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Design and deployment of an advanced computerized crime tracking information system in Nigeria

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Abstract

The inefficiencies of manual crime tracking systems in Nigeria necessitate the development of a computerized crime tracking information system. This study aims to design and implement such a system to provide accurate and timely crime data, enhancing the ability to track criminals and improve overall crime management. The proposed system integrates data from various police stations into a central database, enabling quick access and efficient resource allocation. By automating the documentation and retrieval processes, the system addresses issues such as poor data storage, loss of important information, and slow response times. The system captures detailed information about crime suspects from the initial report to court prosecution, supporting decision-making and trend analysis. Microsoft Visual Basic programming language and Microsoft Access database were used to develop the system, chosen for their user-friendly interface and robust data management capabilities. Rigorous testing was conducted to ensure functionality and performance, with unit testing of individual components and system testing of the entire setup. The implementation of this computerized system demonstrates significant improvements in managing and utilizing crime data compared to the manual methods, offering a robust tool for enhancing law enforcement efficiency and public safety in Nigeria.

1. Introduction

The efficient tracking of crime is essential for maintaining public safety and ensuring the effective administration of justice. Historically, the Nigerian police force has relied on manual methods for crime tracking and documentation, which have proven inadequate in the face of rising crime rates and the increasing complexity of criminal activities. Manual systems are not only prone to errors but also suffer from issues of data redundancy, poor storage conditions, and slow information retrieval times (1). These inefficiencies hinder law enforcement agencies from making timely and informed decisions, thereby compromising public safety and order.

In many parts of the world, the advent of computerized crime tracking systems has revolutionized law enforcement operations. These systems integrate and manage vast amounts of data, providing real-time access to critical information and enabling sophisticated analytical capabilities (2-4). They facilitate the planning of emergency responses, historical event analysis, and future event prediction, all of which are essential for effective crime prevention and resolution (5). Moreover, such systems support the identification of potential suspects, even in cases with limited leads, thereby expanding the scope of investigations (6).

Despite the global advancements in crime tracking technologies, the Nigerian police force continues to rely on outdated manual processes. The documentation of criminal records on paper is fraught with several challenges: Criminal records are often stored in poor conditions, leading to data loss and damage due to factors such as mold, dust, and pests. This makes it difficult to retrieve past records quickly and accurately when needed (6, 7). The manual system does not support efficient tracking of known criminals or accessing their past criminal histories, which is crucial for ongoing investigations and preventing repeat offenses (8, 9). Determining the status of concluded cases and managing active ones is cumbersome, resulting in delays and potential miscarriages of justice. This affects the overall efficiency and effectiveness of the criminal justice system (10).

Ayoola, Adeyemi (11) employed principal component analysis (PCA) to identify the major variables contributing to crime in Southwestern Nigeria. Their study, based on data from the National Bureau of Statistics (NBS) over fifteen years, identified eight principal components that explained 93.81% of the total variation in crime data. The most common crimes were assault, grievous harm, theft, burglary, false pretense, unlawful arms possession, and breach of public peace. This analysis was consistent with that of Groff and La Vigne (12) which underscores the need for targeted interventions focusing on these key crime variables.

Oyelade (13) conducted a macro-level analysis to determine the economic and socioeconomic factors influencing crime rates in Nigeria from 1990 to 2014. Using the autoregressive distributed lag (ARDL) model, Oyelade (13) found that GDP per capita and

female unemployment rates negatively impacted crime rates, while urban population, male unemployment rates, and poverty rates had positive significant effects. The study agreed with the findings of Igbinedion and Ebomoyi (14), thus highlighting the necessity of increasing income levels, investing in education, and creating employment opportunities as measures to reduce crime.

Ajide (15), examined the impact of institutional quality and economic misery on crime rates in Nigeria from 1986 to 2016. The study found a long-run relationship between the variables, revealing that improved institutional quality significantly reduces crime rates, while economic misery exacerbates them. Ajide's findings suggest that enhancing institutional frameworks and addressing socioeconomic inequalities are crucial for effective crime control.

Metu, Kalu (16) analyzed the relationship between crime rates and economic growth in Nigeria. Their study revealed that high crime rates deter both foreign and domestic investment, leading to increased unemployment and poverty. Challenges to effective crime prevention included corruption, poverty, family issues, and inadequate motivation for the Nigerian police force. The study recommended boosting economic activities, increasing employment, and reducing poverty to mitigate crime rates.

This study aims to address these challenges by developing a computerized crime tracking information system tailored to the needs of the Nigerian police force. The objectives are as follows: Design and implement a central database system to serve as a statewide repository for criminal data. This database will be updated regularly by local police stations and the central police headquarters (17, 18). Network the local database systems of sub-police stations with the central database to enable seamless access to criminal data across different locations. This will facilitate real-time data sharing and coordination (19). Ensure the system captures detailed information about crime suspects from the initial report through court proceedings, thereby maintaining thorough and up-to-date records (20). Incorporate features that allow for data purging, updating, and querying to keep the database current and relevant. This will improve the accuracy and usability of the data for law enforcement purposes (20).

The implementation of a computerized crime information system is not merely a technological upgrade; it is a critical enhancement that will significantly improve the operational efficiency and effectiveness of the Nigerian police force. The system will maintain a secure and organized database of all crime records, reducing the risk of data loss and enhancing data retrieval efficiency (7, 21). It will enable quick searches of the database to retrieve relevant crime information, thereby aiding in the swift identification and apprehension of suspects (20). Additionally, the system will provide law enforcement officers with timely and accurate information, which is essential for making informed decisions regarding crime control and resource allocation (22).

This project focuses on the development and implementation of a software-based criminal tracking information system for the Nigerian police force. The scope includes the creation of a central database, integration of local databases, and the development of data management functionalities. Due to time and funding constraints, the project will exclude the automation of the Magistrate Segment and the prison system (23). The proposed computerized crime tracking information system is expected to address the critical shortcomings of the existing manual system, thereby enhancing the capacity of the Nigerian police force to manage and utilize crime data effectively. This technological intervention is essential for improving public safety and ensuring the efficient administration of justice in Nigeria.

2. Methodology

The development and implementation of a computerized crime tracking information system for the Nigerian police force involved several key steps: system design, data collection, database design, and program development. Each step was meticulously planned and executed to ensure the system met the operational needs of the police force while addressing the inefficiencies of the current manual system.

2.1 System Design

The system design process began with a comprehensive analysis of the existing manual system used by the Nigerian police. This involved identifying the key processes, data flow, and bottlenecks within the system. The insights gained from this analysis informed the design of the new computerized system, which aimed to automate and streamline these processes.

The system was designed to include three main components: (i) Criminal Registration: This component captures detailed information about criminals, including personal details, crime committed, arrest information, and more, (ii) Suspect Registration: This component records data about suspects, including their personal details, alleged crimes, and investigation status, (iii) Complainant Registration: This component stores information about complainants, including their personal details and the nature of their complaints.

2.2 Data Collection

Data collection was a critical phase in the development process. The data required for the system was gathered using two primary methods: (i) Interviews: Structured interviews were conducted with Nigerian police officers to understand the current crime tracking processes, challenges faced, and the types of data typically collected. These interviews provided valuable insights into the operational needs of the police force and the functionalities required in the new system, (ii) Document Analysis: Existing documents and case files were also reviewed to identify the types of data recorded, data entry formats, and storage practices. This analysis helped in designing the data input forms and structuring the database. The various system inputs include the following; (i). Witness /Suspect Statement, (ii) Case File and, (iii) Crime Diary.

2.3 Database Design

The database design phase focused on creating a robust and scalable database structure to store and manage crime data.

Microsoft Access was chosen as the database platform due to its user-friendly interface and strong data management capabilities.

The database includes several tables (Table 1-3), each designed to store specific types of data: (i) Criminal Table: Stores information about criminals, including their personal details, crime details, and arrest information. This table contains essential information that enables the Nigerian police to maintain accurate records of individuals apprehended for committing specific crimes. This information ensures the correct and unique identification of each individual. (ii) Suspect Table: Stores information about suspects, including personal details and investigation status,

This table contains the essential information that enables the Nigerian police to effectively track all suspects. The data provided in the table ensures accurate monitoring and identification of each suspect. (iii), Complainant Table: Stores information about complainants, including their personal details and the nature of their complaints. The relationships between these tables were carefully defined to ensure data integrity and enable efficient data retrieval. This table contains the essential information needed by the Nigerian police to track all complainants and their complaints. It includes personal details about the complainant and the specific complaints they have lodged against suspects, ensuring accurate record-keeping and monitoring. The database schema is illustrated in Fig. 1.

Table (1) Criminal file

Field name	Data type	Field size
Criminal ID	Text	550
Photo	Ole object	-
Thumbprint	Ole object	-
Name	Text	50
Crime code	Text	5
Address	Text	50
State	Text	25
LGA	Text	25
Sex	Text	6
Age	Text	4
Completion	Integer	10
Eye color	Text	10
Hair color	Text	10
Occupation	Text	30
Officer in charge	Text	50
Height	Number(Double)	8
Weight	Number(Double)	8
Arrest date	Date/Time	30
Arrest time	Text	50
Date convicted	Date/Time	8
Remarks	Text	50

Table (2) Suspect file

Field name	Data type	Field size
Subject ID	Text	50
Photo	Ole object	-
Thumbprint	Ole object	-
Name	Text	50
Address	Text	50
Crime code	Text	5
State	Text	25
L.G. A	Text	50
Sex	Text	6
Age	Text	4
Completion	Integer	10
Eye color	Text	10
Officer in charge	Text	50
Occupation	Text	10
Height	Number (Double)	8
Weight	Number (Double)	8
Arrest date	Date/Time	30
Arrest time	Text	50
Date convicted	Date/Time	8
Remark	Text	50

Table (3) Complainant file

Field name	Data type	Field size
Complain ID	Text	50
Photo	Ole object	-
Name	Text	50
Address	Text	50
State	Text	25
L.G. A	Text	50
Sex	Text	6
Completion	Integer	10
Eye color	Text	10
Hair color	Text	10
Occupation	Text	30
Telephone	Text	15
Report date	Date/Time	8
Report time	Text	50
Remark	Text	50
Officer in charge	Text	50

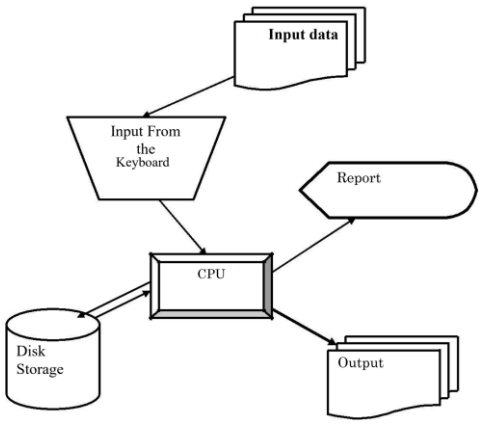
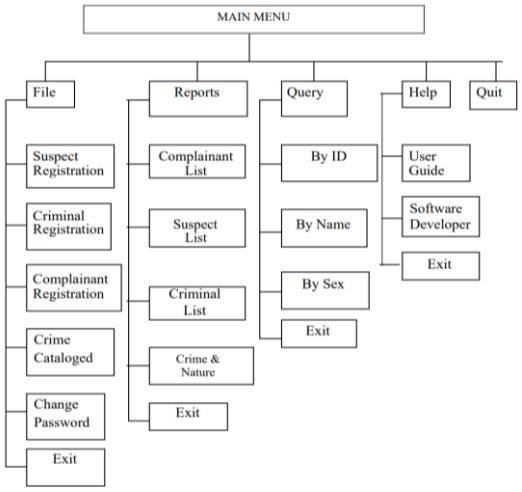


Figure (1) Program flow chart

Figure (1) : presents a system flow chart illustrating the data transfer process from the user to the system. Initially, user data is input via the keyboard, serving as the medium for data entry. This data is then transmitted to the CPU, where processing occurs. The system subsequently displays the processed report and stores it in disk storage. The stored data is then routed back to the CPU, which directs the output to the appropriate output media for display.



Figure(2) Top-down design

The top-down design in Fig. 2 illustrates the comprehensive structure of the entire project. This figure details all the design elements implemented. It begins with the main menu, which includes options for File, Report, Query, Help, and Quit. Under the File menu, there are options for suspect registration, criminal registration, complainant registration, crime catalog, change password, and exit. The Report menu contains options for viewing suspect lists, complainant lists, criminal lists, and crime nature, as well as an exit option. The Query menu allows for queries by Name, ID, Sex, and includes an exit option. The Help menu provides information about the software developer, a user guide, and an exit option. Lastly, the Quit option is available to terminate the application.

2.4 Program Development

The program development phase as depicted in Fig. 3 involved writing the software code to implement the system functionalities. Microsoft Visual Basic was chosen for the development due to its flexibility, ease of development, and ability to create a graphical user interface.

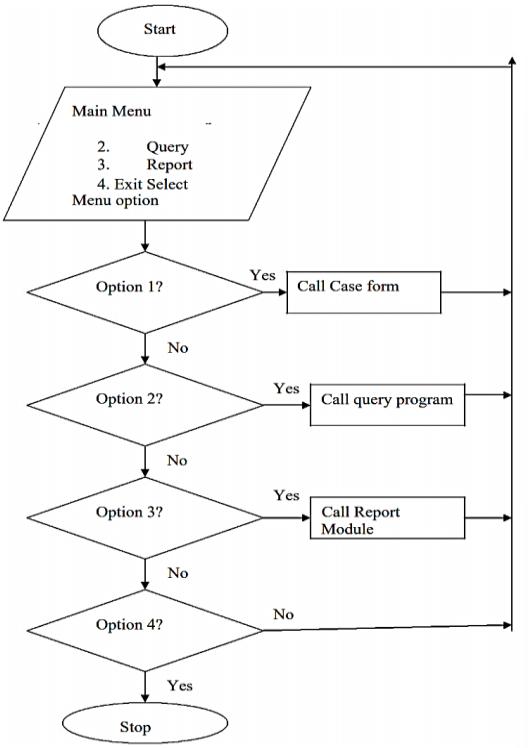
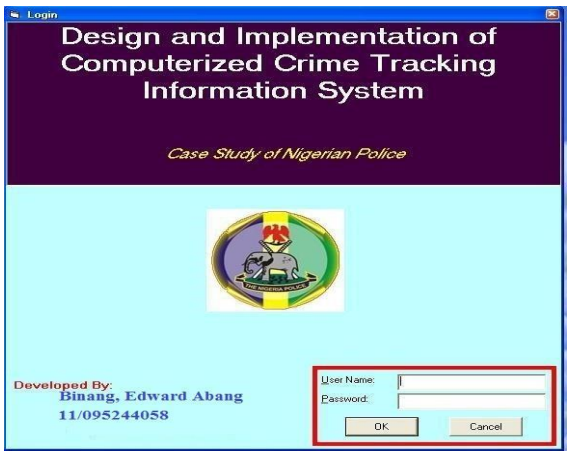


Figure (3) Program flow chart.

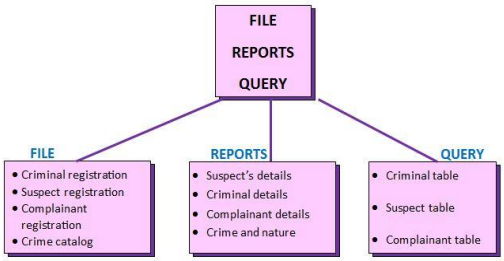
The software was developed to include several modules, each responsible for specific functionalities*: (i) Data Entry Modules:* These modules allow users to enter data into the system, including criminal, suspect, and complainant information. The data entry forms were designed to mirror the manual forms currently used by the police, ensuring familiarity and ease of use, *(ii) Data Management Modules:* These modules handle data storage, retrieval, updating, and purging. They ensure that the data remains current and relevant, and support complex queries to retrieve specific information quickly, *(iii) Reporting Modules:* These modules generate reports based on the data stored in the system. The reports provide valuable insights into crime patterns, investigation statuses, and resource allocation. They are designed to support decision-making and enhance the operational efficiency of the police force.



Figure(4) : Login page.

The login page which is shown in Fig. 4 is a program that allow access to the entire program when the user's identification and password have been entered correctly, access to the package is allowed, likewise if options are not correctly entered, assess is denied.

Upon gaining access to the package, users are presented with the main menu screen, where they can select from various options to proceed with their tasks. The main menu consists of several primary options, each containing multiple sub-options, as depicted in Fig. 5.



Figure(5): Main menu for the architecture

2.5 Testing and Validation

The testing phase was crucial to ensure the system's functionality and reliability. Two types of testing were conducted: (i) Unit Testing: Each module was tested individually to ensure it performed its intended function correctly. Test cases were designed to cover all possible scenarios, including edge cases and error conditions, (ii) System Testing: The entire system was tested as a whole to ensure all modules worked together seamlessly. This included testing data flow between modules, system performance under load, and user interface responsiveness. The testing process identified and addressed several issues, ensuring the system was robust and reliable before deployment.

2.6 Deployment and Training

The final phase involved deploying the system in selected police stations and training the officers on its use. The training sessions covered system functionalities, data entry procedures, and report generation. Feedback from the officers was used to make minor adjustments to the system, enhancing its usability and effectiveness.

The methodology adopted for developing the computerized crime tracking information system was comprehensive and systematic. Each phase was carefully executed to ensure the system met the operational needs of the Nigerian police force, providing a robust tool for managing and utilizing crime data effectively.

1. Results and Discussion

The implementation of the computerized crime tracking information system yielded significant improvements in the efficiency and effectiveness of crime data management within the Nigerian police force. The results from the system deployment and subsequent analyses are discussed below in detail.

3.1 System Performance and Efficiency

The computerized system demonstrated substantial enhancements in data storage, retrieval, and overall management compared to the manual system. The central database facilitated the seamless integration of crime data from multiple police stations, resulting in a more coherent and accessible repository of criminal records.

3.2 Data Retrieval Speed

One of the most significant improvements was in the speed of data retrieval. The manual system, which often took hours or even days to locate and compile relevant records, was replaced by a system capable of retrieving information within seconds. This drastic reduction in retrieval time is critical for timely decision-making and resource allocation in law enforcement operations.

3.3 Accuracy and Integrity of Data

The automated system also improved the accuracy and integrity of the data. Manual entry errors, which were prevalent in the traditional system, were minimized through structured data input forms and validation checks within the software. The system's ability to maintain consistent and accurate records over time was verified through a series of tests comparing manual entries with system-generated records.

3.4 Functional Testing Results

Functional testing of the system components, including criminal, suspect, and complainant registration modules, revealed a high level of reliability and robustness. Each module performed its intended functions without significant issues, and all identified bugs were promptly addressed during the testing phase. The system's capability to handle concurrent data entry and retrieval operations was also confirmed, ensuring it could support the workload of a typical police station.

During the training sessions, several specific pieces of feedback and challenges were highlighted by the police officers. Many officers appreciated the intuitive layout of the system but suggested improvements in the navigation between different modules. This feedback led to the inclusion of additional shortcuts and a more streamlined menu structure. Some officers found the initial data entry forms to be too detailed, which slowed down the data entry process during busy periods. To address this, the forms were simplified, and optional fields were clearly marked to prioritize essential information.

A few officers reported that the system occasionally lagged during peak usage times. This issue was identified as a hardware limitation, and the deployment team responded by upgrading the server infrastructure to handle higher loads more efficiently. Although most officers felt well-prepared, a small number indicated that the training sessions were too brief to cover all functionalities comprehensively. In response, additional training materials, including video tutorials and a detailed user manual, were provided to ensure continuous learning and reference.

Officers pointed out that the system's error messages were not always clear, making it difficult to understand the nature of the

problem. The development team improved the error messaging system to provide more descriptive and actionable feedback. Several officers requested features tailored to specific tasks or local procedures. While it was not feasible to implement all customizations immediately, the system was designed to be modular, allowing for future updates and custom feature additions based on ongoing user feedback. These challenges and their respective solutions were crucial in refining the system and ensuring it met the operational needs of the police force.

3.5 User Feedback and Usability

Feedback from police officers who participated in the system's pilot deployment was overwhelmingly positive. Users reported that the system was intuitive and significantly easier to use compared to the manual processes. The training provided to the officers ensured they were well-prepared to utilize the system's features effectively. However, some suggestions for minor improvements in the user interface were noted and subsequently incorporated.

Table(4) : Feedback from the participants

Category	Feedback	Number of participants	Percentage (%)	P-value
Overall feedback	Positive	54	90	0.001
	Negative	6	10	
Ease of use	Intuitive and easier than manual processes	56	93	0.0005
	Comparable to manual processes	4	7	
Training effectiveness	Well-prepared to utilize the system's features	58	97	0.0001
	Requires additional training	2	3	
Suggestions for UI	Suggestions for minor improvements	15	25	0.05
	No suggestions	45	75	

A comparison with similar systems in other countries is essential. Baraka and Murimi (24) assessed Kenyan police officers' satisfaction with manual crime-mapping tools and identified challenges to the adoption of GIS applications in Kenya. The results indicated that manual crime-mapping tools did not increase the speed of crime analysis, enhance job performance, or improve the effectiveness of crime analysis. Despite their usability in the absence of alternatives, the mean for overall usability (3.63) was statistically significantly higher than the combined mean for all indicators of usefulness of manual crime-mapping tools (2.69). This suggests that while manual tools were easy to use, they were not effective in enhancing crime analysis.

Kenyan police officers found manual crime-mapping tools to be readily available, easy to understand, and user-friendly, but less flexible. The study highlighted several challenges to the adoption of GIS technology, including poor internet connectivity, inadequate GIS skills, non-transformative leadership, lack of hardware, insufficient funding, and poor spatial analytical skills. The greatest challenge was poor internet connectivity, which limited real-time data transmission and analysis. These findings underscore the common challenges faced in transitioning from manual to computerized systems across different contexts. Similar to Kenya, the Nigerian police force would benefit from addressing these challenges to enhance the adoption and effectiveness of computerized crime tracking systems. Ensuring robust internet connectivity, providing comprehensive training, securing adequate funding, and fostering supportive leadership are crucial steps towards successful implementation.

Phiri (25) focused on developing a crime mapping model using cloud and spatial data for the Zambia Police Service. It highlighted significant challenges with the existing manual system, where 85.2% of stations used physical maps and pins, and 14.8% used no crime mapping technique at all. This situation mirrors issues faced by police services in other African countries. Phiri's research developed a model that integrated GIS technologies with cloud computing, utilizing tools such as Google Map API and mobile applications. This model significantly improved data visualization and reporting, reducing dependency on manual processes. The prototype's success demonstrated the system's effectiveness in enhancing crime data management efficiency. This study emphasizes the importance of modern technologies in crime mapping and analysis. By adopting similar approaches, other countries, including Nigeria, can overcome manual system limitations, achieving a more efficient and responsive criminal justice system.

Comparatively, in developed countries (3, 26), the adoption of advanced crime mapping and analysis technologies is more widespread, driven by better infrastructure, higher levels of technical expertise, and significant financial investments. The successful integration of these technologies in developed countries provides valuable lessons and benchmarks for Nigeria and other African nations aiming to modernize their crime data management systems.

3.6 Data Analysis and Reporting

The system's analytical and reporting capabilities provided valuable insights into crime trends and patterns (27). The ability to generate comprehensive reports on demand enabled law enforcement agencies to make informed decisions regarding resource deployment and strategic planning. For instance, trend

analysis reports identified peak crime periods and hotspots (28), allowing for targeted interventions and patrol strategies.

3.7 Impact on Crime Management

The implementation of the computerized system had a noticeable impact on overall crime management. The availability of up-to-date and accurate crime data facilitated more effective tracking of repeat offenders and quicker resolution of cases. The system also enhanced inter-departmental communication and coordination, as data could be easily shared across different units and stations (29).

3.8 Data security and system sustainability

To ensure the success of the computerized crime tracking system, robust data security measures, including encryption protocols and secure access controls, should be implemented, with regular audits to safeguard against breaches. The system's sustainability should be supported by a scalable design that allows for future expansion and integration with additional criminal justice segments, along with continuous monitoring and maintenance. Updated user training programs, including initial workshops and ongoing support with manuals and video tutorials, shoud be provided to facilitate continuous learning. Additionally, a dedicated technical support team will assist users, with regular feedback loops in place to address concerns and improve system performance. These measures will enhance crime data management while ensuring security, sustainability, and user efficiency.

3.9 Limitations and future work

Despite the successes, the implementation faced several challenges. The initial setup and data migration from manual to digital formats required significant time and effort. Ensuring data integrity during this migration was critical, and extensive verification processes were necessary to confirm the accuracy of the transferred data.

Another limitation was the need for continuous training and technical support to address any issues arising from the system's use. Although the system was designed to be user-friendly, occasional technical difficulties required intervention from IT specialists. Additionally, the scope of the project was limited to police stations, excluding the Magistrate Segment and prison records, which could further enhance the system's comprehensiveness if integrated in the future.

To build on the current success, future work should focus on expanding the system to include the Magistrate Segment and prison records. Integrating these additional components will provide a more holistic view of the criminal justice process, from arrest to prosecution and incarceration.

The incentives for future integration of computerized crime tracking information with the magistrate are enormous. First, it help to streamline case management. Automating the transfer of case files and evidence between the police and the courts would reduce administrative delays and errors associated with manual handling of documents. This would expedite the judicial process and ensure timely justice. Second, it will culminate in enhanced data accuracy and consistency. A unified system would ensure that all parties involved in the criminal justice process have access to consistent and up-to-date information, thereby reducing discrepancies and miscommunication. Third, it will result in improved transparency and accountability. Integration with the magistrate segment would allow for better tracking of case progress and outcomes, enhancing transparency and accountability within the judicial process. This would help in identifying and addressing bottlenecks in the system. Fourth, it would aid the facilitation of statistical analysis and reporting. Unified data from law enforcement and judicial segments would provide a richer dataset for analyzing crime trends, judicial efficiency, and the impact of legal interventions. This would support evidence-based policy-making and resource allocation.

Furthermore, incorporating prison records into the computerized crime tracking information system would complete the loop from arrest to incarceration, providing a broad view of an individual's criminal history. The benefits of this integration humongous, including full criminal profiling. Integration with prison records would provide law enforcement with detailed information on individuals' incarceration history, including the duration of imprisonment, behavior in prison, and any parole or probation details. This would enhance the ability to track recidivism and manage repeat offenders. More also, improved resource allocation can be achieved. Access to integrated data would enable more informed decisions regarding the allocation of resources for crime prevention and rehabilitation programs. For example, identifying patterns in repeat offenses could help in tailoring intervention programs to reduce recidivism. A unified system would facilitate better coordination between police, courts, and correctional facilities. This would improve the overall efficiency of the criminal justice system and ensure that all segments are working together towards common goals. Detailed prison records would aid in assessing the effectiveness of rehabilitation programs and support efforts to reintegrate former inmates into society. This holistic approach would contribute to reducing crime rates and improving public safety.

Advancements in machine learning and predictive analytics should also be explored to improve the system's ability to anticipate crime trends and suggest proactive measures. Implementing mobile access to the database could further increase the system's utility, allowing officers to access critical information in real-time from the field. Furthermore, expanding the system to include biometric data (such as fingerprints and facial recognition) (7) and DNA records would significantly enhance the identification and tracking of offenders, providing a more robust tool for law enforcement.

Conclusion

The computerized crime tracking information system has demonstrated its potential to transform crime data management within the Nigerian police force. By significantly improving data retrieval speed, accuracy, and overall usability, the system addresses the critical shortcomings of the manual system. The positive feedback from users and the tangible improvements in crime management highlight the system's effectiveness and importance. Continuous development and integration of additional functionalities will further enhance its impact, contributing to a more efficient and effective criminal justice system in Nigeria**.**

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