

**DESIGN AND IMPLEMTATION OF AN NFC-BASED PATIENT REGISTRY SYSTEM WITH WEB PORTAL INTEGRATION FOR HEALTHCARE SERVICE MANGEMENT**

**(CASE STUDY: VERITAS UNIVERSITY)**

**By**

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**A PROPOSAL SUBMITTED TO**

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# CERTIFICATION

This is to certify that the project titled “**[PROJECT NAME]**” was carried out by [Name]with matriculation number [Matric Number] under the supervision of MR FELIX ULOKO and that this work has not been previously submitted for the award of any degree in this or any other university.

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**MR FELIX ULOKO (Project Supervisor) DATE**

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**PROF. OLUMIDE OWOLABI**

**(External Examiner) DATE**

# DECLARATION

I, [Name] with matriculation number [Matric number] hereby declare that I Carried out this project work titled, “**[PROJECT TITLE]**” which has been carried out by me under the supervision of MR FELIX ULOKO and that this work has not been previously submitted for the award of any degree in this or any other university.

[Name]

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Signature Date

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# DEDICATION

I dedicate this work first of all to God Almighty, for guidance and protection over me. Your divine guidance has been a constant presence in my life, filling me with strength, inspiration, and wisdom. Your grace has enabled me to overcome challenges, push boundaries, and strive for excellence in all that I do. I also dedicate this work to my lovely parents, [NAMES], I honor your sacrifices and endless belief, your unwavering support has shaped my success. I am forever grateful for your love and encouragement.

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# **BACKGROUND**

The healthcare industry has seen a significant surge in technological advancements aimed at improving the quality of patient care and service delivery. However, the management of patient records remains a critical challenge, with many healthcare systems relying on outdated paper-based methods that are inefficient and prone to errors (DesRoches et al., 2008). Paper-based records can be misplaced, damaged, or lost, leading to incomplete patient data and compromised care (Fleischmann et al., 2020). In response, electronic medical record (EMR) systems have been widely adopted, but they are not without limitations. Many existing EMR systems lack seamless integration with emerging technologies such as Near Field Communication (NFC), which could further streamline the identification of patients and improve the accessibility of their medical records (Latha & Krishnan, 2020).

NFC technology, which enables short-range, contactless communication between devices, is increasingly being used across various industries, including healthcare (Ramaswamy & Babbar, 2019). NFC's ability to allow quick and accurate identification through a simple tap of a card or device offers healthcare providers a more efficient and secure means of managing patient data (Venkatesan et al., 2019). By leveraging NFC, healthcare facilities can minimize the time spent on manual data entry and reduce the risk of human errors during patient identification, a critical factor in improving the overall quality of care (Mani et al., 2021).

Incorporating a web-based portal alongside NFC technology enhances the usability of the system for both patients and healthcare providers. A web portal allows patients to access their medical records remotely, update personal details, and manage appointments, contributing to improved patient autonomy and engagement with their healthcare (Jones et al., 2014). Furthermore, healthcare providers can benefit from the ability to manage patient information centrally and securely, reducing administrative workloads and focusing more on patient care (Brown & Brown, 2018).

The proposed NFC-based patient registry system integrates both NFC technology and a patient web portal to create a modern, efficient, and secure approach to healthcare service management. By doing so, the system aims to improve record accuracy, enhance data security, and empower patients to take an active role in their healthcare. This innovative solution addresses the growing need for faster, more reliable, and patient-centered approaches to healthcare information management (Riedl et al., 2013).

# **PROBLEM STATEMENT**

Efficient and accurate management of patient records is crucial in healthcare service delivery, yet many healthcare institutions in Nigeria, including hospitals and university clinics like Veritas University Clinic, still rely on traditional paper-based systems. These systems are inefficient, prone to errors, and susceptible to loss or damage (DesRoches et al., 2008). In Nigeria, where healthcare facilities often experience resource constraints, these systems not only hinder prompt retrieval of patient information but also lead to delays in care, increased administrative burden, and higher potential for medical errors (Fleischmann et al., 2020). While electronic health records (EHRs) have been introduced in some facilities to tackle these challenges, existing EHR systems often lack integration with advanced technologies such as Near Field Communication (NFC). This technology could further streamline patient identification and record management (Latha & Krishnan, 2020).

NFC offers a promising solution by enabling quick and contactless communication between devices, facilitating the efficient identification of patients and seamless access to medical records (Venkatesan et al., 2019). However, NFC adoption in healthcare systems across Nigeria remains limited, and there is an apparent gap in integrating NFC-based patient identification with web-based systems that provide patients with remote access to their health records. The absence of a fallback mechanism, in case of NFC device failure, adds to the risk of inaccessibility to patient records during critical situations.

This research aims to address these issues by designing and implementing an NFC-based patient registry system tailored to Veritas University Clinic and adaptable to broader healthcare settings in Nigeria. The system will integrate a web portal for healthcare service management, streamline patient identification processes, enhance data accessibility for healthcare providers and patients, and introduce a fallback mechanism using a unique patient ID. By developing a comprehensive solution, this research seeks to tackle inefficiencies in patient record management, address the challenges specific to Nigerian healthcare facilities, and contribute to improved healthcare service delivery.

# **RESEARCH AIM**

To design and implement an NFC-based patient registry system that allows hospitals to manage patient records, through both NFC technology and a web portal in order to enhance the management of healthcare services.

# **RESEARCH OBJECTIVES**

They following are my research objectives:

1. ⁠Design a system architecture integrating NFC and a web portal for patient identification and service access.
2. Implement NFC-based authentication and a fallback mechanism using a unique ID.
3. ⁠Develop a patient web portal for accessing medical records and updating biodata.

# **RESEARCH QUESTIONS**

This research aims to explore the design and implementation of an NFC-based patient registry system with web portal integration for healthcare service management. To guide the investigation, the following research questions have been formulated:

1. How can NFC technology be effectively integrated into a healthcare system to streamline patient identification and service access?
2. What are the design and security considerations for implementing an NFC-based patient registry system?
3. How can a web portal complement the NFC system by enabling patients to securely access and manage their medical records remotely?

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# **RESEARCH MOTIVATION**

The motivation for this research arises from the urgent need to modernize patient record management systems in healthcare, addressing inefficiencies that compromise the quality of care. Traditional methods, including paper-based systems and outdated electronic health records (EHRs), are increasingly insufficient in handling the growing complexity of patient data (Nguyen et al., 2020). These antiquated systems contribute to delayed access to patient information, increased administrative burden, and a higher risk of errors, which can jeopardize patient safety and the overall efficiency of healthcare services. Thus, the drive to develop a more efficient, secure, and integrated solution is a significant factor motivating this research.

Near Field Communication (NFC) technology offers a promising avenue for addressing these challenges by facilitating quick, contactless, and secure patient identification and data access (Silva et al., 2021). Despite its proven success in sectors like finance and transportation, NFC remains underutilized in healthcare, where it could drastically improve the speed and accuracy of patient data retrieval and reduce administrative overhead. This research aims to explore how NFC can be effectively implemented in healthcare to streamline patient management and optimize care delivery.

Additionally, the growing demand for patient-centered healthcare systems is another driving factor. Patients increasingly expect more control over their health data, including the ability to access and update their medical records remotely. A web portal integrated with the NFC system would empower patients to engage more actively in managing their health, fostering greater autonomy and convenience (Brown & Clarke, 2021). This approach aligns with modern healthcare trends that emphasize patient empowerment and digital health solutions, making it highly relevant in today’s healthcare landscape.

This research is motivated by the need to fill the gap in current healthcare systems by leveraging NFC technology and web-based solutions. The overarching goal is to design a system that improves the efficiency, security, and accessibility of patient records while enhancing patient involvement in their healthcare management.

# **SIGNIFICANCE OF THE RESEARCH**

## **Significance of the Research to Academia:**

1. Advancement of Knowledge: This research enriches academic discourse by investigating the integration of Near Field Communication (NFC) technology with healthcare systems. It contributes to the growing body of knowledge on digital health technologies and patient management, particularly how innovative tools like NFC can streamline healthcare services.
2. Educational Value: The research can serve as a foundational case study in academic institutions for teaching topics related to digital health, patient data security, and the use of contactless technologies in medical settings. This will help students understand the practical applications of emerging technologies in healthcare.
3. Interdisciplinary Insights: The research bridges multiple fields—healthcare, information technology, and data security—offering a model for interdisciplinary academic research. It can inspire collaboration between computer science, healthcare administration, and bioinformatics departments, fostering a more holistic understanding of technology-driven healthcare solutions.
4. Research Opportunities: The findings of this research provide a solid base for future academic exploration, particularly in areas like the development of enhanced security protocols for NFC systems in healthcare, or the user-experience design of digital health portals. Future research can build upon this study to deepen understanding in these areas.

## **Significance of the Research to Industry:**

1. Improved Patient Management Systems: The NFC-based patient registry system developed through this research offers healthcare providers a more efficient way to manage patient records, enhancing operational efficiency. Hospitals and clinics can streamline patient identification and medical record access, reducing the administrative burden on healthcare workers.
2. Enhanced Data Security: The integration of NFC technology with healthcare systems contributes to a higher standard of data security, a critical requirement in protecting sensitive patient information. The insights gained from this research can help healthcare organizations better comply with data protection regulations such as HIPAA, providing robust security solutions for the industry.
3. Patient Empowerment: By providing patients with a web portal to access and update their medical records, the research promotes patient autonomy. It empowers individuals to take a more active role in their healthcare, fostering a patient-centered approach, which is increasingly becoming a focus in modern healthcare delivery.
4. Cost and Time Efficiency: The use of NFC technology in patient management can lead to substantial cost savings by reducing the time spent on manual data entry and the potential errors associated with it. Healthcare providers can redirect their resources to patient care rather than administrative tasks.
5. Scalability and Innovation: The proposed system is scalable, allowing healthcare providers to expand its use across various facilities and departments. This offers opportunities for industry innovation, where technology providers can develop tailored NFC-based solutions for different healthcare settings.
6. Global Impact: As healthcare systems worldwide seek to enhance service delivery and data security, the findings from this research have the potential to influence global healthcare practices. The adoption of NFC-based patient management systems can improve healthcare delivery in both developed and emerging markets, contributing to better global health outcomes.
7. Competitive Advantage: Healthcare institutions that implement NFC-based solutions can gain a competitive edge by showcasing their commitment to adopting cutting-edge technologies that enhance patient care, data security, and operational efficiency.

In summary, this research holds significant promise for both academia and the healthcare industry. It contributes to academic knowledge on digital healthcare technologies, fosters interdisciplinary collaboration, and creates opportunities for future research. For the industry, it offers practical solutions for improving patient management, data security, and operational efficiency while promoting patient empowerment and innovation in healthcare systems.

# **DELIMITATION OF THE RESEARCH**

This research has specific boundaries to ensure it stays focused on its main objectives, making the study more manageable and clear. The key delimitations are:

1. Technology Focus: The research is limited to using Near Field Communication (NFC) and a web portal for patient management. Other technologies, like blockchain or IoT, are not included, even though they might be useful in healthcare.
2. Healthcare Setting: The study focuses on hospitals and clinics, specifically for managing patient records in those environments. It does not cover other healthcare settings, like telemedicine or home-based care.
3. Patient Group: The research looks at adult patients who can access their medical records online. It doesn’t focus on special groups, such as children or patients with cognitive impairments, who may need help managing their health data.
4. Geography and Regulations: The study is designed around global data protection standards, like HIPAA and GDPR. It does not cover healthcare systems in countries with very different regulations.
5. Time Limits: The research is focused on the initial implementation of the system, so it doesn’t look at how well it works over the long term or how it might scale up to larger environments.
6. Security: While the study addresses basic security measures for protecting patient data, it doesn’t explore all possible cyber threats or advanced security solutions.
7. Web Portal Features: The patient web portal is limited to basic functions, such as viewing and updating medical records. More complex features, like communication with doctors, are not included.

These delimitations help keep the research focused on developing and testing the NFC-based patient registry system within a hospital setting, while leaving room for future studies to explore areas outside this scope.

# **TOOLS AND TECHNOLOGIES TO BE USED FOR THE RESEARCH**

1. Programming Language: Rust

Overview: Rust is a systems programming language that emphasizes safety, performance, and concurrency. Its strong type system and ownership model help prevent memory-related errors, making it ideal for healthcare applications where data integrity is critical.

2. Web Frameworks:

Actix Web: A powerful, pragmatic, and extremely fast web framework for Rust that allows you to create secure APIs for the NFC-based patient registry system. It provides a robust foundation for building web servers and handling asynchronous requests efficiently.

3. Frontend Development:

WebAssembly (Wasm): Compiling Rust to WebAssembly enables running Rust code in web browsers, enhancing performance for web applications. This can be used for parts of the web portal requiring intensive computation.

4. Database Management:

MongoDB: A NoSQL database that provides flexibility in data storage and retrieval. Its document-oriented structure allows for easy handling of complex patient records. MongoDB's scalability makes it suitable for applications with varying data needs.

5. NFC Integration:

nfc-rs: A Rust library for handling NFC operations. This library can be used to read and write NFC tags, enabling seamless integration of NFC technology for patient identification and authentication in the registry system.

6. Testing Frameworks:

Cargo Test: Rust’s built-in testing framework, integrated into the Cargo package manager. It allows for writing unit tests and integration tests to ensure the reliability and correctness of the patient registry system.

7. Development Tools:

Visual Studio Code (VSCode): A powerful and widely used code editor that supports Rust development through extensions such as Rust Analyzer. VSCode provides features like syntax highlighting, debugging support, and integrated terminal, enhancing the overall development experience.

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# **ETHICAL AND PROFESSIONAL CONSIDERATIONS**

This project is guided by a firm commitment to ethical principles throughout all phases of the design and implementation of the NFC-based patient registry system. We acknowledge the critical importance of safeguarding the privacy and data protection rights of all individuals involved in the healthcare services management process. Our approach ensures that all data handling practices adhere to ethical standards, with a strong emphasis on obtaining informed consent from patients prior to data collection.

Transparency, fairness, and non-discrimination are fundamental to our methodology. We are dedicated to implementing robust measures to prevent bias and protect user rights, particularly in the context of patient identification and authentication processes. The use of NFC technology will be ethically justified, focusing on enhancing patient care without compromising individual freedoms or safety.

Moreover, we are resolute in our commitment to complying with healthcare regulations and industry best practices, ensuring that we maintain the highest levels of professionalism, accuracy, and reliability in managing patient records. Our project team adheres to a stringent code of conduct, fostering an environment of trust and accountability.

Throughout this project, we will conduct ourselves with the utmost integrity and responsibility, fully aware of the ethical and professional implications of our work. This commitment ensures that the NFC-based patient registry system is not only effective but also respectful of the rights and dignity of all patients.

# **OPERATIONAL DEFINITION OF TERMS**

1. NFC (Near Field Communication):

A short-range wireless technology that enables communication between devices when they are in close proximity, typically within a few centimeters. In this project, NFC is used for secure patient identification and authentication processes.

2. Patient Registry System:

A comprehensive database that systematically collects, stores, and manages patient information, including personal details, medical history, and treatment records. This system facilitates easy access and retrieval of patient data by healthcare providers.

3. Web Portal:

An online interface that allows authorized users, such as healthcare professionals and patients, to access, update, and manage patient records and information. The web portal serves as a key component of the patient registry system, providing a user-friendly platform for interaction.

4. Authentication:

The process of verifying the identity of a user or device. In this context, authentication involves confirming a patient’s identity using NFC technology and unique identifiers to ensure secure access to their medical records.

5. Unique ID:

A distinctive identifier assigned to each patient in the registry, which serves as an alternative authentication method when NFC is not available. This ID ensures that each patient can be uniquely recognized within the system.

6. Data Protection:

The practice of safeguarding personal information from unauthorized access, use, disclosure, or destruction. This project prioritizes data protection measures to comply with regulations and ensure patient confidentiality.

7. Healthcare Services Management:

The administration and coordination of healthcare services and resources to optimize patient care. This encompasses the processes involved in managing patient information, service delivery, and operational efficiency within healthcare institutions.

8. Performance Optimization:

The process of enhancing the efficiency and effectiveness of the patient registry system, ensuring that it meets performance standards regarding speed, reliability, and user experience.

9. User Experience (UX):

The overall satisfaction and ease of use experienced by users while interacting with the patient registry system and web portal. UX encompasses aspects such as design, accessibility, and usability of the system.

10. Fallback Mechanism:

A secondary method or protocol used to maintain functionality when the primary method fails. In this project, the fallback mechanism allows for authentication through a unique ID if NFC technology is unavailable.

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