requires to do and includes the following methods used;

3.2 Data collection techniques

3.2.1 Interviews

Interviews are a primary data collection techniques used involving direct interaction between the researcher and participants. This method is particularly useful for gathering in-depth information, exploring complex issues, understanding the perspectives and experiences of individuals involved in system use.

The researcher held interviews with the key stakeholders like health professionals, clients in order to get deeper insights of the functional and non-functional requirements to come out with the specific need of the system. The researcher's interviews were structured, semi-structured and unstructured which carried both closed and open ended questions which helped me to collect the information about the existing system, its challenges ,strength, modules and process of the new system.

3.2.2 Questionnaires

Questionnaires is a technique used in research to gather information from a large number of respondents systematically. They are particularly useful for collecting quantitative data and can also gather qualitative insights through open-ended questions.

The researchers used as well questionnaires technique to obtain information from the health professionals that are the user of the system at Mbale Regional Hospital. The questionnaires were submitted to the users of the system to have information at hand and researchers were able to know some of the challenges of the system and compared it with the emergency disease response platform processes.

The researchers were able to know the kind of the system to be developed that is to cater the challenges that the users encounter.

3.2.3 Observation

Observation is a fundamental data collection technique in which the researcher directly observes and records the behavior and events as they occur in their natural settings. This method is particularly valuable for studying real time and obtaining an in-depth understanding of the context and interactions that may not be easily captured through other methods like surveys or interviews.

The researcher observed clearly the activities using their eyes, processes of patients travelling to the Centre directly to report the cases, health professionals receiving information about occurrences a day after the occurrences, as researcher noting down these challenges that the individuals and health professionals encounter in sharing information**.** I documented these observations using pen and paper to ensure thorough and accurate recording of all findings.

3.2.4 Reviewing existing documents

The researcher collected more information about Mbale Regional Hospital response platforms by visiting their websites which added more information required about the system. Literature review gave me a broad understanding with information about the system, on how the former system has been behaving and so on. The findings from the questionnaire, guided the development process by highlighting user requirements and areas for enhancement within the encryption system framework.

3.2.4 Focus groups

Focus groups are a qualitative data collection technique where a small group of people discuss a specific topic or set of issues under the guidance of a facilitator. This method is particularly useful for exploring people's attitudes, perceptions and experiences.

The research organized a group of three health professionals and five individuals where they were able to ask questions and were responded immediately which helped them to get more

information about the challenges that the users are facing as researchers were noting down their responses giving a broad understanding about the system and how the new system will cater for these challenges and solve their problems.

3.3 Data Analysis Methods

The researchers used analysis software like Microsoft Excel for quantitative data and Microsoft Word for qualitative data to carefully gather and record observations about the emergency disease response system was used to capture (record) some of the data from their observations like noting the most common disease that commonly occur, the number of people that are affected by the new disease occurred, the specific professionals that to respond to certain disease outbreaks.

I made graphs and charts to show these things clearly. By doing this, I figured out where the system could work better more user-friendly. This helped me make better choices to improve the system overall.

3.4 System Analysis and Design

The analysis and design of the emergency response system involved carefully defining inputs, processes, and outputs while following system rules. This method ensured that data was well transformed while keeping it confidential and intact. Tools like data flow diagrams showed how information flowed through the system during resource sharing and reporting. Entity-relationship diagrams clarified how different parts of the system connected and depended on each other. These diagrams were crucial in developing a strong encryption decryption system that met technical standards and matched organizational needs and user expectations.

3.4.1. System Analysis

System analysis involves studying a system in detail to understand its components, relationships, and functionality and processes. This process is critical for designing, improving, and implementing systems especially in complex environments like an emergency disease response platform.

It includes gathering requirements by engaging with stake holders to understand their needs and expectations, analyzing these requirements, and modeling the system. In system analysis requirements were determined. The requirements included functional and non-functional base on the system study.

Functional Requirements

Functional requirements define what the system should do. For an emergency disease response platform, the key functional requirements might include:

Designing an emergency disease response platform tailored specifically for Mbale Regional Hospital involves considering the unique needs and constraints of the hospital. Here are ten functional requirements:

Patient Registration and Case Management:

A user-friendly interface for healthcare workers to enter and update patient data, including demographic information, clinical history, and treatment plans.

The system must allow healthcare workers to register new patients and manage their case history, including symptoms, diagnoses, treatments, and outcomes.

Its purpose is to maintain accurate and comprehensive patient records for effective disease management and ensure continuity of care.

Real-Time Data Collection and Integration:

Integrate with existing electronic medical records (EMR) and laboratory information systems (LIS) for automatic data updates.

The platform should integrate with existing hospital systems (e.g., EMR, laboratory systems) to collect and update data in real-time.

The system must ensure up-to-date information is available for timely decision-making.

To provide a single source of truth for all patient-related data.

Surveillance and Early Warning System:

Use algorithms to analyze data for unusual patterns and automatically generate alerts for potential disease outbreaks.

The platform should implement automated surveillance to detect unusual patterns and provide early warnings for potential outbreaks.

To detect and respond to outbreaks before they become widespread.

Data Visualization and Dashboards:

Create customizable dashboards that display real-time data, trends, and geographic distribution of cases.

The platform should provide intuitive dashboards and visualization tools to display key metrics, trends, and outbreak hotspots.

Its function is to help healthcare staff quickly interpret data and make informed decisions.

Predictive Analytics and Modeling:

Develop and integrate models to predict disease spread, resource requirements, and potential impact of interventions.

The platform should incorporate predictive models to forecast disease spread and resource needs based on current data.

Its function is to help in planning and allocating resources effectively.

Resource Management and Allocation:

Track inventory levels of medical supplies, manage hospital bed occupancy, and monitor staff availability.

The system should track and manage medical supplies, hospital beds, and staff availability, optimizing resource allocation.

Its purpose is to ensure that resources are used efficiently and shortages are minimized.

Interoperability with National Health Systems

Ensures the platform can send and receive data from national health databases and other regional health facilities.

Its function is to facilitate coordinated public health responses and data sharing.

Communication and Alerting

Provide communication tools for sending alerts and updates to healthcare providers, hospital staff, and public health officials.

The platform should be able to implement tools for sending timely notifications and updates via SMS, email, and in-app messages.

Its function is to keep all relevant parties informed and coordinated during an emergency to respond quickly.

Security and Privacy Compliance

The system should implement robust security measures to protect patient data and ensure compliance with privacy regulations.

To safeguard sensitive information and maintain patient trust.

Reporting and Analytics:

Generate detailed analytical reports, including trend analysis, resource usage, and outbreak reports.

The system should provide tools to generate comprehensive reports on disease trends, resource utilization, and response effectiveness

To support decision-making, strategic planning, and reporting to health authorities.

Non-Functional Requirements

Non-functional requirements (NFRs) are crucial for ensuring that an emergency disease response platform at Mbale Regional Hospital operates effectively and meets quality standards. Here are ten key non-functional requirements

i. Performance

Performance requirements specify how quickly the system should respond under various conditions. This includes response time, throughput, and system load.

The system must handle high volumes of data and user requests efficiently, with minimal latency.

To ensure fast response times and smooth operation during peak usage times, such as during an outbreak.

ii. Scalability

Scalability requirements outline the system's ability to grow and manage increased demand. This involves adding resources to handle higher loads.

The platform should be able to scale horizontally and vertically to accommodate increasing data loads and users.

To support growth and increased demand without degrading performance.

iii. Reliability

Reliability requirements define the system's ability to function correctly and consistently over time. This includes uptime, failure rates, and recovery mechanisms.

The system must provide high availability and uptime, with mechanisms for failover and redundancy.

Its purpose is to ensure that the system is dependable and available when needed, minimizing downtime and disruptions.

Examples 99.9% uptime, automatic failover in case of server failure, mean time to failure (MTTF) of 1,000 hours.

iv. Usability

Usability requirements focus on the ease with which users can learn and use the system effectively. This includes interface design, accessibility, and user satisfaction.

The platform should have an intuitive, user-friendly interface accessible to healthcare workers with varying levels of technical expertise.

Its functionality is to ensure that the system is user-friendly and accessible to all users, including those with disabilities.

Examples: Intuitive interface design, compliance with WCAG 2.1 accessibility standards, user satisfaction rating of at least 90%.

v. Security

Security requirements address the protection of data and resources from unauthorized access and threats. This includes authentication, authorization, encryption, and auditing. The system must implement robust security measures, including encryption, authentication, and authorization. To safeguard sensitive information and ensure data integrity and confidentiality.

Examples: Multi-factor authentication, end-to-end encryption of data, regular security audits and vulnerability assessments.

vi. Compliance

Compliance requirements ensure that the system adheres to relevant laws, regulations, and industry standards. This includes data protection, privacy, and industry-specific regulations.

The system must comply with relevant healthcare regulations and standards, such as HIPAA or GDPR.

To ensure legal and regulatory adherence, protecting patient rights and hospital liability.

Example: Compliance with HIPAA for healthcare data, GDPR for data privacy, regular compliance audits.

vii. Maintainability

Maintainability requirements focus on the ease with which the system can be maintained, updated, and enhanced. This includes modular design, clear documentation, and supportability.

The system should be designed with modularity and clear documentation to facilitate easy maintenance and updates.

To reduce the effort and cost of maintaining the system and to facilitate future enhancements and updates.

Examples: Modular architecture, comprehensive system documentation, mean time to repair (MTTR) of less than 2 hours.

viii. Backup and Recovery

Backup and recovery requirements ensure that data can be restored in case of loss or system failure. This includes regular backups and disaster recovery plans.

The system must implement regular data backup processes and robust disaster recovery plans. Implement regular data backup processes and robust disaster recovery plans. To protect against data loss and ensure quick recovery from failures.

Examples: Daily backups with a recovery point objective (RPO) of 24 hours, disaster recovery plan that ensures data can be restored within 4 hours.

ix. Accessibility

Accessibility requirements ensure that the system is usable by people with various disabilities. This includes compliance with accessibility standards and guidelines. The platform should be accessible to users with disabilities, complying with accessibility standards like WCAG.

To ensure all users can effectively use the system, regardless of physical or technical limitations.

Examples: Compliance with WCAG 2.1 standards, screen reader compatibility, keyboard navigability.

3.4.2 System Design

i. **Process Modeling**

Process modeling involved the creation of Data Flow Diagrams (DFDs) to illustrate how data moves and interacts across different parts of the encryption decryption system. These diagrams provided a visual representation of the entire data flow process, from where data enters the system to how it is processed and eventually produced as outputs. They were crucial in developing detailed process models that outlined every step and interaction within the system. Information for constructing these DFDs was derived from the Data Dictionary, ensuring a thorough understanding of how data flows and changes within the system.

3.4.2.1 Data flow diagrams

DFDs (Data Flow Diagrams) are graphical representations of the flow of data through an information system. They are often used to model the processes involved in a system, including disease response system. Here's a simplified DFD for an emergency disease response system:

3.4.2.1 DFD0: Context Level Diagram

The DFD0, or Context Level Diagram, provides an overview of the system from a high level perspective, showing the interactions between the system and external entities. In the case of an emergency disease response system, the main external entities could be users, health professionals, new cases, and possibly external storage.

A. Components:

Externel entities

Healthcare Providers

Government Agencies

Public

Emergency Response Teams Processes

Collect data

Analyze Data

Coordinate Response

Communicate with Public

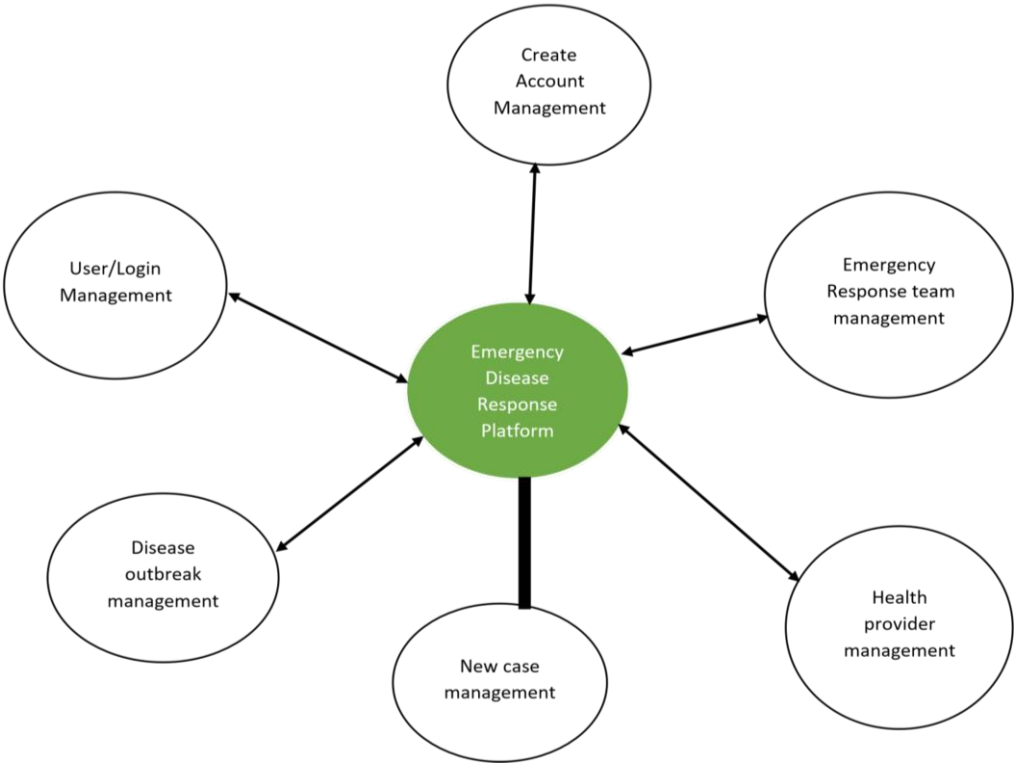
ILLUSTRATION OF DFD O FOR EMERGENCY DISEASE RESPONSE PLATFORM

DFD

1. DATA FLOW DIAGRAM LEVEL 1

The DFD1 elaborates on the processes and data flows identified in the DFD0, breaking them down into more detail. **A. Components:**

Processes



Sub-processes: Collect data from healthcare providers, Collect data from public reports and Validate and store data

Process 2: Analyze Data

Sub-processes: Perform statistical analysis, Identify trends and patterns and Generate reports

Process 3: Coordinate Response

Sub-processes: Develop response strategies, Allocate resources and Monitor response activities

Process 4: Communicate with Public

Sub-processes: Prepare public announcements, Distribute information through media and Address public inquiries

 Input Processing: Responsible for receiving data from external entities and preparing it for encryption or decryption.

I

III. Data Flows

 Input Data: Flow of information about disease outbreaks into the system.

DFD2: Level 2 Data Flow Diagram

The DFD2 provides even more detail, breaking down the processes and data flows identified in DFD1 into sub-processes and data transformations.

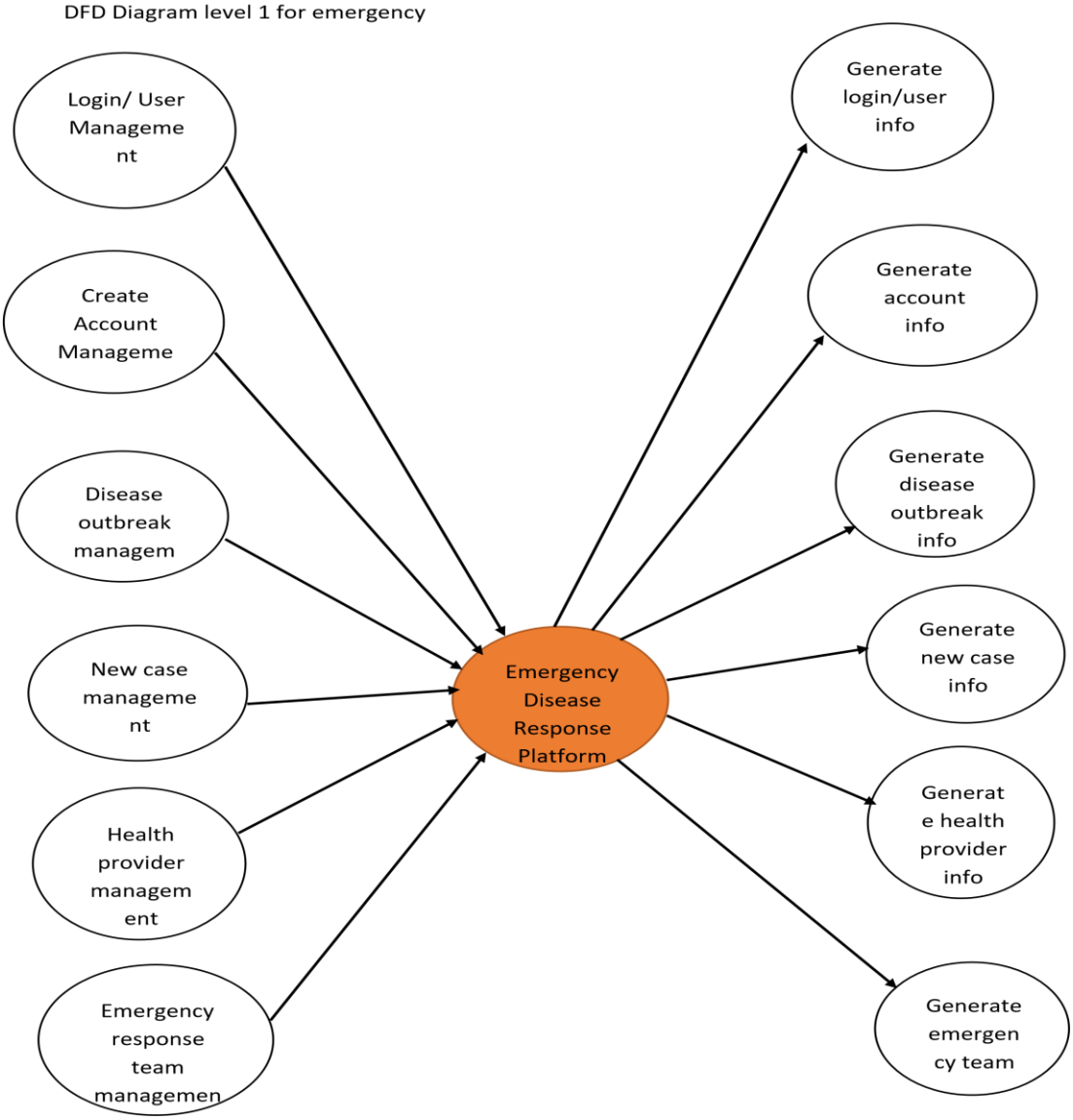
A. Components:

Sub-Processes

I. Key Generation:

- Sub-process responsible for generating report for the new case.
- Generates health provider's information.
- Generates accounts information for the user and logins.

DFD Diagram level 1 for emergency



II. Data Stores

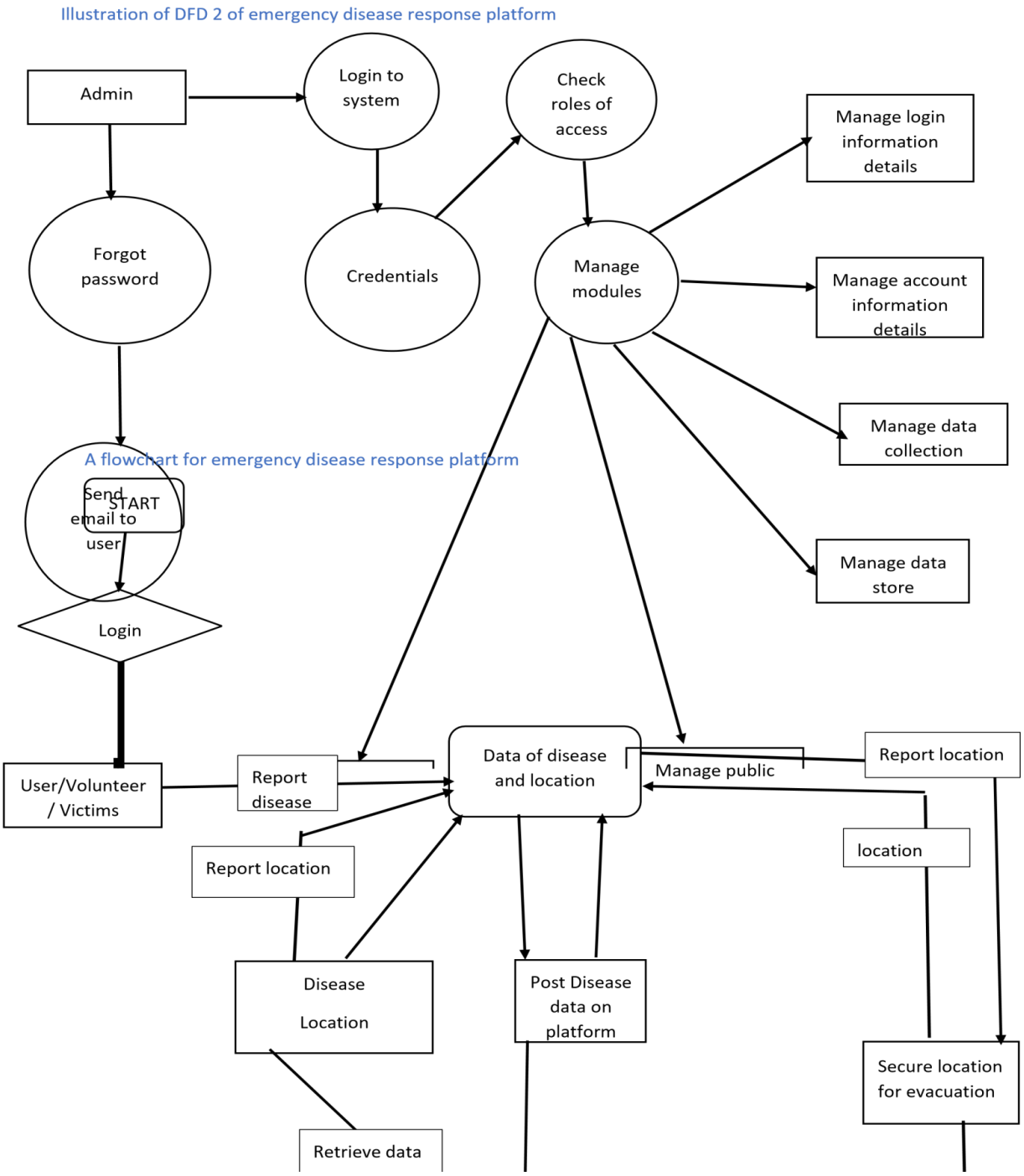
 Key Store: Stores information about the outbreak securely.

III. Data Flows

- Key Generation Data Flow: Flow of data related to key generation process.
- Encrypted Data Flow: Flow of data during resource sharing process.

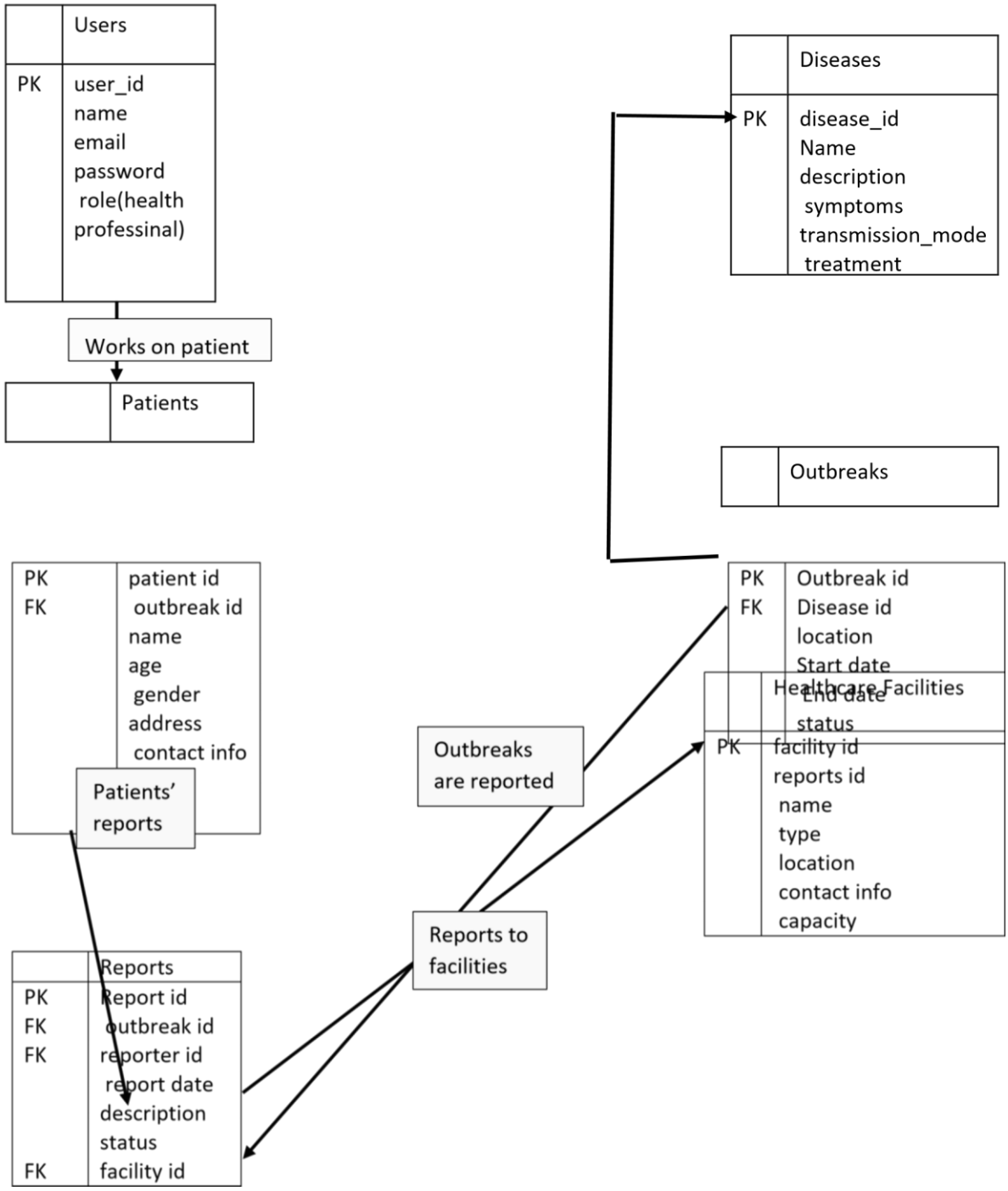
These three levels of Data Flow Diagrams provide a comprehensive understanding of the emergency disease response platform, detailing the processes, data flows, and interactions between various components of the system. This structured approach helps in visualizing the system's functionality and identifying potential areas for improvement or optimization.

FIG 1 showing Processing flow diagram of an emergency disease response platform algorithm



ii. Data modeling, on the other hand, utilized Entity-Relationship Diagrams (ERDs) to define the data requirements and relationships within the emergency disease response system. ERDs depicted entities (like data objects or tables), their attributes (characteristics or properties), and the relationships between them. This visualization helped in establishing the structure of relationships and attributes needed for the system's relational database schema. It enabled effective design and organization of data storage, retrieval, and manipulation processes within the system, ensuring efficient handling and utilization of data resources.

An ERD diagram for emergency disease response platform



3.5 System Implementation

The system implementation phase is where the designs of the database and the application are turned into working systems. This phase involves creating the actual database and the application programs. I used the Data Definition Language (DDL) of the selected Database Management System (DBMS) for this task. DDL commands help in defining, modifying, and managing the database structure, ensuring it matches the design specifications.

First, I set up the database schema using DDL commands to create tables, indexes, and relationships. Then, I developed application programs that interact with the database, handling data input, processing, and retrieval. These programs ensure the application performs as required. During this phase, I also conducted thorough testing to identify and fix any issues, ensuring the system operates efficiently and without errors.

3.5.1 Implementation Tools

Various tools were used during the implementation stage to aid in the development of the system. The main tools included XAMP/Apache server, MySQL, PHP, VScode, and the Windows operating system. Each tool was chosen for its specific capabilities and contributions to the development process.

3.5.1.1 Visual Studio Code

Visual Studio is a comprehensive integrated development environment (IDE) from Microsoft. It supports a wide range of programming languages and provides tools for developing various types of applications, including web, desktop, mobile, and cloud applications.

Visual Studio offers advanced code editing features such as syntax highlighting, IntelliSense (code completion), and code navigation.

Integrated debugging tools allow developers to set breakpoints, inspect variables, and step through code to identify and fix errors. Supports integration with version control systems like Git, allowing developers to manage code changes and collaborate with others.

Provides templates for creating different types of projects, such as ASP.NET web applications, Windows Forms applications, and mobile apps. Visual Studio's functionality can be extended with a wide range of extensions and plugins available from the Visual Studio Marketplace. With Visual Studio, developers can build applications for Windows, Linux, MacOS, Android, and iOS.

In my project, I used VScode extensively for coding. Vscode syntax is straightforward and flexible, allowing for quick development and deployment. Using the VScode, I integrated HTML, PHP, and CSS content that is used run

3.5.1.2 XAMPP Server

XAMPP Server is a complete server package that provides a solid environment for web development. It includes Apache, MySQL, and PHP, which are crucial for creating dynamic web applications. Apache is a widely used web server that allows developers to host and manage web pages.

Once XAMPP Server is installed, it configures Apache on your computer, making it possible to save web pages in a designated directory that can be accessed through the machine's IP address. This configuration provides developers with the ability to test and improve their web applications locally before making them live on the internet. The inclusion of MySQL and PHP in this setup allows for smooth communication between the server, database, and application code, creating an integrated and efficient development environment.

3.5.1.3 Apache

Apache HTTP Server, commonly referred to as Apache, is a highly popular and powerful web server software. It is responsible for handling requests from clients, such as web browsers, and serving web pages in response to those requests. Here's how it works: Installation and Setup: When XAMPP Server is installed, Apache is set up on your local machine. This allows your computer to act as a server, hosting web pages that can be accessed locally or over a network.

- Hosting Web Pages: Apache serves web pages stored in a specific directory on your machine. In XAMPP Server, this directory is typically the "htdocs" folder. You place your HTML, PHP, and other web files in this directory.
- Handling Requests: When a web browser requests a page from the server, Apache processes the request and delivers the corresponding web page. For example, if you enter "http://localhost/index.php" in your browser, Apache will look for the "index.php" file in the "htdocs" folder and serve it to the browser.
- Configuration: Apache is highly configurable. You can modify its settings using the "httpd.conf" configuration file to manage aspects like directory permissions, URL rewriting, and server modules.

3.5.1.4 PHP

I have used as well PHP purposely to build the content management system. PHP's syntax is straightforward and flexible, allowing for quick development and deployment. PHP scripts run on the server, generating HTML content that is sent to the client's browser. This server-side processing enables the creation of interactive and dynamic web applications, where content can be generated and modified based on user input and database queries.

PHP (Hypertext Preprocessor) is a server-side scripting language that is embedded within HTML to create dynamic web pages. Here's how PHP works within XAMPP Server:

- Server-Side Processing: When a browser requests a PHP page, Apache processes the request and passes the PHP code to the PHP interpreter. The interpreter executes the PHP code on the server.
- Dynamic Content: PHP can generate dynamic content based on user interactions, database queries, and other logic. For example, a PHP script can display a personalized greeting based on user input or retrieve and display data from a MySQL database.
- Database Interaction: PHP includes functions to connect to MySQL databases, execute SQL queries, and handle the results. This allows your web application to store and retrieve data as needed.
- Embedding in HTML: PHP code is embedded within HTML tags using the "<?php ... ?>" syntax. This allows you to mix PHP code with HTML to create dynamic web pages.

3.5.1.5 MySQL

MySQL is an open-source relational database management system (RDBMS). It is widely used for managing and storing data for web applications. SQL (Structured Query

Language): MySQL uses SQL for querying, updating, and managing data in databases.

Data is organized into tables (rows and columns), with support for defining relationships between tables (e.g., one-to-many, many-to-many).

Supports transactions, allowing multiple operations to be executed as a single unit of work, ensuring data integrity. MySQL can handle large databases and a high number of concurrent users, making it suitable for both small and large applications.

I used MySQL to manage the database, storing all the data required by the application. Its open-source nature allows for customization and scalability, ensuring the database can grow and adapt to changing needs. I used SQL commands to define the database schema, insert and retrieve data, and manage relationships between tables. MySQL's robustness and performance were crucial in ensuring the reliability and efficiency of the system.

Here's how it works within XAMPP Server:

- Database Creation: You can create databases using MySQL to store various types of data needed by your web application, such as user information, product details, and transaction records.
- Structured Query Language (SQL): MySQL uses SQL for database operations. SQL commands allow you to create tables, insert data, retrieve data, update records, and delete entries. For example, the command "CREATE TABLE users (id INT, name VARCHAR (100));" creates a new table called "users."
- Data Handling: MySQL is designed to handle multiple users and large amounts of data efficiently. It supports indexing, which speeds up data retrieval, and transactions, which ensure data integrity.
- PHP Integration: PHP scripts can connect to MySQL databases using built-in functions. This integration allows your web application to dynamically interact with the database, such as displaying user data on a webpage or processing form submissions.

3.5.1.6 HTML

HTML, or Hypertext Markup Language, is the standard language for creating web pages and web applications. It provides the structure and layout for web content, using elements such as headings, paragraphs, links, and lists. HTML also supports embedding multimedia elements like images and videos and integrates with other web technologies like CSS and JavaScript.

In my project, I used HTML to build the front-end interface of the content management system. HTML tags and attributes were used to define the structure and presentation of web pages, ensuring a consistent and user-friendly interface. The use of HTML allowed us to create a responsive and interactive web application, enhancing the overall user experience.

3.5.1.7 CSS (Cascading Style Sheets)

CSS (Cascading Style Sheets) is integral to system implementation as it defines the visual presentation and layout of web-based applications. By styling HTML elements, CSS ensures consistency in design across all system components, enhancing usability and user experience. It enables developers to create responsive designs that adapt seamlessly to various devices and screen sizes, improving accessibility and user engagement. CSS also supports modular design practices, facilitating code reusability and maintainability. Through frameworks and preprocessors, such as Bootstrap and Sass, CSS streamlines development by providing ready-made styles and tools for customization, branding, and performance optimization. Overall, CSS plays a critical role in shaping the aesthetic appeal, functionality, and accessibility of systems, making it essential for creating intuitive and visually appealing user interfaces.

In summary, the system implementation phase involved the careful and systematic development of the database and application programs. By using a range of tools, including XAMP/Apache server, PHP, MySQL, HTML, and CSS, I was able to create a robust and functional system. Each tool played a vital role in different aspects of the development process, contributing to the successful realization of the project.

3.6 System Testing and Validation

3.6.1 Testing

Testing within the system implementation process is a critical phase aimed at verifying the functionality and performance of application programs. The primary objective is to uncover errors or bugs in the software and ensure that it operates as expected under various conditions. Initially, the testing process involved executing the application programs and systematically identifying any faults that emerged. Each identified issue was meticulously corrected, and the testing cycle repeated until the system consistently performed according to the specified requirements and performance benchmarks.

- **System Performance and Efficiency Testing**: The testing phase included rigorous evaluation of the system's performance metrics such as response times, throughput, and resource utilization. This ensured that the system could handle expected workloads efficiently without performance degradation. Metrics like CPU usage, memory consumption, and disk space utilization were monitored to optimize system efficiency and ensure smooth operation.

- **Compatibility Testing**: Another crucial aspect of testing was verifying the system's compatibility across different operating environments. Compatibility tests were conducted on various operating systems like Windows XP, Linux distributions, and Windows 7. This process involved deploying the system on each platform and evaluating its functionality to confirm seamless operation across diverse environments. By ensuring compatibility, the system could reach a broader user base and maintain consistent performance across different platforms.

- **Security Testing**: Security testing focused on assessing the system's resilience against potential threats and vulnerabilities. This included testing for vulnerabilities that could be exploited by remote attacks and evaluating the effectiveness of authentication mechanisms. Measures such as penetration testing, vulnerability scanning, and authentication scenario testing were employed to identify and address security weaknesses. By prioritizing security testing, the system was fortified against unauthorized access and data breaches, safeguarding sensitive information and ensuring compliance with security standards.

3.6.2 Validation

Validation within the system implementation context was a comprehensive evaluation process to confirm that the Emergency disease response platform effectively met its intended purpose and satisfied the needs of its users. This phase focused on verifying whether the system aligned with the identified user requirements, functional specifications, and non-functional criteria.

- **Validation of User Requirements**: The validation process involved engaging end user representatives who interacted directly with the system. These representatives tested the system functionalities and workflows to validate that they met the intended user requirements. Feedback from end users was collected and analyzed to ensure that the system's features and usability aligned with user expectations and operational needs.

- **Functional and Non-functional Validation**: Beyond user requirements, validation encompassed a thorough assessment of the system's functional capabilities and nonfunctional aspects such as performance, reliability, and scalability. Functional validation verified that the system performed tasks accurately and efficiently, meeting operational goals like financial transaction processing and account management.

Nonfunctional validation ensured that the system could handle concurrent user sessions, maintain data integrity under load, and scale effectively to accommodate future growth.

- **Continuous Improvement**: Throughout the validation phase, continuous improvement and refinement of the system were prioritized based on user feedback and testing outcomes. Adjustments and enhancements were made iteratively to optimize system performance, address any identified gaps, and enhance overall user satisfaction. By validating the system against comprehensive criteria and user expectations, stakeholders could confidently deploy the Online Financial Transfer Management System, knowing it was robust, reliable, and aligned with organizational goals.

3.6.3 Conclusion

In conclusion, this chapter detailed the diverse methodologies used throughout the research, covering research patterns, data collection approaches, analysis techniques, and system design tools. It began by highlighting both qualitative methods and quantitative methods (such as data analysis) to ensure a thorough understanding of the study's goals. Data collection was accurately planned, using direct observations, structured interviews, and online questionnaires to gather relevant and reliable data. The analysis was conducted, ensuring robust and credible findings. Additionally, the chapter examined the tools and technologies used for system design and implementation, such as integrated development environments (IDEs), version control systems, and database management systems, emphasizing their critical role in the project's success. This comprehensive approach laid a strong foundation for the system's effective design and implementation.

CHAPTER FOUR

SYSTEM STUDY, ANALYSIS AND DESIGN

4.0 Introduction

This chapter addresses the examination of the existing emergency disease response platform, the analysis of system requirements, and the creation of process and data models to support the development of a more efficient and responsive system.

4.1 The study of the Existing System

Based on data collected through interviews, observations, and reviews of existing documentation, the current state of the emergency disease response platform was evaluated. The findings highlighted significant challenges in the current system, particularly in how responses to disease outbreaks are managed and coordinated.

The existing emergency disease response platform requires health officials and responders to manually coordinate activities, share information, and report cases. This process often involves physical meetings, phone calls, and fragmented data management, leading to inefficiencies and delays in responding to disease outbreaks.

And from the study conducted the challenges Identified are as follows;

Coordination Delays: The reliance on manual processes and face-to-face meetings for decision-making and information sharing leads to delays in coordinating responses, which can be critical during fast-spreading disease outbreaks.

Fragmented Data Management: Data on disease outbreaks, patient tracking, resource allocation, and response actions are often scattered across multiple systems or recorded manually. This fragmentation makes it difficult to obtain a real-time, unified view of the situation, which is crucial for effective decision-making.

Communication Barriers: Ineffective communication channels between different levels of responders (e.g., local health workers, regional coordinators, and national agencies) further complicate the timely and accurate exchange of information.

Rationale for System Improvement: Given these challenges, there is a clear need for an Integrated Emergency Disease Response Platform. Such a platform would facilitate real-time data sharing, streamlined communication, and coordinated actions across all levels of the

response team. This would significantly reduce response times, improve resource management, and enhance the overall effectiveness of the emergency response.

Analysis of the Existing System: Further analysis of the current emergency disease response system has led to the creation of a flowchart (see Figure 4.1) that illustrates the processes involved, from the initial detection of a disease outbreak to the coordination of response activities. This flowchart provides a visual representation of the existing system and serves as a foundation for understanding the necessary improvements. (See Figure 4.1).

4.1.1 Workflow for the emergency disease response platform Processes

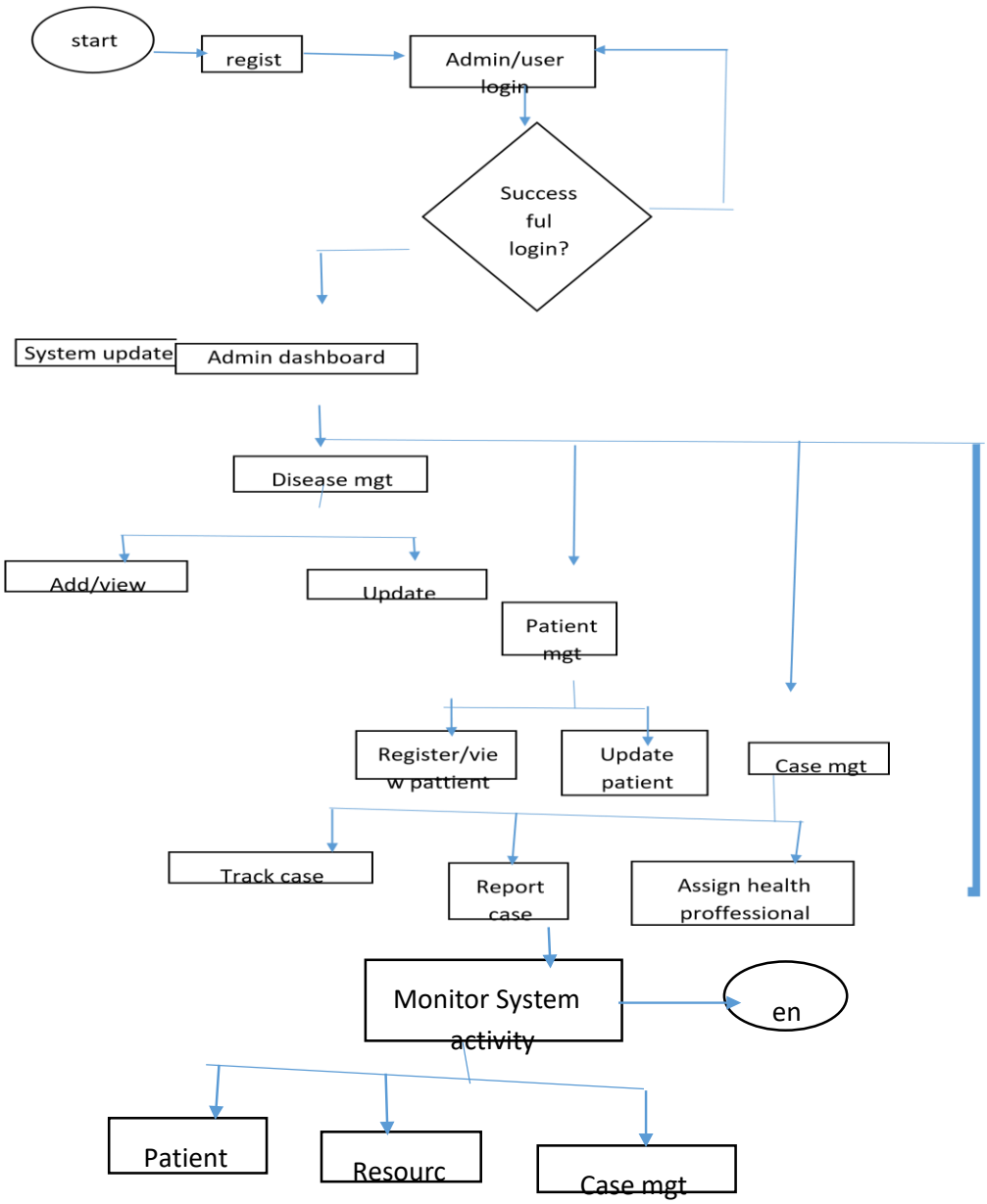


Figure 4. 1: Flow chart for the emergency disease response platform

4.1.2 Strength of the existing System

i. Generation of Reports and Notifications: At Mbale Referral Hospital, the emergency disease response platform is adept at generating detailed reports and notifications related to disease outbreaks. This capability ensures that healthcare professionals and public health officials receive timely updates, enabling them to respond quickly to emerging health threats.

ii. Robust Security Mechanisms: The platform integrates high-level security mechanisms, which are crucial for protecting sensitive patient data and outbreak information. This ensures that unauthorized individuals cannot access or manipulate the data, maintaining the integrity and confidentiality of the information.

iii. Data Storage and Retrieval: The hospital's platform efficiently stores and retrieves vast amounts of data, including patient records, disease case histories, and resource availability. This feature is vital for managing large volumes of information during outbreaks and for making informed decisions on how to allocate resources effectively.

4.1.3 Weakness of existing System

i. Lack of Instant Verification and Validation: One of the significant shortcomings of the platform at Mbale Referral Hospital is its inability to instantly verify and validate incoming disease reports and patient information. This delay can hinder the hospital's ability to respond promptly, especially during rapidly evolving situations such as epidemics.

ii. Delays in Communication: The platform sometimes experiences delays in transmitting crucial information to healthcare workers and emergency responders. These delays can be detrimental in a fast-moving disease outbreak, where time is of the essence to prevent the spread of disease and to treat patients.

iii. System Congestion: The platform is susceptible to congestion, particularly during times of high demand, such as during major outbreaks or health emergencies. This congestion can slow down the processing of data and communication, leading to inefficiencies and delays in the hospital's overall response efforts.

4.2 Data analysis results

Researchers conducted an in-depth analysis of the emergency disease response platform at Mbale Referral Hospital, using various data collection methods to evaluate its performance and identify challenges. The analysis revealed several critical issues that impact the hospital's ability to manage disease outbreaks effectively:

Time Wastage: A significant challenge identified was the time wasted due to delays in processing incoming reports and mobilizing resources. These delays can be particularly problematic during an outbreak, where every minute counts in containing the disease and treating affected individuals.

System Congestion: The platform frequently encounters congestion, especially when the hospital is dealing with a high volume of cases or a particularly severe outbreak. This congestion leads to bottlenecks in data processing and communication, further exacerbating delays in response times.

Long Response Times: As a result of the time wastage and system congestion, the hospital experiences longer response times during emergencies. This delay can severely affect the hospital's ability to effectively control the spread of disease and provide timely care to patients.

The data collected was analyzed and represented in tables and graphs for clear interpretation. The findings highlighted the need for significant improvements to the existing system to enhance the hospital's emergency response capabilities.

This table provides a summary of the key challenges faced by Mbale Referral Hospital's emergency disease response platform. The high percentage of respondents indicating time wastage and long response times underscores the urgent need for system enhancements to improve the hospital's ability to respond to health emergencies efficiently

4.2.1 The tabular representation of the challenges associated with the current financial management system

Table 1: Challenges associated with the current system.

Challenges	Number of respondents out of 5	Percentage of respondents
Time wastage		
	4	80
System Congestion		
	2	40
Long Response Times		
	3	60

4.2.2 The Graphical Representation of the Challenges faced by the current Emergency Disease Response Platform.

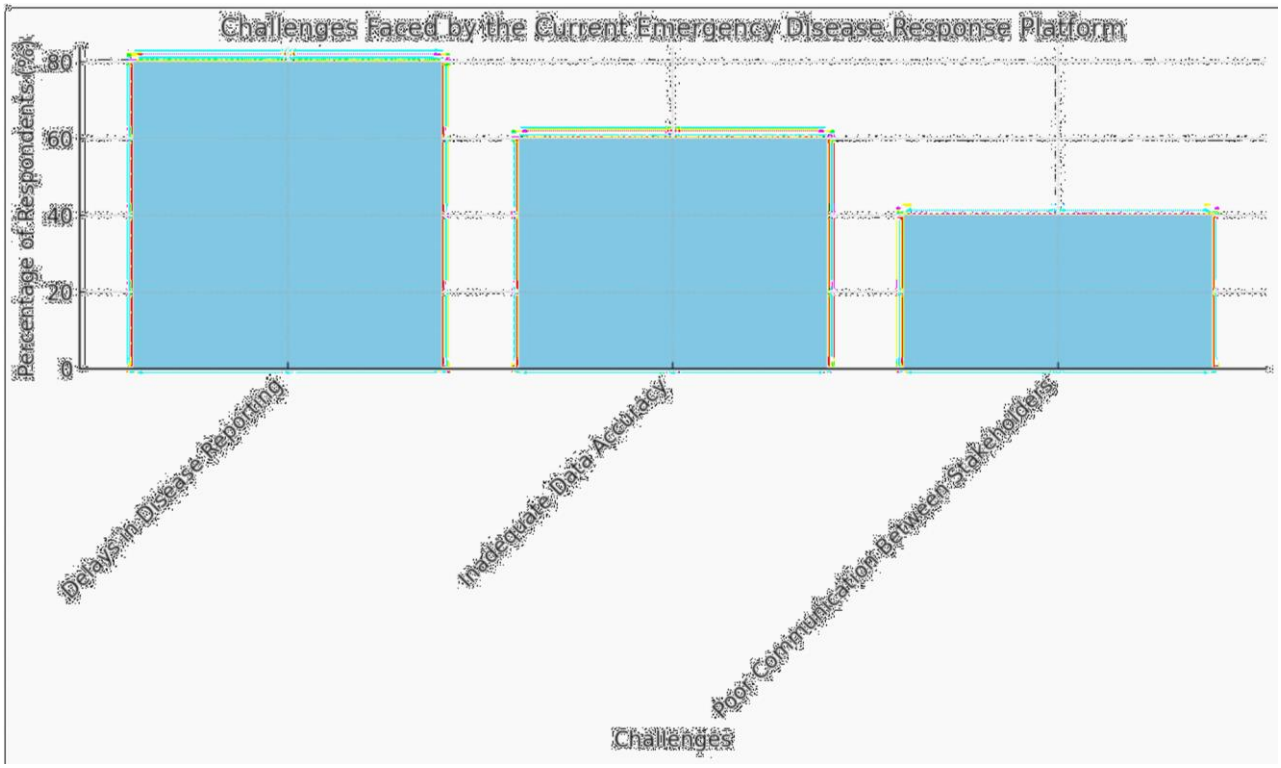


Figure 4. 2: A graphical presentation of the challenges faced by the current emergency disease response platform.

4.2.1 User Requirements

User requirements are statements that describe what services the system should provide and the constraints under which it must operate. These requirements are expressed in natural language to ensure they are easily understood by all stakeholders. Below are the user requirements for the emergency disease response platform at Mbale Referral Hospital:

i. The system should generate notifications and alerts: The platform should produce timely notifications and alerts about disease outbreaks and other health emergencies to keep hospital staff and public health officials informed.

ii. The system should generate detailed reports: It should be capable of generating comprehensive reports on disease cases, response actions, and resource utilization, which are essential for effective decision-making.

iii. The system should be user-friendly: The platform must be easy to navigate and use by healthcare professionals, ensuring that they can quickly access the information they need during emergencies.

iv. The system should authenticate users: To maintain data security, the platform must authenticate users through a secure login process, ensuring that only authorized personnel can access sensitive information.

v. The system should facilitate communication between departments: The platform should include features that allow for seamless communication between different departments and healthcare teams involved in the emergency response.

4.2.2 Functional requirements

Functional requirements describe the activities and services that the emergency disease response platform provides in terms of data processing and handling. Based on the data collected from users, the following functional requirements were identified:

i. The system should generate weekly and real-time reports: The platform must generate reports on disease cases, resource allocation, and response activities on a weekly basis and in real-time as needed.

ii. The system should store and retrieve patient and disease data: It should have the capability to store detailed records of patient information, disease cases, and outbreak data, with easy retrieval for analysis and decision making.

iii. The system should enable online access to disease and patient data: Healthcare workers should be able to view and update patient records and outbreak information online, ensuring that they have the latest data at their fingertips.
iv. The system should update records after every interaction: The platform must automatically update patient records, resource usage, and other relevant data following each transaction or interaction, ensuring data accuracy and currency.
v. The system should allow healthcare workers to input new case data: Employees should be able to quickly and accurately input new patient details, disease cases, and other relevant data into the system.

4.2.3 Non-functional requirements

Non-functional requirements describe the characteristics and constraints that define the quality and performance of the system. These include how the system should perform and other essential attributes. The non-functional requirements considered during the design of the platform include:

i. The system should be accessible 24/7: Healthcare professionals must be able to access the platform at any time, ensuring continuous monitoring and response capabilities.

ii. The system should authenticate users through secure login credentials: Security is critical, so the platform must authenticate users via a secure username and password system to prevent unauthorized access.

iii. The system should provide fast processing of all user requests: The platform should be designed to handle requests quickly, ensuring that healthcare workers can obtain and process information without delays.

iv. The system should be flexible and easy to update: It should be adaptable to new requirements and updates, allowing for easy modifications as new challenges or diseases emerge.

v. The system should reliably process user tasks: The platform must perform tasks efficiently and without failure, ensuring that all user operations are completed accurately and on time.

vi. The platform should be reliable: The system must maintain a high level of reliability, minimizing downtime and ensuring that it is always available when needed.

4.2.4 System requirement

System requirements describe the hardware and software necessary to support the platform. These requirements outline the essential infrastructure and properties needed to operate the platform effectively as mentioned below;

4.2.4.1 Hardware Requirements

Hardware requirements refer to the physical components that are necessary for the effective operation of the emergency disease response platform. These components must be capable of handling the computational load, data storage, and other operational demands of the platform. Ensuring that the hardware meets or exceeds the required specifications is critical for the platform to function smoothly, especially in a high-pressure environment like a hospital during a disease outbreak. Below is a detailed explanation of the hardware requirements

Table 2: Hardware requirements

Hardware component	**System requirement**	**Justification**
Processor	Intel Pentium IV or above	The Intel Pentium IV processor includes Hyper Threading technology, which enhances multitasking capabilities and performance. This is essential for handling multiple tasks simultaneously, such as processing patient data, generating reports, and managing real-time alerts during an outbreak.
Processor speed	800MHZ or above	A processor speed of 800 MHz or higher is necessary to ensure that the platform operates smoothly and can handle the computational demands of data processing and user interactions. This speed is sufficient to run the emergency disease response platform efficiently.
Disk space	80 GB or above	An 80 GB hard disk or larger is required to store the extensive data generated by the platform, including patient records, disease case histories, and resource management information. This storage capacity ensures that the platform can maintain a comprehensive database of all relevant information.

4.2.4.2 Software Requirements *Table 3: Software requirements*

Software Component	**System Requirement**	**Justification**
Operating System for the server	Windows NT or above	Windows NT adopts a new layered deviced river architecture that provides many advantages in terms of flexibility, maintainability, and portability. Windows NT offers a layered device-driver architecture, which enhances flexibility, maintainability, and portability. This is important for ensuring that the server can manage complex tasks like data processing, security, and communication between departments
Operating system for the client PC	Windows XP	Windows XP can be used on personal computers, including home and business desktops, laptops and media centers. Windows XP is suitable for use on personal computers within the hospital, providing a stable and user-friendly environment for healthcare workers to access the platform. It is compatible with a wide range of hardware and supports the software applications needed for the platform.
Web Server	Apache Web Server Version 1.3	This is a web server software notable for playing a key role in the initial growth of the World Wide Web. Apache Web Server is a reliable and widely used web server software, critical for hosting the platform and ensuring it is accessible to users within the hospital and potentially to external stakeholders involved in the emergency response
Web Browser	Opera Mobile Emulator	It is the default browser shipped with Windows XP and is also made available for Windows NT 4.0.Opera Mobile Emulator can simulate mobile browsing environments, which is useful for ensuring that the platform is accessible on various devices, including smartphones and tablets, allowing healthcare workers to access the platform remotely or on-the-go.

Database Management System	MySQL server version 3:23.48	MySQL is an open-source relational database management system that supports multi-user access to the platform's databases. It is essential for managing and organizing the large volumes of data generated by the platform, including patient records, disease cases, and resource allocation data.

4.3 System Design

In designing an Emergency Disease Response Platform for Mbale Referral Hospital, the system design phase encompasses both process modeling and data modeling. Process modeling involves using Data Flow Diagrams (DFDs) to map out how data moves through the system, while data modeling involves using Entity Relationship Diagrams (ERDs) to define and organize the data entities and their relationships. The system must be robust, efficient, and capable of managing the complex and critical tasks associated with responding to disease outbreaks.

4.3.1 Architectural Design for the System

The architectural design shows how the OFTMS is comprised of the different subsystems namely Data collection, Data Processing, Data Storage and Data Display. The figure below shows an architectural diagram of the Online Financial Transfer Management System.

4.3.1 Architectural Design for the System

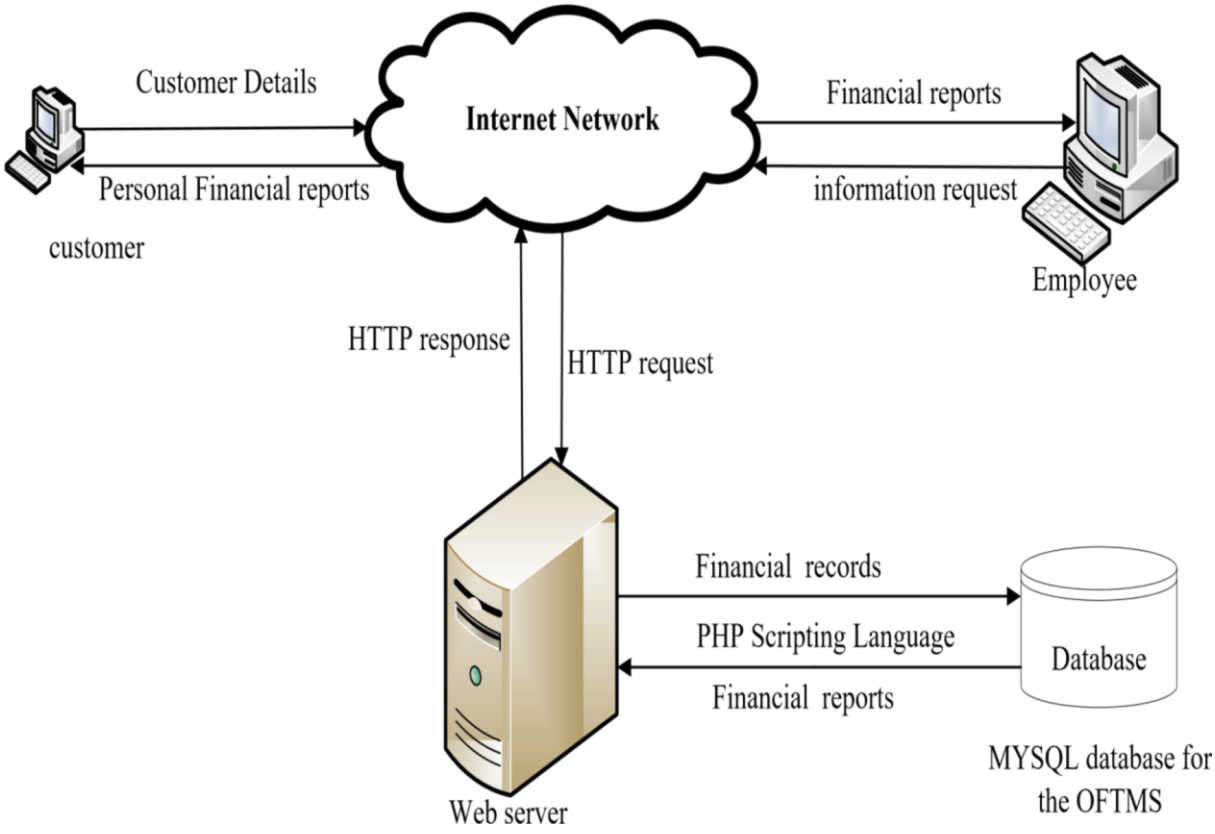
The architectural design outlines the overall structure of the Emergency Disease Response Platform, detailing how different subsystems interact. The key subsystems include:

Data Collection: Gathers real-time information from various sources, such as patient records, lab results, and epidemiological data.

Data Processing: Analyzes and processes the collected data to generate actionable insights, such as identifying hotspots of infection or predicting the spread of the disease.

Data Storage: Securely stores all data, including patient information, disease trends, and resource availability, in a centralized database.

Data Display: Provides an interface for healthcare workers, administrators, and decision makers to view and interact with the processed data through dashboards, reports, and visualizations.



Server for the for the

OFTMS

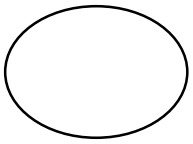
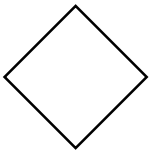
Figure 4. 3: The Architectural Design for an online financial transfer management system

4.3.2 Process Modeling

Process modeling involves illustrating how information or data moves within the

Emergency Disease Response Platform. This section outlines the symbols used in Data Flow Diagrams (DFDs) and their descriptions from the entry to various repositories or data stores.

4.3.2.1 Key Symbols

Symbol	Name
	External entity
	Process
	Data flow
	Decision

Description of the above key symbols;

i. External Entity: Represents real-world objects or entities (e.g., healthcare workers, patients) that interact with the system.

ii. Data Store: Indicates where data is stored after being processed, such as a database or file system.

iii. Data Flow: Shows the movement of data within the system, connecting processes, data stores, and external entities. iv. Process: Represents a series of activities or actions performed to accomplish a specific task within the system. An activity or series of actions undertaken by the platform to achieve a particular outcome, such as verifying patient information or generating a disease outbreak report.

4.3.3 Data Flow Diagrams (DFD)

Data Flow Diagrams are critical tools used by system analyst in system design, illustrating how data flows within the platform. The DFDs use various symbols to represent the four key components: Processes, Data Stores, Data Flows, and External Entities.

4.3.3.1 The Context Level DFD

Medical records

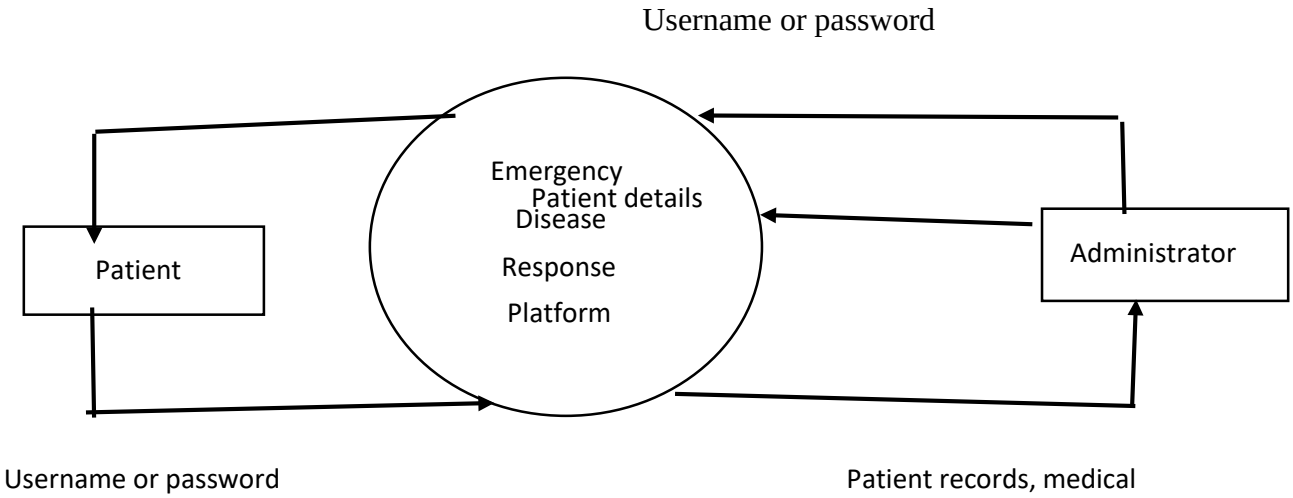


Figure 4. 4: Context Diagram of an emergency disease response platform.

The context-level DFD provides a high-level overview of the Emergency Disease Response Platform, showing how users interact with the system. For example:

In figure 4.3: User Interaction: Healthcare workers log into the platform to access patient records, submit reports, or monitor disease trends. Upon authentication, they can request specific resources or data, and the system provides the necessary feedback.

Administrator Interaction: Administrators log in to manage system operations, query data, and generate high-level reports to guide decision-making during a disease outbreak.

4.3.3.2 The Level 1 DFD for the Emergency disease response platform

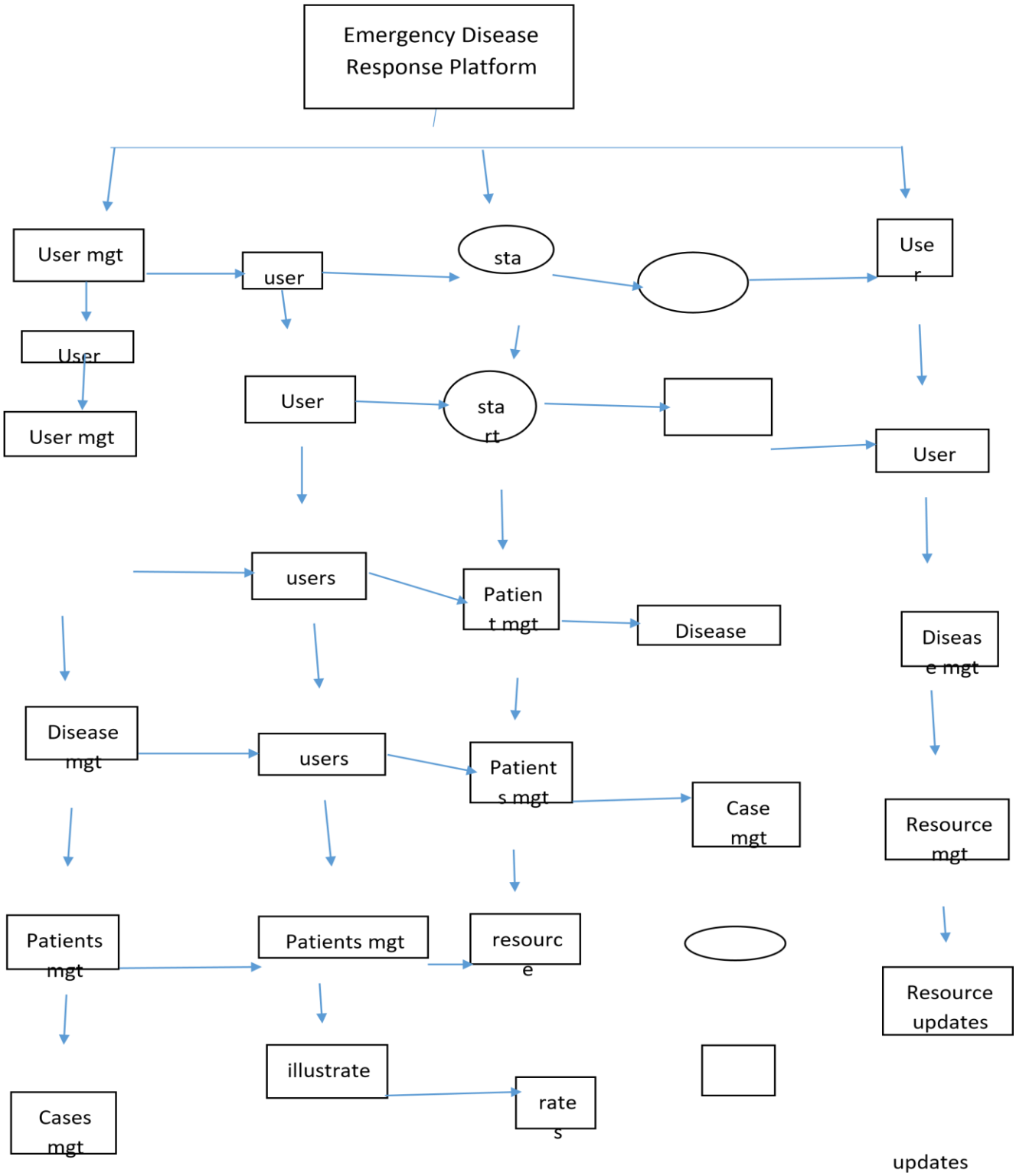


Figure 4. 5: Level 1 DFD for the emergency disease response platform

Description for the level 1 DFD

In this subsection, there are tables describing all the design objects used in developing the system. They include Processes, Data flows, Data stores and the External entities.

The Level 1 DFD breaks down the high-level processes into more detailed components. Each process is described, along with its interactions with other processes, data stores, and external entities.

4.3.7 Mapping of ERD to Relational Schema Description for Processes

Table 4: Description of Processes

Process	**Description**
Authentication Process	Verifies the credentials (username and password) of users.
User Registration Process	Capture all user details
Data Analysis Process	Analyzes and processes collected data to identify trends and patterns in disease outbreaks.
Data Collection Process	Gathers real-time data from various sources (e.g., patient records, lab results).
Resource Management Process	Manages and allocates resources such as medical supplies and personnel based on the analyzed data

Description of Data Stores

Table 5: Description for Data stores

4.3.3.3 Description of Data Stores

Data store	**Description**
User Data store	Stores user information including usernames and passwords
Patient Data Store	Contains detailed records of patients, including medical history and test results.
Disease Outbreak Data Store	Holds information on disease outbreaks, including infection rates and geographical spread
Resource Data Store	Stores data on available medical resources, including supplies and personnel

Description for External Entities

Table 6: Description of External Entities

4.3.3.4 Description of External Entities

Entity	Description
Healthcare Workers	Input patient data, request reports, and respond to system alerts.
Patients	Provide data that is input into the system by healthcare workers.
Laboratories	Submit test results and diagnostic information to the platform
Health Administrators	Oversee platform operations and use data for decision-making during outbreaks

4.3.4 Identification of Entities and their Attributes

Table 7: Identification for Entities and their Attributes

Entity	Description	Attributes
Patient	An individual receiving medical care.	Patient ID, Name, Age, Gender, Contact Information, History
Healthcare Worker	A person providing medical services	Worker ID, Name, Role, Contact Information, Department
Disease	A specific illness or infection.	Disease ID, Name, Symptoms, Transmission Mode, Severity
Resource	Medical supplies or personnel	Resource ID, Name, Type,
		Quantity, Location

4.3.5 Modeling Relationships between Entities

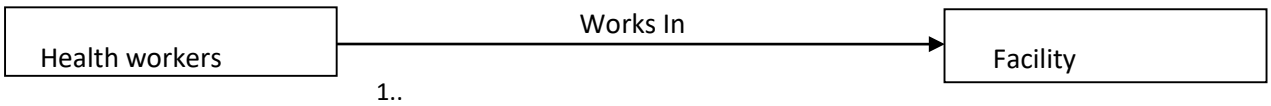


Figure 4. 6: Relationship between Health workers and cases

One or many cases can be handled by one health worker and many health workers can handle one case handles

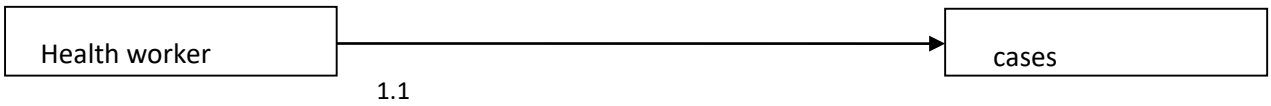


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Figure 4. 7: Relationship between Patient and Disease

A patient may be diagnosed with one or more diseases, and each disease may affect multiple patients.. Has

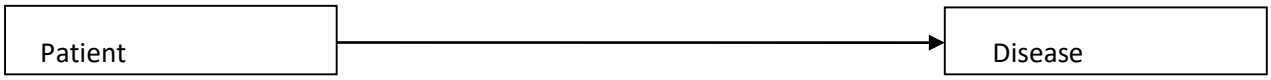

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Figure 4. 8: Relationship between Healthcare Worker and Patient

A one health worker can attend to many patients and only one patient to be worked on attends

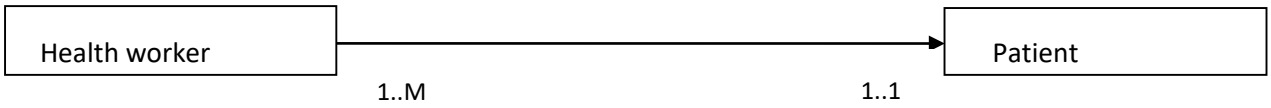
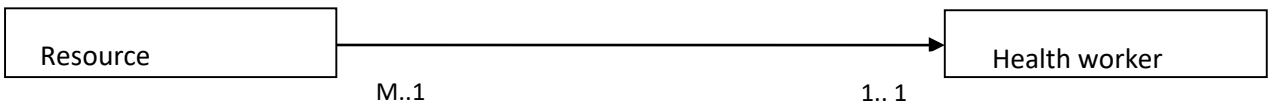


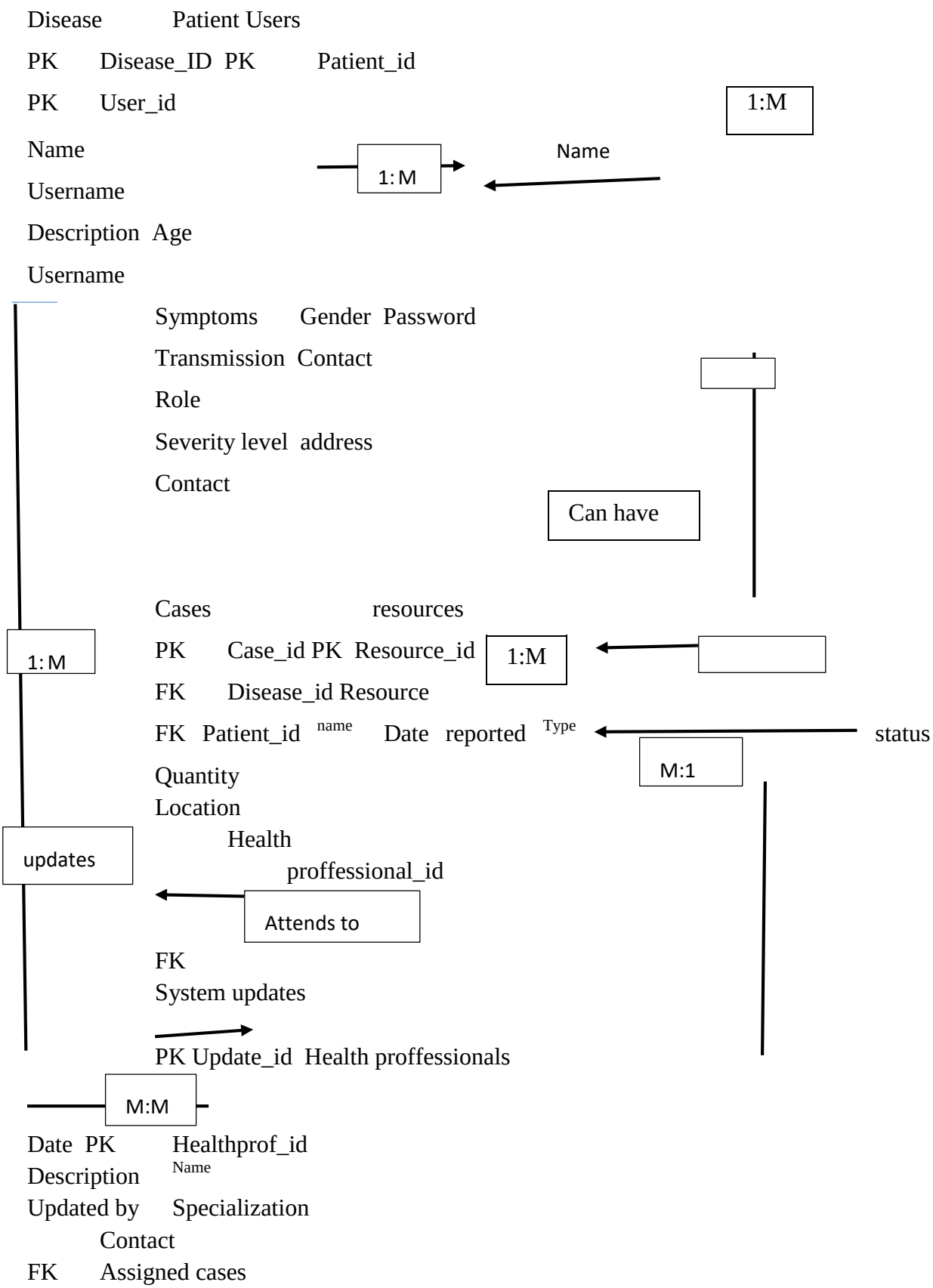
Figure 4. 9: Relationship between Resource and Health worker

Resources are allocated to healthcare workers based on their needs and the demands of the disease outbreak.

Allocated to



4.3.6 The Entity Relationship Diagram for emergency disease response platform



4.3.6 The Entity Relationship Diagram for emergency disease response platform

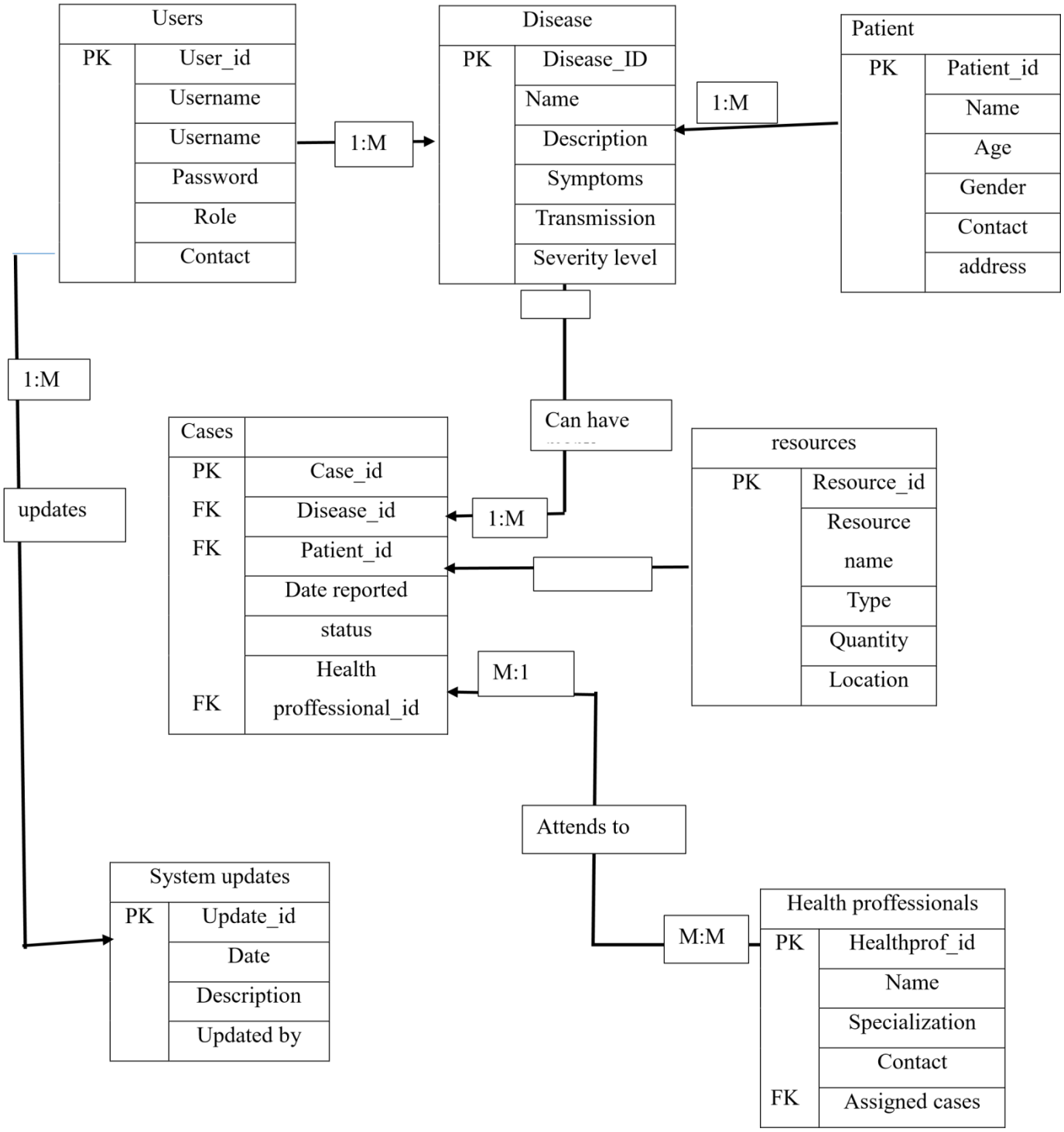


Figure 4. 10: The Entity Relationship Diagram

4.3.7 Mapping of ERD to Relational Schema

4.3.7.1 Patient

Table 8: The Patient table

Field Name	Data Type	Constraint
Patient_ID	int(12)	Primary Key, Not null
Name	varchar(50)	Not null
Age	int(3)	Not null
Gender	varchar(10)	Not null
Contact_Info	varchar(100)	Not null
Medical_History	text	Null
Symptoms	varchar(20)	Null
treatment	varchar(20)	Not null

4.3.7.2 Healthcare worker

Table 9: Healthcare Worker Table

Field Name	Data Type	Constraint
Worker_ID	int(12)	Primary Key, Not null
Name	varchar(50)	Not null
Role	varchar(30)	Not null
Contact_Info	varchar(100)	Not null
Department	varchar(30)	Not null

4.3.7.3 Disease

Table 10: The Disease Table

Field Name	Data Type	Constraint
Disease_ID	int(12)	Primary Key, Not null
Name	varchar(50)	Not null
Symptoms	text	Not null
Transmission_Mode	varchar(30)	Not null
Severity	varchar(20)	Not null

4.3.7.4 Resource

Table 11: The Resource Table

Field Name	Data Type	Constraint
Resource_ID	int(12)	Primary Key, Not null
Name	varchar(50)	Not null
Type	varchar(30)	Not null
Quantity	int(10)	Not null
Location	varchar(100)	Not null

4.3.7.5 Cases

Table 12: The Cases table

Field Name	Data Type	Constraint
Case_ID	int(16)	Primary Key, Not null
Patient_id	varchar(20)	Not null
Disease_ID	int(12)	Not null
Notes	Int(16)	Not null
Created at	Varchar(20)	Not null

4.3.7.6 User

Table 13: The User table

Field Name	Data Type	Constraint
User_ID	int(16)	Primary Key, Not null
Username	varchar(20)	Not null
Telephone	int(12)	Not null
Email	varchar(30)	Not null
Created at	Varchar(15)	Not null

4.4 Conclusion

This chapter provides a comprehensive overview of the system design for the Emergency Disease Response Platform at Mbale Referral Hospital. It covers the architectural design, process modeling, data flow diagrams, entity identification, and relational schema mapping. The design ensures that the platform is capable of efficiently managing data related to disease outbreaks, providing healthcare workers and administrators with the tools they need to respond effectively.

CHAPTER FIVE

SYSTEM IMPLEMENTATION, TESTING AND VALIDATION

5.0 Introduction

This chapter describes the implementation of the design models for the Emergency

Disease Response Platform (EDRP) at Mbale Referral Hospital, and shows various results generated by the system. Screenshots of the system will be provided to demonstrate how the system displays results upon user commands.

5.1 System Functions

The Emergency Disease Response Platform provides various functionalities for different user roles, including administrators, healthcare workers, and patients. The administrator gives right to access the platform and share information about any outbreak of diseases, verify cases and update it. The health workers are able to access information about any new occurrence and enter data related to any outbreak, data about patients concerning the kind of treatment to be given.

5.1.1 Functions provided to all users.

The Emergency Disease Response Platform includes user authentication and security features that require usernames and passwords for accessing system services like viewing potential outbreaks, view the cases occurred,

5.1.2 Functions provided to the customers

The Patients, when authenticated are able to view their health records and medical history, Access information about ongoing disease outbreaks and receive notifications and updates related to their health status, treatment to be given.

5.1.3 Functions provided to the employee

The Healthcare workers are able to interact with the system in order to access patient records, enter and update patient data, view and manage disease outbreak data and as well are able to receive alerts about potential outbreaks from different locations for realtime data.

5.1.4 Functions provided to the manager/administrator

The Administrators can are able to view and manage all system data and records. As well is able to verify and validate disease outbreak information, manage user accounts and permissions, generate and review reports on disease outbreaks and resource utilization.

5.2 System map

Figure 5.1: System Map

Description: This diagram illustrates the functions provided by the Emergency Disease Response Platform to various user roles. The system map outlines the key components and their interactions, highlighting how different users interact with the platform and benefit from its features.

Figure 5.1: System Map showing functions provided by the system to each user

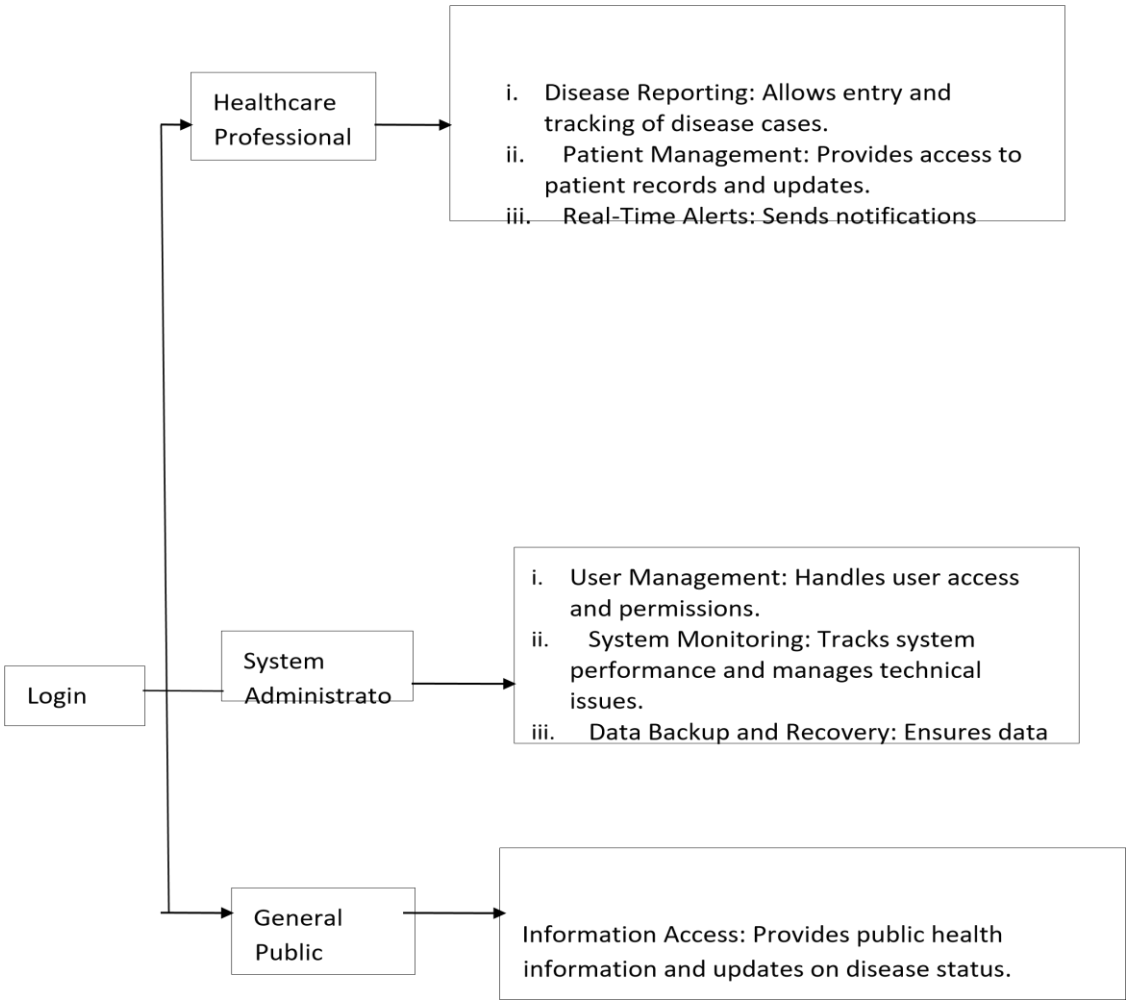


Figure 5. 1: System Map

5.3 Sample Screen-shots 5.3.1 System home page

Figure 5.2 Shows the homepage that allows all users to login into the system in order to access their pages and perform their tasks. On selecting the login option especially by the administrator, login page for the administrator will be displayed as shown on the screenshot below.

Figure 5. 2: System home page

5.3.2 Administrator's login page

Figure 5.3: Shows the administrator's login page where he or she selects the Admin option and fills in his or her password to login into the system. This gives an administrator access to view the following: account types, view dashboard, password setting, view the cases recorded, update the records among others. Also in case of wrong username and password, the user will be denied access to the system.

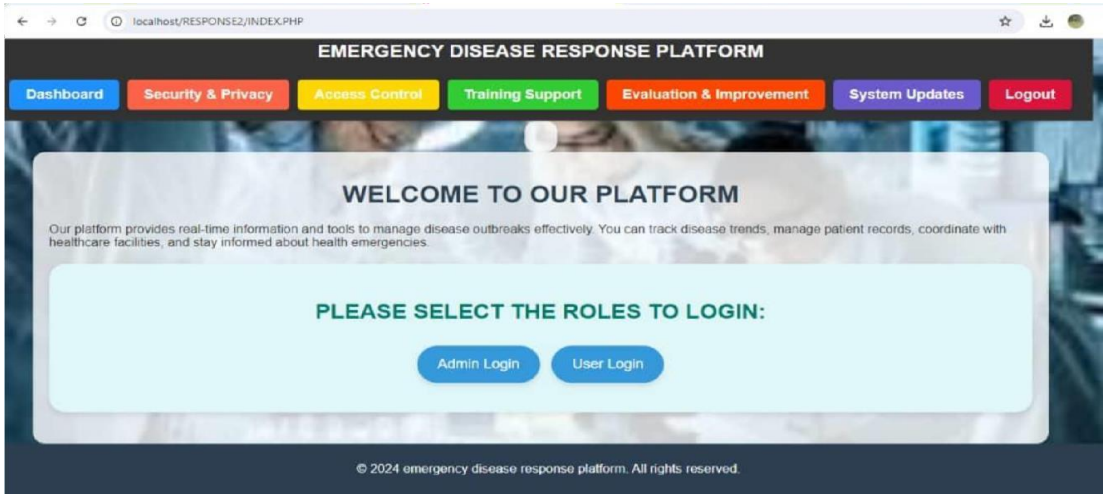


Figure 5. 3: Administrator login page

5.3.3 Administrative view page

Figure 5.4: Shows the administrator fully logged in where he can perform all duties assigned to him through navigating on the links shown on the screenshots in red color below. He can create accounts, set the passwords, view different account types, make updates, manage training and verify and validate all details of the patients.

Figure 5. 4: Administrative view page

5.3.4 patients's login page

Figure 5.5: Shows the patient's account page where they can view their health status, access updates, and receive alerts about disease outbreaks.*

Shows an patient's login page where he or she selects the employee option as his or her username and fills in a password to login into the system where he or she can either make updates or register a new case or also view the details.

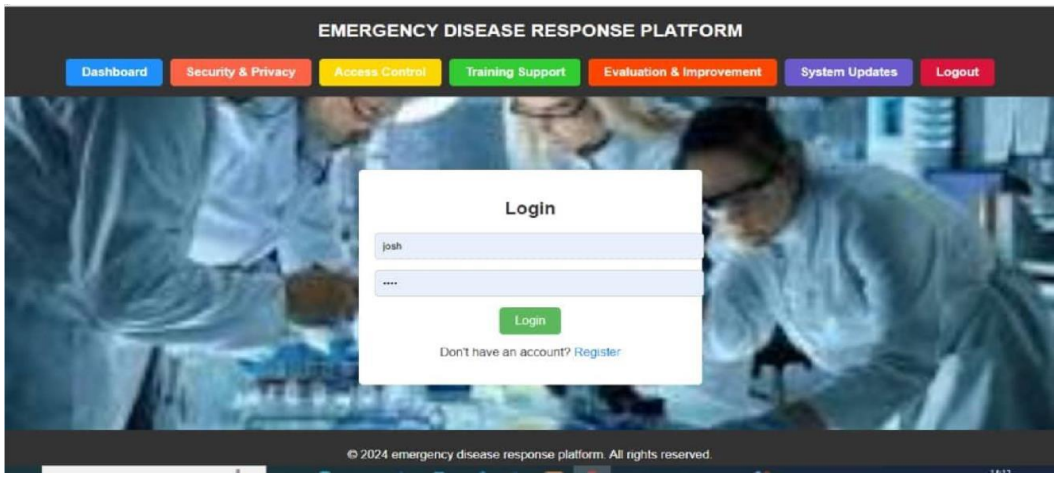


Figure 5. 5: cases page

5.3.5 view cases page

Figure 5.6: Shows the page from where a user can login and access the dashboard and as well the health professional to login and update information about the occurrency..

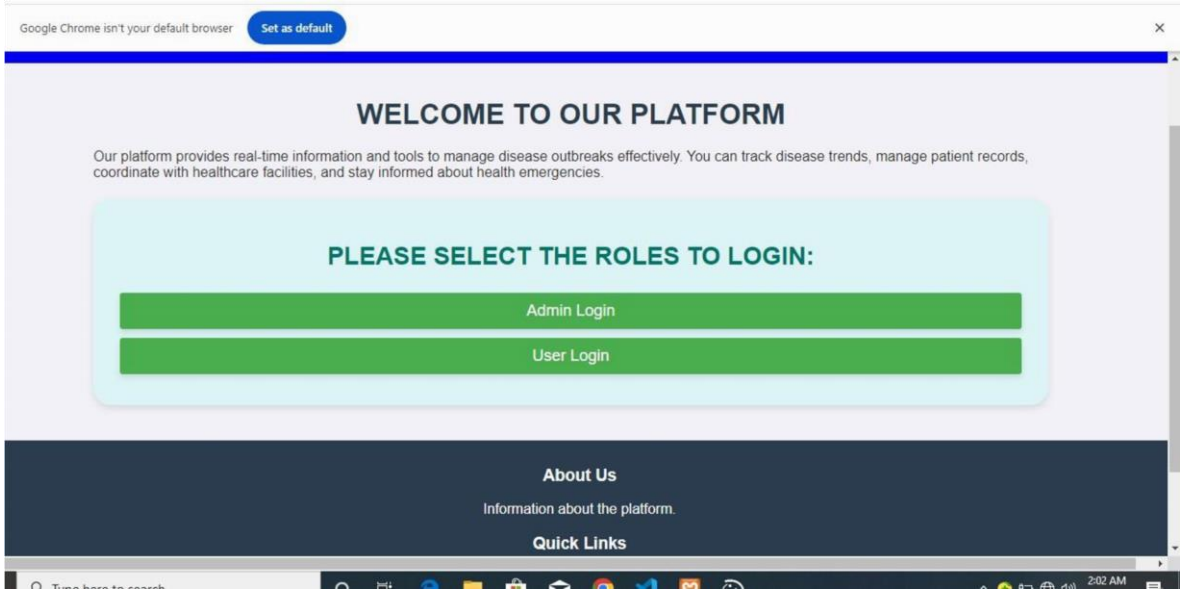


Figure 5. 6: Cash Deposit page

Figure 5. 7: User dashboard page

5.3.7 User dashboard Details' page

Figure 5.8: Shows dashboard's details for those users who wants to access the services of the platform.

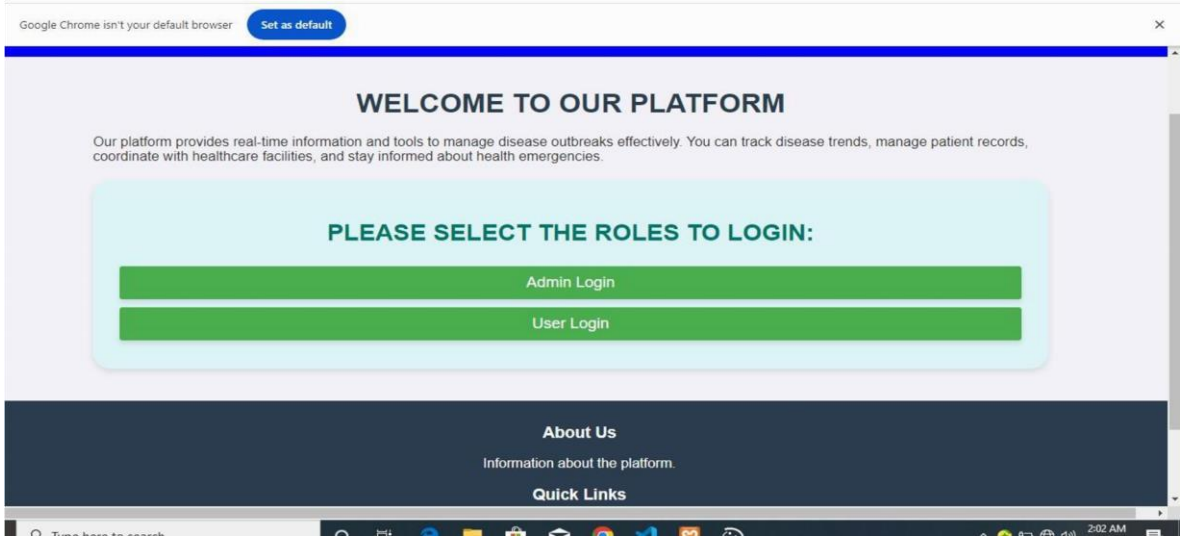


Figure 5. 8: patient's register page

5.3.8 Patient's register page

Figure 5.9: Shows a patient's register page where he or she selects the option as the username and fills in his or her password to login into the system. This gives a patient access to view their platform and make updates.

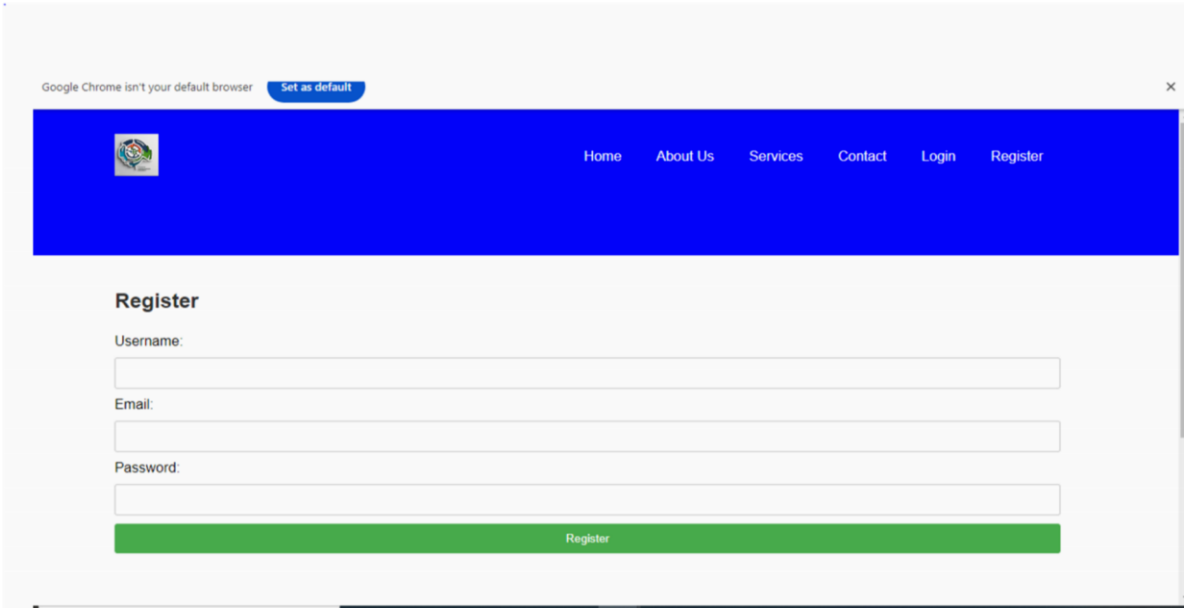


Figure 5. 9: patient login page

5.3.9 Logged into the platform

Figure 5.10: Shows a patient logged into his system where he is able to view his pages details to navigate , make updates and receive information about symptoms of a disease.

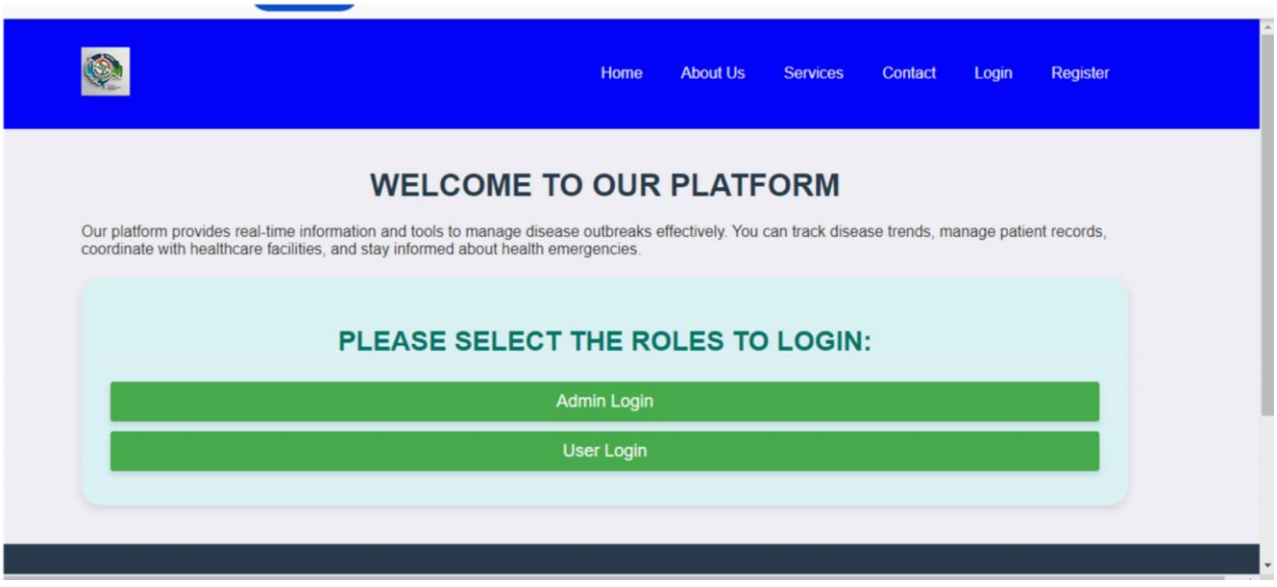


Figure 5. 10: Logged in to view cases

5.4 System Testing and Validation Results

We carried out system testing with an aim of finding out errors that were in the system. We also performed system Validation to ensure that the system satisfies user needs and requirements. We presented the system to some of the users so as to get feedback about the system performance in relation to their requirements

5.4.1 System Testing Results

The Emergency Disease Response Platform (EDRP) was subjected to comprehensive testing to identify any errors and ensure that it performed as expected. The testing process involved presenting the platform to various users, including healthcare professionals and system administrators, to evaluate its functionality and reliability.

During the testing phase, the system was monitored for any faults or issues. These issues were documented and corrected, and the testing was repeated to verify that the platform met all user specifications and performance criteria. The iterative nature of this process ensured that the EDRP was refined and optimized to function effectively in real-world scenarios.

Additionally, the system was tested for its ability to capture and handle valid data accurately. This involved inputting incorrect or erroneous data into the system to observe its response. The EDRP successfully generated alert messages indicating the type of error, demonstrating its capability to manage data integrity and provide useful feedback to users.

Overall, the testing and validation process was completed successfully, confirming that the EDRP operates as intended and meets the critical needs of its users in managing disease surveillance and response.

5.4.2 Validation Results

The Emergency Disease Response Platform (EDRP) was evaluated by a range of users, including healthcare workers, public health officials, and system administrators, to gather feedback on its performance and effectiveness. This feedback was crucial in determining whether the system met the needs and requirements for which it was designed.

The validation process involved a thorough examination of both input and output data within the system. This step was essential to ensure that all data collected and processed by the EDRP were complete and accurate, particularly in relation to the database management. The goal was to confirm that the system adhered to established standards and benchmarks for similar platforms under specified operating conditions.

In addition to these checks, further validation tests were conducted to verify that the EDRP fulfilled the detailed requirements outlined by its users. These tests aimed to ensure that the platform performed as expected in real-world scenarios, effectively supporting disease surveillance, outbreak tracking, and communication within the healthcare setting.

The users were satisfied with the system and concluded that the system was simple to use allowing them to navigate through the system with ease. The system was fast in responding to the different requests and that it satisfied the intended user needs or requirements. A questionnaire was also designed to capture their responses and thoughts (see Appendix III page 47).

Table 14: System Validation.

The table presents user feedback on different aspects of the system. High percentages in learnability and problem-solving indicate that the system is effective and user friendly.

Table 15: System Validation

Feature		Number of users out of 5	Percentage users Of users
Ease of Learning		5	100.0%
Intuitive Interface		4	80.0%
Enhances Disease Efficiency	Management	4	80.0%
Reduces Time Lag in Reporting Disease Cases		3	60.0%

5.5 Conclusion

In summary, this chapter has provided an overview of the functionalities offered by the Emergency Disease Response Platform (EDRP) to various users, including healthcare workers, administrators, and public health officials. It detailed the specific features of the system designed to support disease management and outbreak response, along with illustrative screenshots demonstrating the platform's user interface.

Additionally, the chapter discussed the rigorous testing and validation processes undertaken to ensure the system's reliability and effectiveness. These procedures involved assessing the EDRP for any technical errors and verifying that it fulfilled the specified requirements set by users. The results of these evaluations confirmed that the platform operates as intended and meets the critical needs of its users in enhancing disease surveillance and response capabilities.

CHAPTER SIX

SUMMARY, RECOMMENDATIONS AND CONCLUSION

6.1 Summary

The Emergency Disease Response Platform (EDRP) has proven to be a transformative tool in enhancing disease management at Mbale Referral Hospital. This platform was designed to address critical gaps in the management of disease outbreaks and the handling of patient data, offering a comprehensive solution for real-time tracking and communication.

The successful implementation of the EDRP has resulted in significant improvements across several key areas. First and foremost, the system has streamlined the handling of patient information, which is crucial for timely and accurate diagnosis and treatment. By automating various processes, the EDRP has reduced the time required to access and update patient records, thereby improving the efficiency of healthcare delivery.

Additionally, the EDRP has significantly enhanced the hospital's ability to track disease outbreaks. The platform provides real-time data on the spread of diseases, which is essential for timely interventions and resource allocation. This capability is particularly valuable in managing public health crises and ensuring that appropriate measures are taken swiftly to contain outbreaks.

Overall, the EDRP has met its objectives by automating key processes, reducing response times, and enhancing the overall management of disease-related information. The platform's ability to provide real-time data and facilitate communication has made a significant impact on the hospital's readiness and capability to handle disease outbreaks effectively.

6.2 Recommendations

Further research is essential in this area to address the limitations of existing emergency disease response platforms. As new health crises and disease outbreaks continue to arise, it is crucial that these platforms are adapted to handle the evolving challenges in public health. Additionally, similar systems should be developed for other regions and organizations that still rely on manual or outdated processes. For instance, an online system for managing outbreak records could streamline the process, enabling healthcare providers and authorities to access and manage vital information more effectively. This would lead to better coordination, faster response times, and ultimately, a more robust response to health emergencies.

6.3 Future work

Looking ahead, there are several areas where the system could be further developed to enhance its effectiveness. One potential improvement is the creation of a

communication platform specifically designed for healthcare professionals. This platform would serve as a space where doctors, nurses, and other healthcare workers can share their experiences, discuss disease management strategies, and collaborate on best practices. Such a forum would foster a more cohesive approach to managing health crises, enabling quicker dissemination of critical information and supporting more informed decision-making during outbreaks.

Another area for future work is the **performance evaluation** of hospitals and healthcare facilities. By integrating features that analyze how well hospitals are performing in terms of patient care, resource allocation, and response times, the system could provide valuable insights that help optimize operations. This would not only improve the efficiency of individual hospitals but also contribute to a more effective overall response to health emergencies by ensuring that resources are used where they are most needed.

Finally, there is a significant need for enhanced **supply chain management** within the system. Implementing tools that allow for the tracking and management of healthcare supplies would be crucial in ensuring that essential items, such as medical equipment, personal protective gear, and medications, are available when and where they are needed most. By maintaining real-time visibility into supply levels and distribution, the system could prevent shortages and bottlenecks, thus supporting a more resilient response to emergencies.

6.4 Conclusions

The Emergency Disease Response Platform has successfully achieved its primary goals, significantly enhancing disease management and the handling of patient information at Mbale Referral Hospital. The platform has proven to be a valuable tool in streamlining the processes involved in tracking and managing disease outbreaks. Among its key strengths are its ability to efficiently monitor disease trends and provide real-time updates, which are crucial for timely interventions.

Additionally, the platform's user-friendly interfaces have made it accessible to healthcare workers of varying technical expertise, allowing them to quickly navigate the system and make the most of its features. This ease of use has contributed to a smoother workflow,

reducing the time and effort required to manage patient data and coordinate responses to health emergencies.

Furthermore, the platform has significantly improved communication among healthcare teams, enabling more effective collaboration and information sharing. This enhanced communication has been instrumental in ensuring that all relevant parties are kept informed and can respond promptly to emerging health threats. Overall, the platform has demonstrated its value in improving both the efficiency and effectiveness of disease management at Mbale Referral Hospital.

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APPENDICES

Appendix I: Interview schedule sample questions

i. What is your opinion about the effectiveness of the current disease response systems in your organization?

ii. What is your highest academic qualification attained?

iii. Does your organization utilize an effective system for managing disease surveillance and outbreak response?

iv. What are the expected roles of an emergency disease response system in your organization?

v. Does your organization establish protocols and guidelines for disease reporting and management?

vi. What are some of the challenges you are experiencing with your current disease response system?

vii. Is the current system user-friendly for healthcare professionals and administrators?

viii. What improvements or solutions do you think could enhance your current disease response system?

ix. Does your system support data backup and recovery for critical health information?

x. What are your expectations from the new emergency disease response platform?

xi. How would you rate the performance of the current system in managing disease outbreaks?

xii. How would you rate the reliability of the current system in terms of uptime and data accuracy?

xiii. How would you rate the simplicity of the current system in terms of ease of use and navigation?

xiv. How would you rate the security of the current system in protecting sensitive health data?

Appendix II: Questionnaires

Dear Respondent,

We are final-year BSIT students from UCU conducting research on health platforms with a focus on: An Emergency Disease Response Platform; A Case Study of Mbale Referral Hospital. This research is purely academic, and all information you provide will be treated with the highest level of confidentiality.

We greatly appreciate your assistance in answering the following questions. Please mark the appropriate response by ticking ( ) the spaces provided.

i. What is your position in the organization?

- Top Management …….
- Middle Management …….
- Operational Management …….

ii. Number of years worked:

- 10 years and above ……
- 5-10 years …….
- 3-5 years ……
- 0-3 years …….

iii. What is your highest education qualification?

- Certificate ……
- Diploma ……
- Degree …….
- Masters …….
- PhD …….

iv. Do you currently use an Emergency Disease Response Platform?

- No ……..
- Yes ……

v. Do you review and update your Emergency Disease Response Platform regularly?

- No …….
- Yes ……

vi. Does your current system track disease outbreaks and provide real-time data?

- No …….
- Yes ……

vii. Do you use your system to generate reports on disease management and response?

- No …….
- Yes ……

viii. What additional features should the new Emergency Disease Response Platform provide?

……
……
……

ix. How do you rate the costs associated with your current system?

- Very expensive ……
- Expensive ……
- Affordable ……
- Very affordable ……

x. How user-friendly is your current system?

- Excellent …….
- Good …….
- Fair …….
- Poor ……

Appendix III: The System Validation Questionnaire

i. Is the new emergency disease response platform easy to learn?

- Yes …….
- No ……..

ii. Does the new system enhance the disease tracking and response processes?

- Agree …….
- Disagree ……
- Not sure …….

iii. How would you rate the user-friendliness of the new emergency disease response platform?

- Below 40% …….
- 50% …….
- 60% …….
- Above 80% ……

iv. Does the new system capture all the necessary information for effective disease management and response?

- Yes …….
- No ……..

v. Does the new system address the problem of delays and inefficiencies in disease reporting and response?

- Yes …….
- No ……..

vi. Provide any additional comments or suggestions:

……
……
……
……

Appendix IV: Pseudo code

Pseudo Code for Patient Information Management

Start;

User enters username and password

If username or password is invalid

Return an error message

Else

Return patient details

User enters request (e.g., update patient record, view patient details)

If request requires data update

Validate new data

If data is valid

Update patient record

Else

Return error message

Else

Display patient details

End;

```
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Pseudo Code for Disease Outbreak Management**

Start;

Healthcare worker logs into the system

If credentials are invalid

Return an error message Else

Display dashboard

Healthcare worker inputs outbreak data

If data is complete

Save data to the system

Notify relevant staff

Else

Return error message for missing information

End;