DESIGN OF A SECURE ONLINE ACADEMIC DOCUMENT VERIFICATION SYSTEM:

A CASE STUDY OF NKUMBA UNIVERSITY

BY:

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DECLARATION

I **Namukose Mpongo Sarah** hereby declare /certify that, this research proposal entitled, "**Design of a Secure Online Academic Document Verification System**" is my own work and original.

Signed…………………………………………. Date.…/……/…...

NAMUKOSE MPONGO SARAH

2016-AUG-MCIS-M220770-WKD

APPROVAL

This research dissertation has been submitted for examination with the approval of my supervisor.

<u>Supervisor</u>

Signed: ……………………………   Date …../…….../……...

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DEDICATION

This research dissertation is dedicated to my beloved mother Mrs. Isiko Joyce Muyoka for her valuable contribution towards my education since childhood. I would like also to dedicate it to my entire family especially my beloved husband Mr. Maholo Mulongo Denis, my sisters, brothers, and all relatives, friends and loved ones for every effort, sacrifice, encouragement, and support they provided throughout my academic life.

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This research report is a joint contribution of the student, colleagues, lecturers, respondents and the supervisors. I am so grateful to all those who contributed to the successful production of this good academic research work.

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To all those who provided responses to my data collection instruments, I say thank you and may God bless you so much. Lastly, I thank everybody who supported me in different ways during my education whose contribution has led to the successful completion of this dissertation.

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Abbreviations and Acronyms

NUICTS: Nkumba University Information and Communication Technology Services

GUIs: Graphical User Interfaces

MVC: Model–view–controller

NU: Nkumba University

ADVS: Academic Document Verification System

PHP: Hypertext Preprocessor

WLAN: Wireless Local Area Network

WCU: West Coast University

ABSTRACT

Academic Document Verification system is an online system designed to computerize the process of verifying and authenticating Nkumba University's issued academic documents considering the problems faced by doing this manually. Document Verification is the process of establishing the authenticity, validity, and accuracy of something such as the verification of official documents. Verification of academic certificates is one of the important research areas today. In this study, the documents in reference were the issued academic documents of Nkumba University.

This study was based on an effort towards the elimination of fake university academic documents / certificates. The study contributes towards solving problems in academic fraud. The manual system was studied carefully and relevant people were interviewed to collect the required information. The designed Academic Document Verification system (prototype) allows easy retrieval of accurate and timely information basing on the supplied query for an effective and efficient academic document verification process. The system is secure, user friendly and can be accessed 24/7 from anywhere on demand. The system was designed in PHP.

The study also focused on the application of the developed prototype as proof of concept, the system was able to verify the academic documents in question online using the unique serial number on each transcript matching it with sample data in the database.

Nkumba University requires such a system due to high demand of such services in the current high rate of advances in Technology use worldwide.

CHAPTER ONE:

INTRODUCTION

1.0 Introduction

Universities and Institutions in Uganda issue certificates and transcripts as proof to those who have satisfactorily and successfully completed a particular course or program.

The global demand for higher education currently exceeds the world's existing university capacity. This shortfall is likely to persist for the foreseeable future, raising concerns that frustrated students might choose to purchase fraudulent credentials from counterfeiters or diploma mills. International efforts to encourage the development of reliable, authoritative lists of recognized universities are currently underway (Gollin, 2014).

An employer might use such lists and related databases to determine the legitimacy of a school attended by a prospective employee. But an additional approach to credential authentication is possible in which degree verification is performed automatically using the same information security tools that permit secure financial transactions to proceed over open communication networks. It is possible that the development of reliable databases (which require active engagement in order to be useful) in combination with a widely adopted standard for self-authenticating academic documents could drive nearly all counterfeiters and diploma mills out of business.

The Internet is one of the most frequently used means of exchanging information among people. The electronic data transmission breaks the distance barrier. Online Certificate Verification system represents the direction of future certificate authenticating development. Promotion of

Online Certificate Verification system will bring great benefits to the society and the economy. Online Certificate Verification system improves the speed and quality of services of Certificate Authentication, promotes the globalization of markets, and cuts down cost. The system will be designed for employers, universities, and the public.

An academic document is an official document, which confirms a student's basic programme and award information. It includes a student's course start and end dates, date of award and classification, if applicable (Leeds, 2018). Verification is the process of establishing the truth, accuracy, or validity of something such as the verification of official documents.

1.2 Background to the Study

Nkumba University through NUICTS Directorate (Nkumba University Information and Communication Technology Services) is attempting to harden the security of produced academic documents/transcripts to eliminate the ongoing vice of counterfeiting academic transcripts from different universities in the Uganda. Nkumba University is one of the large private Universities in East Africa. It is a non-profit, non-denominational institution granted a Charter in 2006 by the Government of Uganda. The University aims to promote multidisciplinary education in information technology, nursing, electrical and electronics, business, arts, social sciences, sciences, and cultural fields as well as stimulate the spirit of enterprise and entrepreneurship.

Information security incidents in the case of a university can be in the form of information theft, data tampering, viruses, worms and data loss (Burd, Cherkin, &Concannon, 2011). The source of security incidents can be external, such as hackers, or internal, originating from both staff

and students (Gaoglu, Ucar, &Eren, 2009)

Universities are known to be soft targets for a number of reasons, such as the existence of large number of computing resources that can be used in a secondary attack as zombies (Cooke, Jahanian, & McPherson, 2005),and also the existence of a large number of network users. As a result enforcement of security policies is often difficult to achieve.

Universities also get access to Intellectual Property (IP) belonging to individuals and companies during research processes and this can potentially be targeted by competition as university environments are normally less secure than a company's research and development laboratories. The Information Technology department of any university should be adequately equipped and prepared to avert such incidences.

From my research, I clearly state that fake academic documents are produced everyday targeting different institutions of learning in Uganda. This tarnishes the reputation of these institutions and Uganda's education system whenever they are identified or not. I have no doubt that my research has as well contributed positively towards controlling if not eliminating the fake academic documents. Recruiting firms and employers will not only base on the presented documents to recruit the document bearer but will also be in position to verify and authenticate these documents themselves by a single click. It is hoped that when the developed system is implemented, the occurrence of counterfeit certificate will be greatly reduced.

This thesis was centered on the need to design a secure online academic document verification system (prototype) to save Nkumba and other universities in Uganda the huddles of a manual academic verification system; the University lacked such a system. This enabled parents/guardians, current and prospective employers to check and verify the authenticity of

Nkumba University's academic transcripts/certificates online, without having to contact or coming to the university which is costly and time wasting. The user is required to enter the correct transcript unique serial number on the provided university portal. On successful verification, the system displays similar details on the screen. Failure to display details on the screen makes the academic document invalid.

1.3 Statement of the Problem

Higher academic institutions in Uganda rely on traditional verification processes that extensively use paper records and manual procedures to verify and authenticate presented academic documents. Moreover, employers and other academic institutions have been experiencing a high alarming rate of fake university academic certificates.

According to (Wandera, 2015) in an interview with oneEmmanuel Omuna, a 24 year old graphics designer on Nasser Road-Kampala, narrated that the need to forge university transcripts is something many students have approached him with. "Usually, when the graduation date is closing in, students are always here looking for a transcript. And it is possible to design one that nobody will second guess, unless of course you work in the university's registrar's office," Omuna shares.

The current system, is a typical traditional verification process characterised by tedious, repetitive and boring search and locate procedures that accompany every verification request. A process that could require less than one hours' duration sometimes takes not less than two weeks; one day's costs may become more than six days' costs.

It should be noted that a graduation transcript is one of the most important documents issued by universities and other educational institutions. It is proof of a graduate's qualification. However, due to advances in printing and photocopying technologies, fake transcript can be created easily and the quality of a fake transcript nowadays can be as good as the original. The transcripts of many prominent universities have been forged and these forgeries are very difficult to detect. Lack of a mechanism for instant verification of graduates' academic transcripts has been and remains a major wish in higher academic institutions in Uganda.

Currently, employers, recruiters, and other organizations experience difficulties to authenticate Nkumba University's academic documents instantly since one has to come physically to the university or send an email, which takes time. Incidences of graduates losing opportunities due to the delay in the verification process have been common. The continued illegal production of counterfeit academic documents has not spared Nkumba University.

In view of the public concerns raised in different forums, there is need to undertake a study to develop a prototype of a secure online academic document verification system.

1.4 Study Objectives

The purpose of this research was to design and implement a Secure Online Academic Document Verification System based on the verification process adopted by Nkumba University

1.4.1   Specific Objectives

i) To investigate the old verification system (manual) of academic documents at Nkumba University.

ii) To examine the relationship between implementation of various security levels in the verification process and the public.

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iii) To enable verification system accessibility to the public

1.4.2   Research Questions

i)   How has the old verification system (manual) at Nkumba University affected the reputation of produced transcripts?

ii) How does implementation of the various security levels in the verification process affected the public?

iii) To what extent does accessibility to the verification system affected the public and Nkumba University?

1.5 Research Scope

1.5.1   Geographic Scope

Entebbe lies at 0o.04N, 320.280E and is 37 kilometers South East of Kampala the capital city of Uganda.   It is situated in Wakiso District bordering Lake Victoria in the South.   The Municipality is located on a peninsular into Lake Victoria covering a total area of 56.2 km2, out of which 20km2 is water. Nkumba University which is my case study lies at 0.0950^{o} N, 32.5069^{o} E and is located 27 kilometers southwest of Kampala. The university is found in the newly established Katabi Town Council under Entebbe Municipality.

1.5.2   Subject Scope

The study was confined to eliminating and controlling the faking of academic documents from different universities in Uganda focusing on Nkumba University as a case study. This was

achieved after studying the challenges of the old manual system. An academic document verification system was designed to verify the academic documents. The system targeted employers, parents/guardians, students, and the public.

1.5.3 Time Scope

This study focused on the design of a secure Academic Document Verification System. The study took a period of three months between July and September 2018.

1.6 Significance of the Study

a) **Improve Academic Transcript value and Security**

The outcome of the study is of great importance to a number of institutions in Uganda. Nkumba University and other institutions of higher learning would use the findings of the study to address the challenges of counterfeiting their academic documents/transcripts. This also improves on the authenticity and respect of graduates and academic documents in the public. Other academicians and researchers may use the findings of this study in gathering related literature on related subject.

b) **Access to the Online Verification System**

The current network infrastructure at Nkumba University also allows the implementation and hosting of the verification system. This eliminates a third party which improves system security; it's the university's responsibility to guarantee security and integrity to graduates vital information. This will not only protect and strengthen the value of Nkumba University academic documents but it will also save those intending to verify transcripts money and time since with the current system one has to travel down to the main the main campus in Entebbe to have academic documents verified. The system will be accessed from anywhere.

However, as far as transcript verification is concerned, adequate planning and investment are before system implementation to enable this transition.

1.7 Justification of the Study

According to the researcher, Nkumba University is the best key implement such a system. In the area of academics, Nkumba University is one the first private and best universities in Uganda and this make the institution's academic documents a target to counterfeiters.

i) **Improved Image and Authenticity of Documents**

True anywhere and anytime access to the Nkumba University Academic Document Verification System and other network resources will continue to strengthen the image of the university, produced academic documents, and the graduates value and their authenticity.

ii) **Extra Ordinary Transcript Protection**

Nkumba University will enjoy the advantages of a truly future-proof academic document. The WLAN can scale as needed to support additional users. The improved transcript security will provide a foundation for other universities in Uganda that haven't deployed a similar system to look into it.

CHAPTER TWO:

STUDY LITERATURE

2.0 Introduction

This chapter provides a broad overview of academic document verification and its associated technologies. Different sections will be devoted to explanation of how the process works, document verification challenges, technologies and securities involved.

2.1 Literature Survey

According to Aisltd (2017), you may already have a quality control department and proof-readers who are supposed to catch mistakes and counterfeited documents. The problem is that those people are only human. Humans, no matter how conscientious, may get tired and start letting errors slip through. A computerised Document Verification System will find all discrepancies between a document and the master copy. Your quality control department doesn't need to spend time comparing pages that are already 100% identical. They can focus on the problem pages which will make their jobs more efficient. And by being a tool rather than a solution your people can do what they are good at – deciding if the discrepancy is serious enough to need fixing.

In a safety critical area such as the pharmaceutical industry a single misplaced dot could turn a dosage of 160mg into 16.0mg causing the treatment to be ineffective. Or, if it were to happen the other way around, it could cause a patient to take an excessive dose. (Aisltd, 2017)

In an academic industry mistakes can simply sour your customer's /client's opinion of you. Consider a university academic document for example. If an alumni / employee has spent hours trying to have an academic document verified since the process involves opening archives to

locate a requested master copy, they're likely to curse the University for Serving and operating inefficiently.

According to Yogesh A.C (2001), in March 2016 Samit Shivadekar, Stephen Raj Abraham, and Sheikh Khalid information technology students from Navi Mumbai, India developed a Document Validation and Verification System whereby the documents generated by government were digitally signed and verified by the government authorities using digital signatures.   The system authorizes certificates in government sectors using cloud computing environments. University of Grants Commission in India also developed an e-certificate verification system (Yogesh A.C, 2001).

2.2 Problems in Authenticating Paper Academic Documents

Many of the security issues concerning academic documents are similar to those relating to paper currency transactions. For example, a job candidate might be asked by a prospective employer to provide a transcript showing his university courses and grades. Without confirmation from a third party that the document is valid, how can the employer tell whether the transcript was actually produced by the university rather than by a counterfeiter? Legitimate printers use various kinds of security paper and special inks to make it more difficult to counterfeit their documents. But these also are used by counterfeiters: A high-quality counterfeit transcript, printed on security paper, can be purchased online for less than $100.

An added complication with academic documents is the wide variation from school to school in transcript layout and printing technology. An employer typically is unfamiliar with the standard format of a transcript issued by a particular institution; just as a 19th century U.S. merchant in one state was unfamiliar with the legitimate currency of another state. Ultimately, it probably is

more important for a counterfeit transcript to look good than for it to resemble a genuine transcript from the target school. The St. Regis diploma mill sold counterfeits of at least 77 legitimate schools' documents but made little effort to have such counterfeits conform to the layout and design utilized by those schools.(United States Sentencing Memorandum, Government Exhibit A, United States of America, Plaintiff vs. Dixie Ellen Randock, Defendant, 2008)

An employer could ask a job applicant to have a transcript sent directly by the school's registrar, but this is at best a weak attempt at reducing the chance of receiving a counterfeit document. It is a simple matter to find a re mailing service that, for a price, can receive a dishonest person's document and re mail it from the same postal district as the university in question.

And what is to be done when a job applicant presents credentials from a diploma mill purportedly located Abroad rather than providing counterfeit documents that bear the name of a legitimate school? "West Coast University (WCU)" (westcoast, 2005) claims to have a campus in Seborga and to be accredited by the "Accreditation Council" of Seborga, but a WCU degree has no More legitimacy outside the not quite-real country of Seborga than the Seborganluigino.

It is not practical to expect an academic document delivery system to be robust against determined efforts at fraud without introduction of a trusted third party to assist with verification. Ideally, the third party would confirm that the school named in the document had in fact generated the document, that the document had not been altered, and that the school held proper degree-granting authority according to the appropriate education ministry or state higher education office (Gollin, 2014).

2.3 How University students fake their graduation

According to (Wandera, 2015) hundreds of students fail to graduate annually, although this is a reality many parents never realise since the culprits skillfully hide this. The idea of going to university and walking away with a degree three or four years later is fast turning into a myth for a number of students. The colourful aura of relieved and hopeful students marching in files to the cheer of proud guardians on graduation day may just be overrated.

Unknown to some of the parents, what they usually see is not a degree coming into the family but rather the illusion of it. This is because much as some students actually show up, they are not really graduating but putting up a show to hide the bitter truth as they come well aware that the university, for several reasons, does not have them on the list of graduands.

The dirty tricks:

University students have for long unleashed a bag of tricks with the commonest, and perhaps the most widely employed being forging documents.

Parents turn up to hear the student's name being read, however, when that does not happen, the parent is made to believe the name was mistakenly skipped. Such students are usually quick to present their parents with university transcripts, showing the perfect score.

Emmanuel Omuna, 24, and a graphics designer on Nasser Road-Kampala, confirms that the need to forge university transcripts is something many students have approached him with.

"Usually, when the graduation date is closing in, students are always here looking for a transcript. And it is possible to design one that nobody will second guess, unless of course you work in the university's registrar's office," Omuna shares.

True to his word, when presented with a fraudulent transcript, many parents never sense anything awry about the document as many do not even know how the original transcript should look like.

However, Lawrence Obbo, a Kyambogo University Social Science graduate, says sometimes the students do not need to travel far to get a transcript because university personnel responsible for issuing transcripts have been bribed by students who have the financial muscle to offer them transcripts. However, such transcripts never make it into the university records.

"I have witnessed such cases. And from what I know students are getting these documents from the people in the system. It is sad. Female students offered sex in exchange for the document," Obbo intimates.

Other students who believe their parents will be inquisitive enough to find out about their dirty tricks in case their name does not feature on the graduation list, have feigned illness on graduation day and stayed home. Some choose to disappear from home altogether.

However, disturbing reports have continued to trickle in of students hacking into the university system to feed in marks, often walking away with "authentic" transcripts. As for how possible it is to hack into the system, that remains a question yet to be addressed.

Interestingly, Nicholas Lumu, a Makerere University law student believes it is possible. He says, "We have IT students so sophisticated. The question is not whether they are able to hack into the system; it is how often they are doing it." Lumu remarks.

But why aren't students graduating

A number of reasons explain why students usually fail to attain authentic degrees. One is the fact that many students accumulate retakes, many find it hard to cope with the heavy course load.

According to Nicholas Mugoya, a counsellor at Kula Uganda in Ntinda, students do not want to face the embarrassment back home when they announce that they will not be graduating as a result of having a series of retakes. "Some are just too scared to disappoint their parents and families. They, therefore, find it easier to find a grey trick that can fool the parents come graduation day, and such students will go to the extreme to remain in their parents' good books," Mugoya says.

Whisking tuition away

Take Daniel Wokorach, for instance. The final year student at Nkozi University confesses with a whiff of embarrassment that at one point he partied his tuition away. Like many others, the money his parents gave him as tuition never made it to the bank. He preferred to keep it in sight, at least for a while. Expectedly, soon he was making constant weekend trips back to the city to enjoy nights of unending parties. He says, "Often the temptation to use part of this money is a strong one. I just happened to succumb. We would spend the money on beer, usually buying it for the girls. And just like that almost all my tuition vanished."

With looming university deadlines and no money to meet these obligations, many find themselves in a vicious cycle of lies.

The lying game

After wasting their tuition, students devise means to cover up. The first instinct is to replace the money. A few are lucky enough to find the money, through borrowing, often their phones and laptops acting as collateral. But for others, it is the start of a backlog. Although some universities are lenient enough to allow students to sit for some of the exams without paying full tuition, others do not. Therefore, a great number of retakes are not from papers failed but rather those

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that were missed. This is something many guardians do not know since many are only with "touching the degree" read transcript. It is common practice for students to buy gowns and even allow their parents to show up at the graduation ground, yet all this is in vain.

Hopefully, with the housekeeping most public universities have since taken up, this vice will soon be relegated to the past.

One would argue that the best way to stop students from wasting their own tuition is for the parents to bank the money themselves. But Dr. Laura Ndaba, a senior lecturer at Makerere University Business School believes this is uncalled for.

"We are talking about university students here. These are old people and they are at a stage where they must take on responsibility. So I think by trusting the student to do the banking, the parent is instilling a necessary sense of responsibility in them," she argues.

Dr. Ndaba urges parents to leave the banking to students and instead demand for accountability.

"Once you give the student the money to go and bank, the same day they should bring the bank receipts to you.

"For the case of Mubs and Makerere, we usually offer registration cards after the student has presented valid bank slips confirming payment. So your child must soon accompany the bank slips with university registration cards." She urges parents to be more vigilant in keeping tabs on their children. She adds, "You must even know the hostel or hall your child is staying in. Make it a point to check their results each semester". This way you know how everything is moving and you are aware of any retakes that may stop them from graduating if any. This makes it possible to counsel them in time, before even the final year. And if in the end they fail and can't graduate, at least you will know the facts and won't fall for an illusion of a degree."

2.4 IT Security in Higher Education

According to Analysts, the Higher Education sector is the most breached of any industry. IT security is a hot topic these days, especially at colleges and universities. An April 2008 Symantec Global Internet report noted that the education sector experienced more IT security breaches than any other industry. What's more, the number of higher education breaches and institutions affected continues to rise, as schools are under greater pressure to collect more and more student data. Between 2006 and 2008, the number of incidents reported by schools grew by 101 percent, and during that same period, the number of institutions affected rose by 173 percent. As recently as February 2009, the University of Florida reported an exposure of 97,200 student records, all of which contained names and Social Security Numbers.

Statistics like these in the education sector – as well as the increasing number of breaches in other industries – have garnered a great deal of publicity and have generated cause for alarm. There has been tremendous growth in the field of IT security training, as organizations of all sizes struggle to find professionals to help them address the challenge. There are a myriad books on IT security on the market, and the list grows monthly; and many colleges, universities, and technical schools now offer a degree or certification in IT security.

In December 2008 Gartner Group Survey found that "the role of the chief information security officer (CISO) is no longer rare, but many institutions have yet to formalize the role and the title. Policies and support for educating the community are also still evolving. Work still needs to be done, if security is to be viewed not as an IT problem, but as an institutional problem that needs addressing."

The Gartner survey's key findings include the following:

- "The need for a security officer is now recognized and supported by more than 60 percent of institutions.

- "The risk of losing important data is still a more important business driver for security compared to financial risks.

"Calculating the cost of security breaches and attacks is rare. More than 75 percent of institutions have not even calculated the cost of mobile PC thefts, which should be less difficult to calculate" (higher-education-whitepaper: www.information.Rapid7.com, 2015).

2.5 Universities and Information Security

Universities and higher learning education institutions all over the world have continuously moved away from the traditional file system to more automated computerized information systems. The systems used in various universities have been given various identifying names and acronyms but the core functionality of these systems remain, Academics Records Management information systems, Health Information management systems, Alumni Information management systems, Finance information management systems and many others. The implementation of all or some of the systems varies between the needs of the university and the costs of implementation of a given system.

Information security has been known to be inadequate on university campuses and this has been blamed on mainly the lack of information security awareness for both students and staff [George, North, and North, 2006].

In a study on IT Security Governance, Strategy, and Practice in Higher Education John et al [2003], the authors suggest a number of reasons why universities are unable to keep up with the information security best practices that are recommended for industry. Some of the mentioned challenges are discussed in the following section;

2.5.1 Centralisation vs. Decentralisation

Many institutions operate in a decentralized mode of operation, the schools and colleges with in the university are given autonomy of operating their own IT systems. Some schools and colleges get donation and grants from donors and government which they choose to manage separate of the central ICT infrastructure John et al [2003]. In this case the proper management of such decentralized systems is not very easy. It is not possible for the security administrator to easily know which systems are at risk. This can also be partly blamed on the fact that some institutions do not have organized ICT departments and data centers to work as central distribution points for ICT resources. The enterprise is different in this regard with one central data centre to manage the needs of the entire enterprise. Even in cases where the enterprise spans different geographic areas, there will be efforts to manage the ICT resources centrally.

CHAPTER THREE:

METHODOLOGY

3.0 Introduction

This chapter contains the methodologies used to obtain the perspectives of the respondents towards the study during data collection. A research design encompasses the methodology and procedures employed to conduct research.

3.1 Research Design

A research strategy is an ordered set of steps followed when inquiring into a phenomenon being investigated. In research we often refer to two broad methods of reasoning as the deductive and inductive approaches (Trochim, 2006).

3.2 Research Methods

The research adopted a descriptive research design. This involved both qualitative and quantitative approaches. According to Gall (1993), this design allows the study of different subjects at one point in time. This design generates quick self-reports from the selected participants under study. The quantitative technique was used to collect and analyze data from stakeholders while the qualitative approach was used to assess the significance of other variables.

3.3 Data Collection Methods

The researcher used both primary and secondary data collection methods to collect relevant data. Different data collection methods were used to collect required data for 'online academic document verification system'. These included the following

3.3.1 Document Reviews

This method involved reviewing existing documents that were published by different authors, organizations, and experts, like journals, papers, text books, websites articles. This helped the researcher to identify the strengths and weaknesses of the already existing document verification system. Reference to text books and websites articles that was used in establishing the missing link in the available paper based verification system was made.

3.3.2 Interviews

In this requirements gathering technique, two types of interviews were adopted. Closed interviews with a predefined set of questions and open interviews were used. The researcher interacted with respondents through planned meetings. This method was used since it allows personal contact (face-to-face discussions), it is flexible and adaptive and the researcher can probe for more details in case something is not clear. The researcher interviewed a total of 20 people. These included 10 staff, 5 students, and 5 alumni.

3.3.3 Observation

This includes physical observation and study of the current academic document verification system at Nkumba University. The researcher was in position to observe critically how the current system was utilized during the verification process. This technique was necessary in validating interview results. This technique helped the researcher to obtain first-hand information and it also reduced on errors since it gives a clear view of what is happening.

3.4 Ethical Considerations

While conducting the research, the researcher followed ethical standards to plan, collect, process, interpret and report data in line with the conventional research norms. The objectivity and interviewees' confidentiality was respected. Some of these included:

- Respect to human dignity and secure informed consent from the interviewees.

- Keeping acquired information confidential and only used for research purposes only.

- Respecting the principle of academic integrity by acknowledging the sources of information.

3.5 Limitations of the study

During the research study, different problems were encountered among which included the following;

The main challenge was unwillingness of the user to provide information on how they verify transcripts. It was considered as very sensitive and confidential information to the university. After talking at length with the users some agreed and others refused completely.

Some interviewees weren't willing to answer some questions while others never had time for an interview

CHAPTER FOUR:

SYSTEM ANALYSIS AND DESIGN

4.0 The Current System

Up to the time of the study, Nkumba and thereafter, periodically receives requests from several sources, requiring verification of its academic documents. The sources of the requests include but are not limited to public and private institutions, employers, and alumni preparing for some job or study prospects. Typically, the requests involve presentation of copies of certificates and transcripts mostly hard copies but only occasional soft copies. An institution agent may call or be called as part of the verification process.

How Verification is Carried out Currently

The following scenarios take place:

a)   Alumni return to have their certificates and transcripts verified;

b)   Employers/employment agencies request to have a verification without involving the

applicants; Law enforcement agencies, service agencies e.g. National Council for Higher

Education (NCHE), Uganda National Examinations Board (UNEB), electoral

commission, military commission, medical service commission, and other institutions

These parties initiate communication to request academic documents verification. The institution places some requirements as follows:

a)   A fee is required - payable per copy verified;

b)   Copies of documents to be verified are submitted physically or electronically.

An agent of the Academic Registrar's office at the level of an administrative assistant receives hard copies or retrieves soft copies sent and prints them out. This must be accompanied by evidence of payments for documents received as hard copies. The hard copies are delivered to the deputy Academic Registrar to be certified, a process of matching the copies with original records at the office. In most cases, the copy may be stamped, but rarely some employers or other institutions may just need an email confirmation from the University's official email.

The entire verification process may take from tens of minutes to weeks, depending on the availability of the officers responsible and also how patient the requesting party is.

Some of the weaknesses found with the current verification process include delay since it depends on the availability of the officers, especially the stamp bearer. The process is labor-intensive considering the amount of searching to locate the security records of the document copies. The process is also repetitive since every instance of request for verification comes at a different time, must go through the same steps. This is compounded by the existence of different graduations associated with each certificate and transcript.

There are high costs involved in terms of travel, especially where the verification process is not done in one day. Another weakness is that the security of the stamp cannot be guaranteed since it can easily be forged or misused.

4.1 System Requirements Definition

The system must be able to provide a dynamic way of handling the document verification operations. The available information should guide users on the available services by stating to

them all necessary pre-requisites. The requirements need to be defined as functional and non-functional requirements of the system.

4.2 Functional Requirements

Functional requirements refer to all relevant external system output behavior notably: consistency, unambiguousness, non-redundancy, and non-contradictory with reference to the way the system presents to the users. These specific statements describe the prototype to be provided and how it should react to particular inputs.

The following are some of the inputs sources:

a)   The User, who might be any of these: employer, parent, or other interested party

User login shall not be required

Users are required to enter a valid Transcript Serial number/full examination index-number in the adjacent verification text input box provided, and on pressing the verify-button, receive instant feedback in from of the academic document details. The electronic internal copy of the particular transcript can also be displayed. Moreover, the displayed internal copy is strictly read-only.

b) Administrator

The Administrator may login in order to perform management functions such as adding more graduates, uploading their documents and copies of their photographs and other data manipulations.

4.3 Non-Functional Requirements

The non-functional requirements refer to the system quality attributes which enable the system to carry out and fulfill functional requirements. Some of these requirements include:

System speed: Given the time driven environment of the users of the system, the system should be fast enough to satisfy the online users.

Output presentation: The system shall have a selective search function so that only those results that satisfy the search clue input by the user are displayed. The system shall as well be able to present its output in an orderly and user friendly manner.

System availability: The system should be available 24/7 being an online based system so that the users can access at will. The system should be user friendly in order to support users with varying levels of experience. The system should allow users to successfully accomplish the process of document verification, updating, deleting, uploading and finally printing of reports that can be used to support management's decision making process.

System accessibility: The system should be accessible by the authorized people and should require user membership to use it and should it have a minimum number of people operating it. The system should be also able to provide access to multiple users at the same time with different capabilities according to their access privileges and permissions.

System Security and Integrity: The system should be designed in such a way that it is protected from abuse by unauthorized persons. Only authorized persons should input and manipulate the data. The system should measure to high security to prevent unauthorized users from accessing or corrupting the database or system. The system should be accessed in an authentic way by authorized users. It should also ensure that accurate, complete and valuable information is not modified without authorization. The system should also be in position to keep log of all system changes.

Modifiability: The system components should have the ability to be reconfigured, re-engineered, or replaced with more advanced components if initial use proves ineffective.

Interoperability: The ability of the system or its components to interface or work with other systems or products. The system should provide a mechanism to integrate with other systems.

4.4 Architectural Design of the Prototype

The system briefly consists of four components in this design: verification and issuing application include the security level, a local database adopted by MySQL as a Database Management System (DBMS).

Figure 1: System Architecture Context Diagram
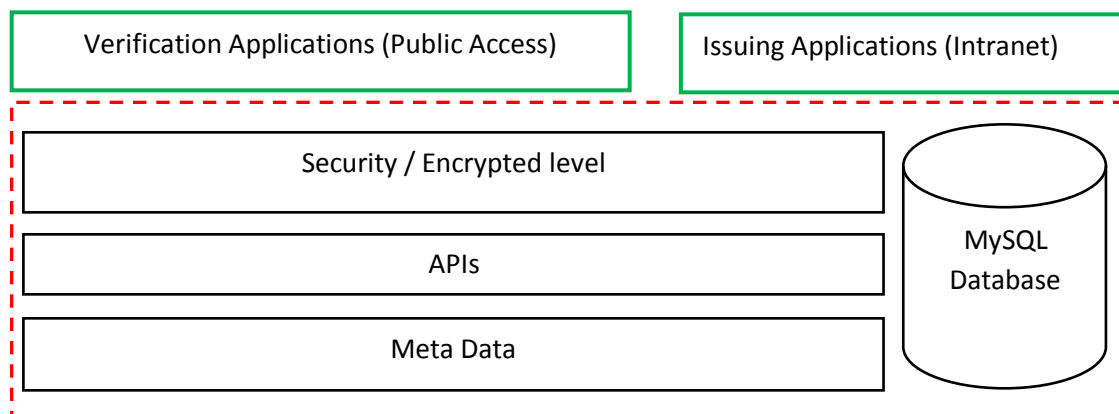
The issuing applications are responsible for the main business logic which includes the certificates printing, examining, signing, issuing, and uploading into the system database. The issuing applications are designed to restrict access to access to the database to only intranet authorized users. Also, the issuing applications deal with the revocations of certificates.

The verification application focuses on checking the authenticity and integrity of the certificates that have been issued basing on the entered serial number. It includes one main component: a

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web-based page / application. They use the same mechanism, and fetch the transaction message through the system API and compare the transaction message with the verification data from the receipt. The mechanism can be briefly described in the following way: check the submitted serial / index-number is valid; match the submitted data with the local stored certificate data; confirm the match by displaying the search results / report; MySQL database was employed since its open source, easy to use and provides high availability and scalability.

4.5 Database Design

A database was designed to contain two categories of data: the public authentication data and the private certificate data. The public authentication data, available to the public help to verify a particular academic document, whilst the private certificate data are stored in the MySQL database where it is securely protected and isolated within the intranet. Data manipulation can only happened from within the intranet access.
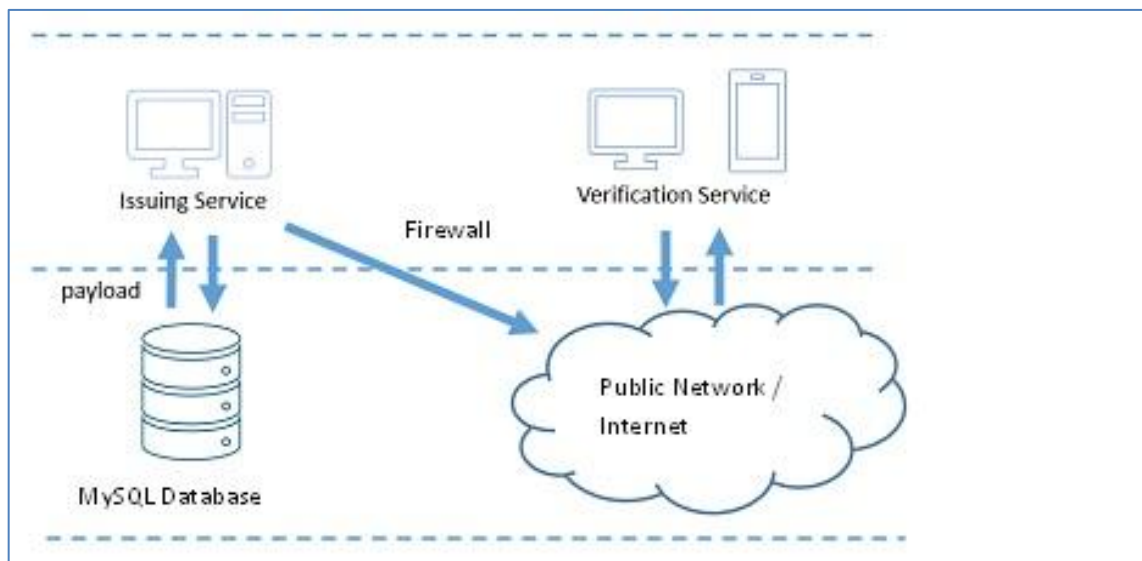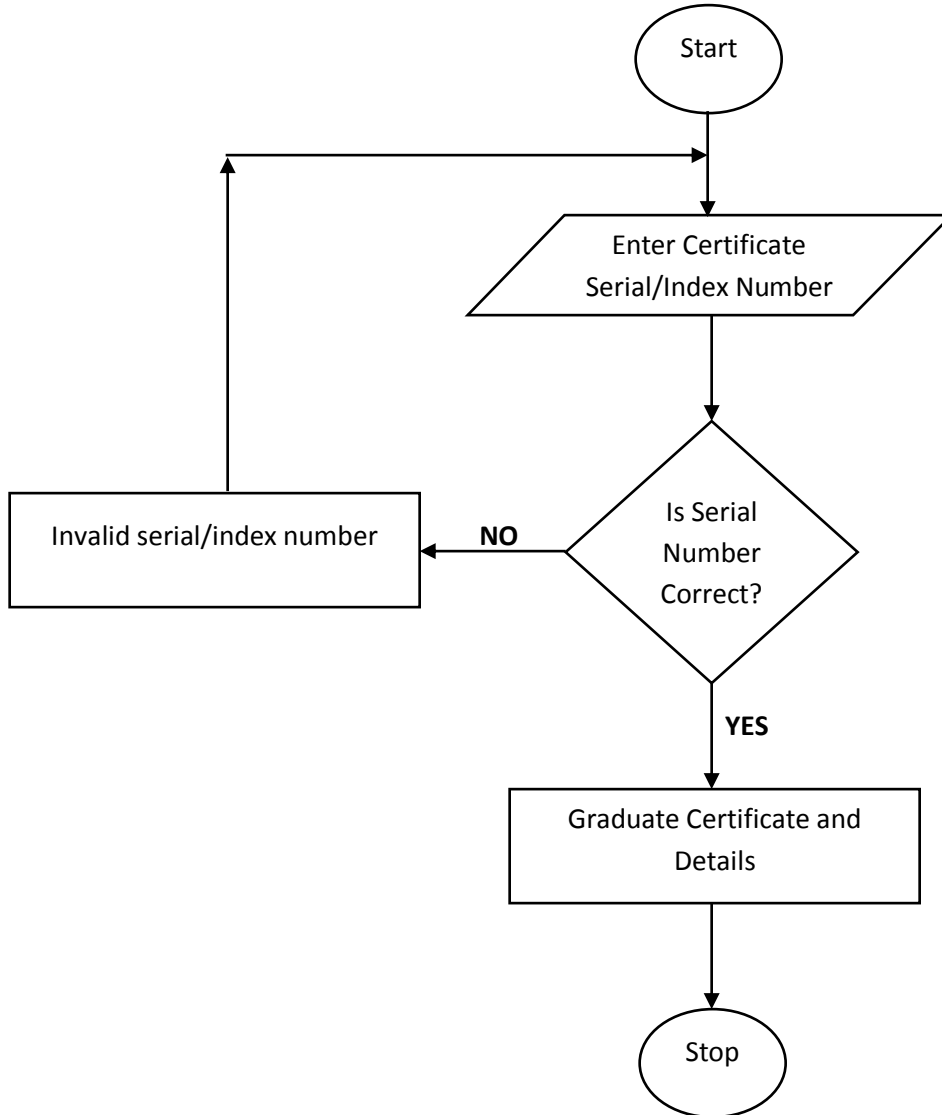
Figure 2: Database Architecture

Figure 2 above maps out the top level data flow diagram, it shows that the data flow is unidirectional from the internal areas to the internet (public Network). The issuing system uploads the certificate details to MySQL Database and broadcasts its "point" data to the public access section / less restricted section of the database. The verification service only needs access to the public access section to check the authenticity and to verify the certificate.

The System Flow Chart

Figure 3 below, when the user accesses the system for transcript verification, he/she is required to enter a valid transcript serial number or index-number in the provided verification input box. On pressing the verify button, the system runs a search query on the database basing on the input data. During this process, the system is making a comparison to find a matching record, failure to find a matching record, the system gives an error feedback to the user otherwise the transcript and the graduate details are displayed matching the user search terms.

Figure 3: System Flow Chart

```
                              ┌─────────┐
                              │  Start  │
                              └────┬────┘
                                   │
    ┌──────────────────────────────┤
    │                              ▼
    │                    ╱─────────────────────╲
    │                   ╱   Enter Certificate    ╲
    │                   ╲  Serial/Index Number   ╱
    │                    ╲─────────────────────╱
    │                              │
    │                              ▼
    │                            ╱─╲
    │                          ╱     ╲
    │                        ╱  Is Serial ╲
┌───┴──────────────┐   NO  ╱    Number     ╲
│ Invalid serial/  │◄──────   Correct?      │
│ index number     │        ╲              ╱
└──────────────────┘          ╲          ╱
                                ╲      ╱
                                  ╲  ╱
                                   │ YES
                                   ▼
                        ┌─────────────────────┐
                        │ Graduate Certificate│
                        │    and Details      │
                        └──────────┬──────────┘
                                   │
                                   ▼
                              ┌─────────┐
                              │  Stop   │
                              └─────────┘
```

4.6 Logical Database Design

Logical design involves arranging data into a series of logical relationships called entities and attributes. An entity represents a chunk of information. In relational databases, an entity often maps to a table. An attribute is a component of an entity and helps define the uniqueness of the entity. This is used to translate the conceptual representation to the logical structure of the database, which includes designing the relations.

Identified Entities

Below are some of the main tables from the designed prototype. These are used to stored captured information about graduates.

a) **Student Records Entity**

Table 1 below, shows the entity used to store graduates records required to process user requests during transcript verification

Table 1: Student Records Entity

FILED NAME	DATA TYPE	DESCRIPTION
StdID (Pk)	Integer (30)	Student ID (Auto-number)
Names	Integer (35)	Student's Name
Gender	Integer (6)	Gender
DOB	Date	Date of Birth
Nationality	Integer (20)	Nationality
indexno	Varchar (25)	Student's Index-number
programme	Integer (25)	Study Programme
school	Integer (45)	school
intake	Varchar (10)	Intake
stdimage	Text (30)	Student's Image/photo
serialno	Number (12)	Transcript Serial Number
transcript	Text (25)	Copy of Transcript

b) User Entity

Table 2 , shows the entity used to store system users details. The entity stores details

of an Administrator and other users including their login credentials.

Table 2: System User Entity

FIELD NAME	DATA TYPE	DESCRIPTION
UserID	Integer (10)	User ID (auto number)
UserName	Integer (20)	Name of User
password	Varchar (20)	User Password
User_Status	Varchar (15)	User Status

4.7 The Conceptual High Level Model for the developed prototype

Figure 4: Conceptual High Level Model for the developed prototype
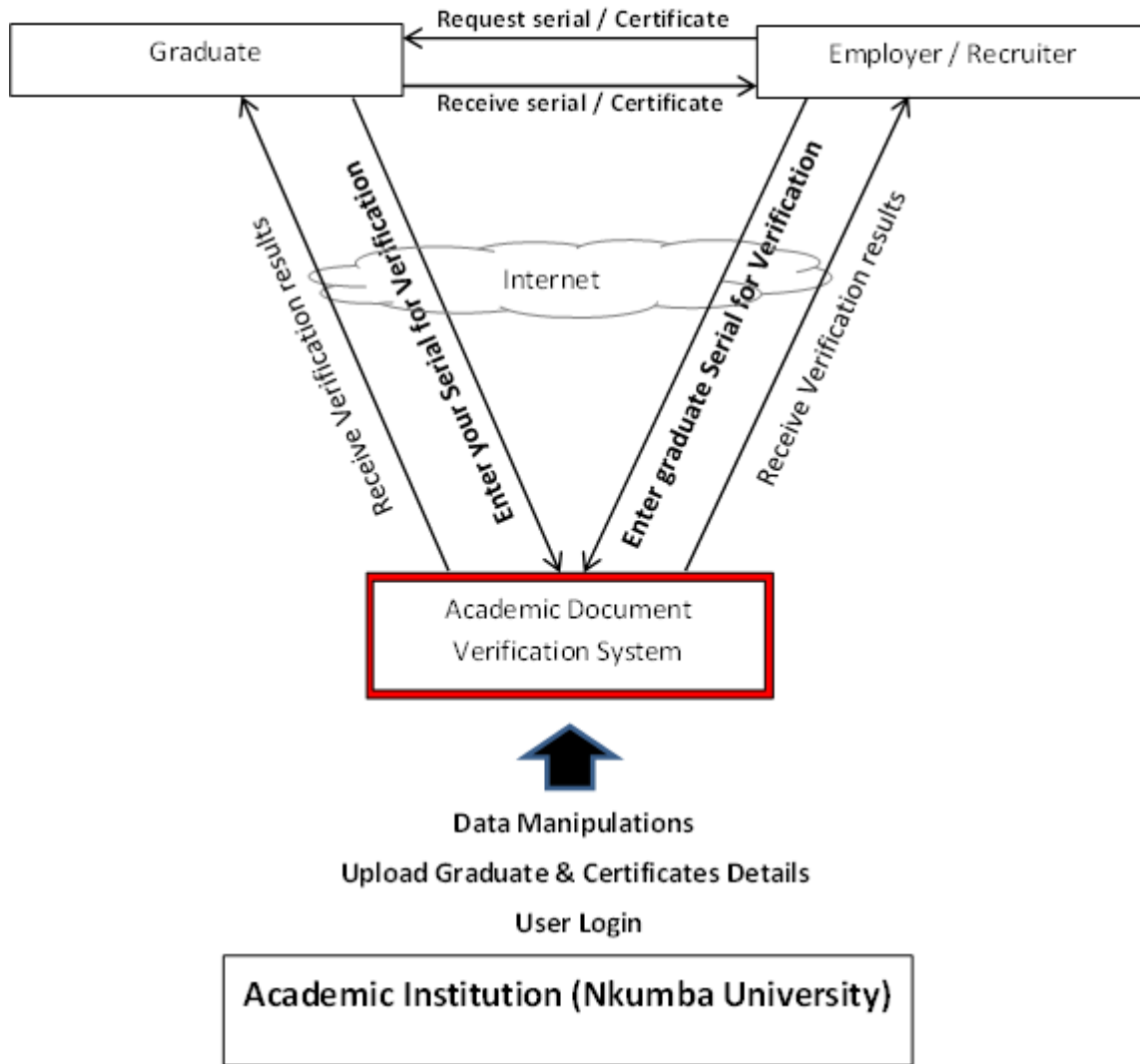
Role of Each Component

The following explains the role and interactions of each component as shown in the conceptual

High Level Model above.

- **Academic Document Verification System**

The Academic Document Verification system is an application for academic document/certificate verification. It is hosted on the server for public access. The service is available for:

- ❖ Employers
- ❖ Parents / Guardians
- ❖ Consultancies
- ❖ Recruiting agencies

- **Potential Employers / Recruiter**

These are people or recruiting agencies that wish to employ the graduates' (certificate owner). Their interaction with the system involves the following.

- ❖ They must get serial / index-number from the certificate
- ❖ Verify the academic document in question by entering the serial number in the search box on the system.

- **Graduate (Certificate Owner)**

These are the owners of certificates who wish to have them verified for an opportunity before them. The owner of certificate must provide the interested party with either the serial number or a copy of the academic document.

Use case Scenario

A case is a view of the functionality (or use) of a prototype from user's perspective. The use case scenario mostly represents a particular instance of the prototype.

Use case 1: Certificate Verification

The user enters either the certificates serial number or index-number in the search box of the prototype and proceeds with verification by clicking the verify button. The user can either be students, recruiters, employer, or parent/guardian.

In figure 5 below, the employee receives a transcript serial / index-number from the graduate. On accessing the system, the employee enters either the serial / index-number in the verification box provided on the system, on pressing the verify-button; the system searches the entire database for a matching record. After a successful search, the graduate details and a copy of the transcript are displayed on the user screen as feedback otherwise, an error message is displayed with instructions. For all this to happen, the university must have uploaded the graduates' details to the system database.

Figure 5: Use case 1: Certificate Verification

1. Transcript Serial & Index Number

Employer

Graduate / Transcript Owner

2. Reply / Feedback

3. Enter Transcript Serial / Index Number

Prototype System (**ADVS**)

MySQL Database

Nkumba University (**NU**)

Uploading Graduate Data
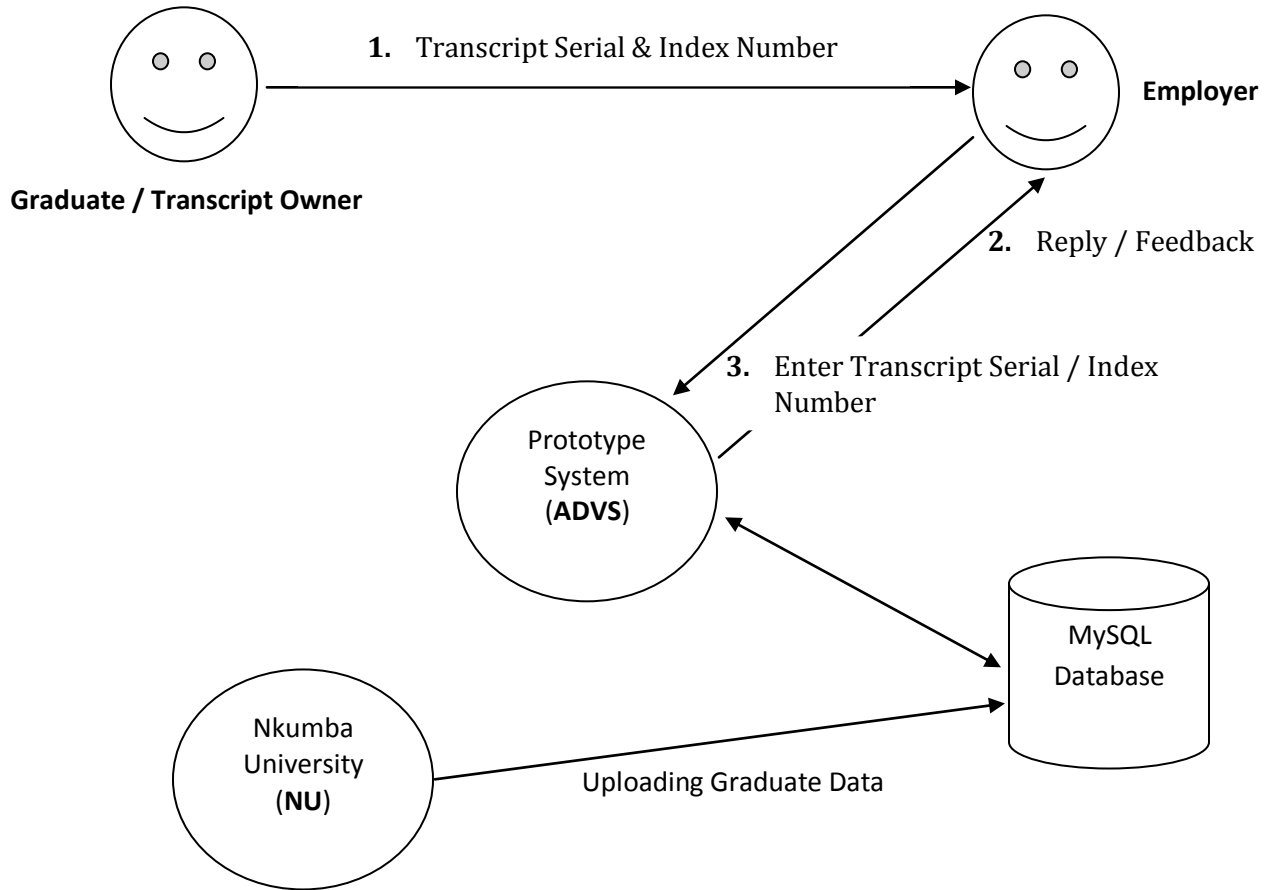
4.8 Modules in prototype

Model-View-Controller

Model–view–controller is an architectural pattern commonly used for developing user interfaces that divides an application into three interconnected parts. This is done to separate internal representations of information from the ways information is presented to and accepted from the user (Burbeck, 1992) . The MVC design pattern decouples these major components allowing for efficient code reuse and parallel development. MVC is also used for desktop graphical user interfaces (GUIs), this architecture has become popular for designing web applications and even mobile, desktop and other clients.

Figure 6: Model-View-Controller
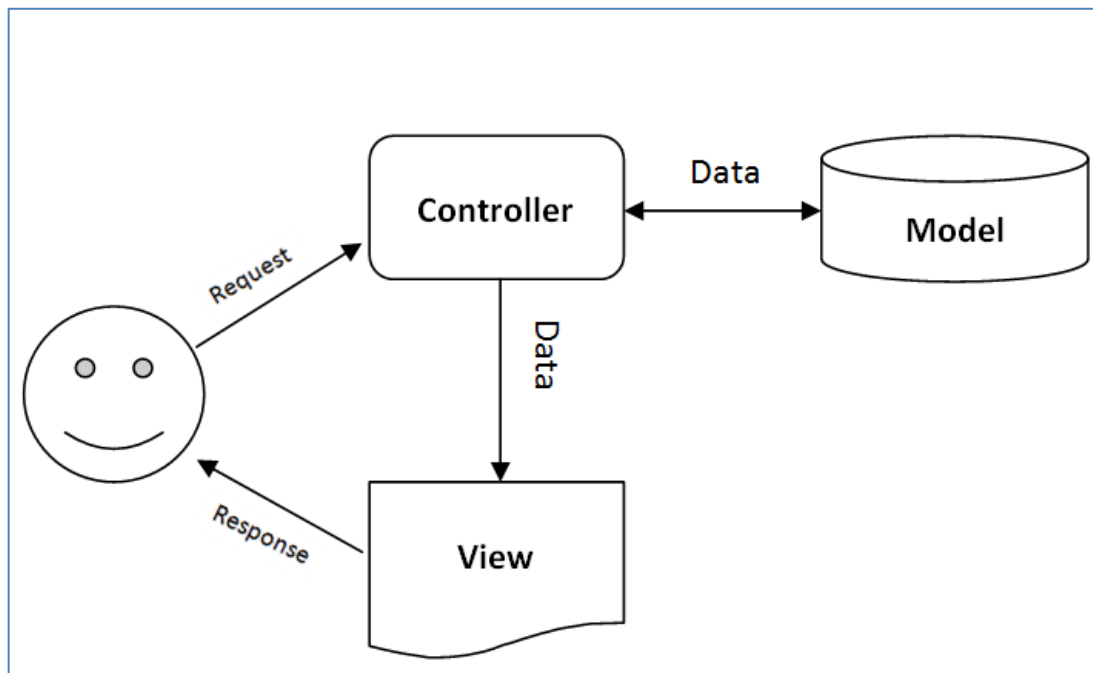
The components are briefly described below:

The model is the central component of the pattern. It is the application's dynamic data structure, independent of the user interface. It directly manages the data, logic and rules of the application. The model is responsible for managing the data of the application. It receives user input from the controller.

A view can be any output representation of information, such as a chart or a diagram. Multiple views of the same information are possible, such as a bar chart for management and a tabular view for accountants. The view means presentation of the model in a particular format.

The controller accepts input and converts it to commands for the model or view. The controller responds to the user input and performs interactions on the data model objects. The controller receives the input, optionally validates it and then passes the input to the model. It's the brains of the application, and ties together the model and the view.

4.9 Design Framework for the System Prototype

In figure 7 below, The Academic Document Verification system is made up of a client side interface for the users. The prototype was built using the PHP framework that uses MVC (model-controller- view). It uses PHP programming language. The MVC Code igniter application chart showing the flow of data is illustrated below:
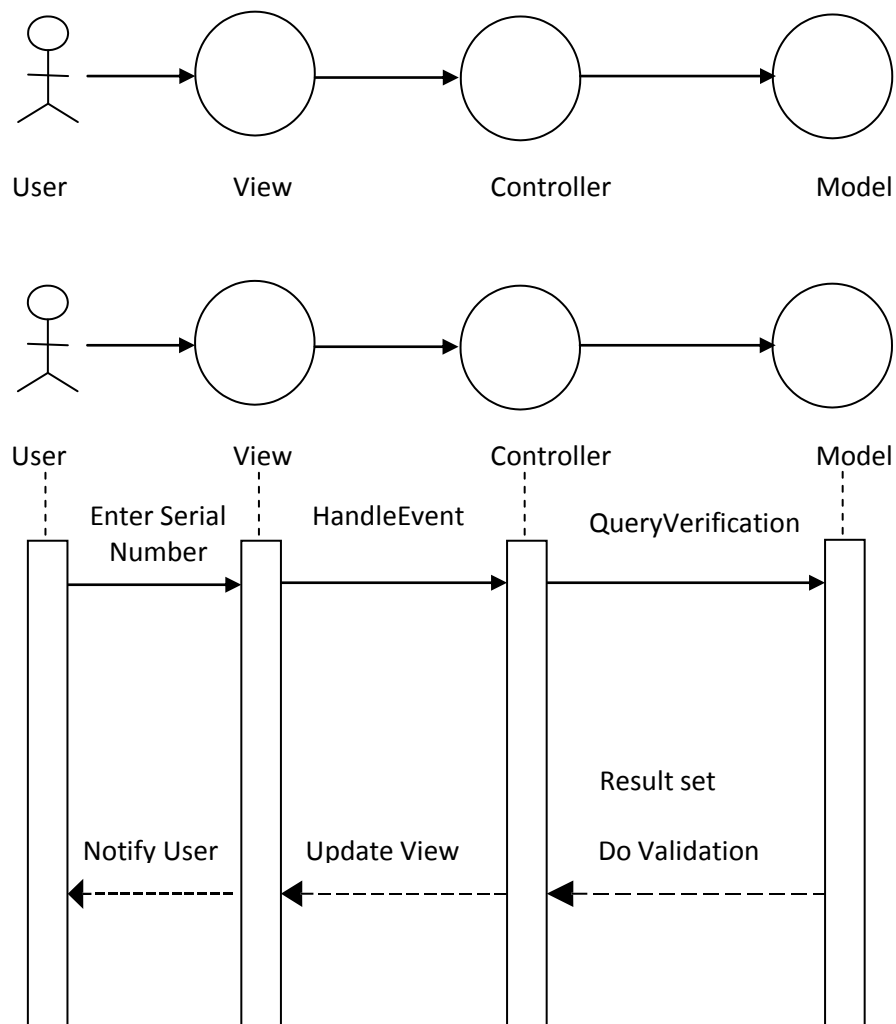
Figure 7: Application MVC flow chart
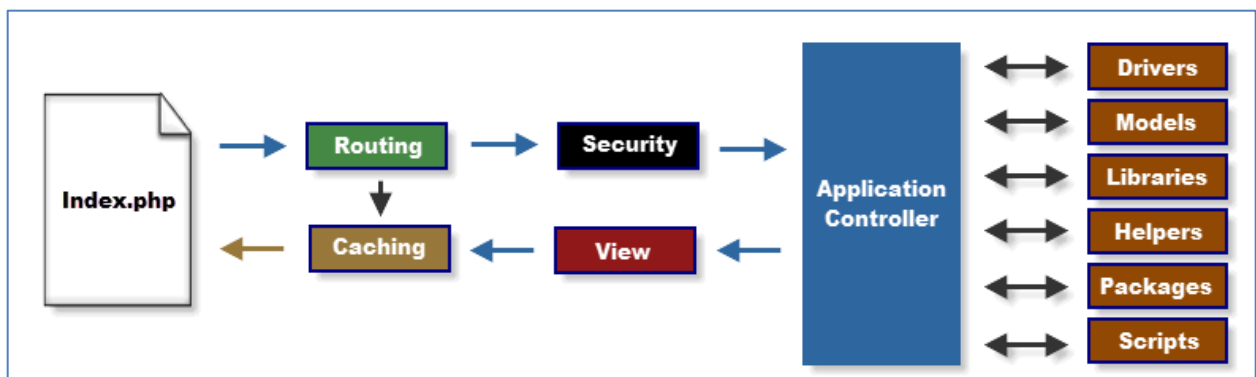
4.10   Sequence Diagram for MVC

Figure 8 below shows that User initiates a query requesting for verification, an event is generated that is handled by the controller, set information that is needed from the model validates the information and passes back the results set to the view.

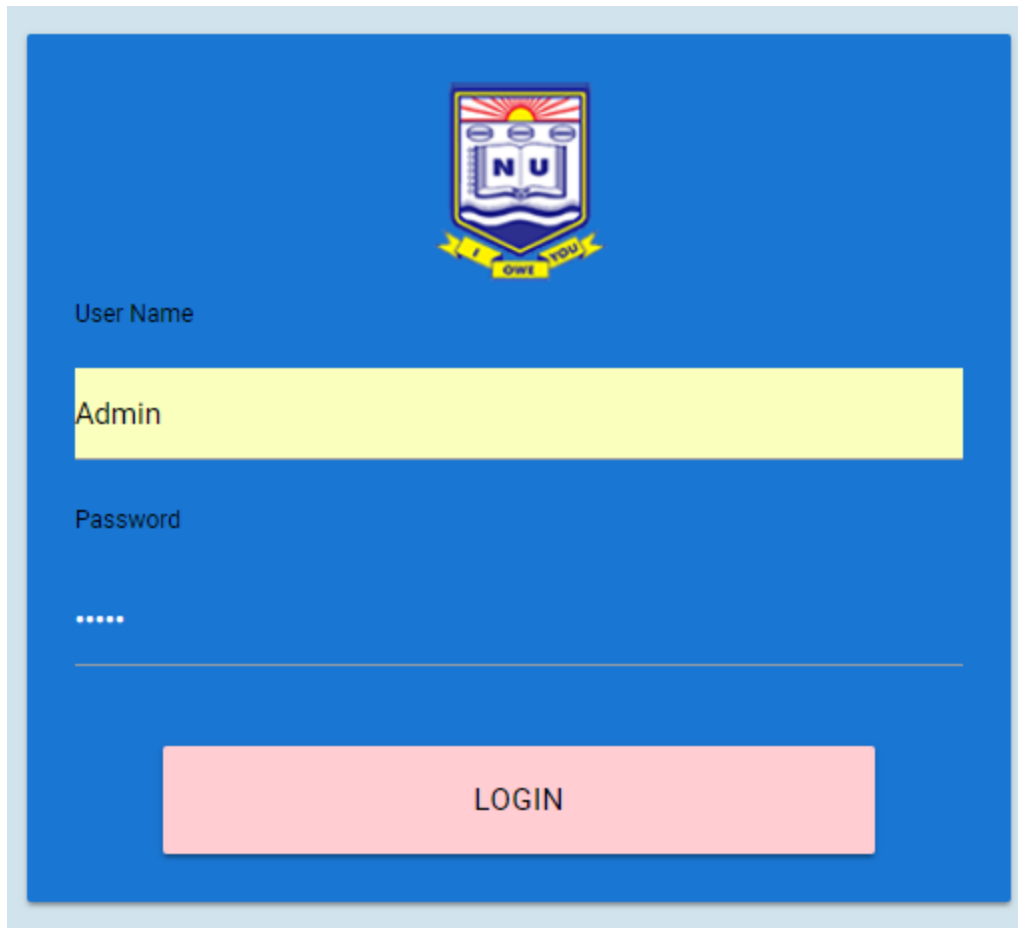**Figure 8: Sequence Diagram for MVC**

4.11   Test Process

The main objective of the prototype is to be able to verify the student's academic records by matching them with the uploaded copy in the systems database basing on the search results.

- The institution awards and issues academic documents to a student after graduating. Every issued document bears a unique index/registration and serial number

- The institution uploads a copy of the issued academic documents into the verification system's database

- The user accesses the system and enters or searches using either an index/registration number or the serial number. The system can use both serial and index number.

- On a successful search, the student's details are displayed on the screen otherwise an invalid / try again message is displayed.

System Login

Figure 9, shows the login interface for the system. System Administrators must login to have access to the system in order to carry out administrative functions.

Figure 9 Screen Shows verification system login
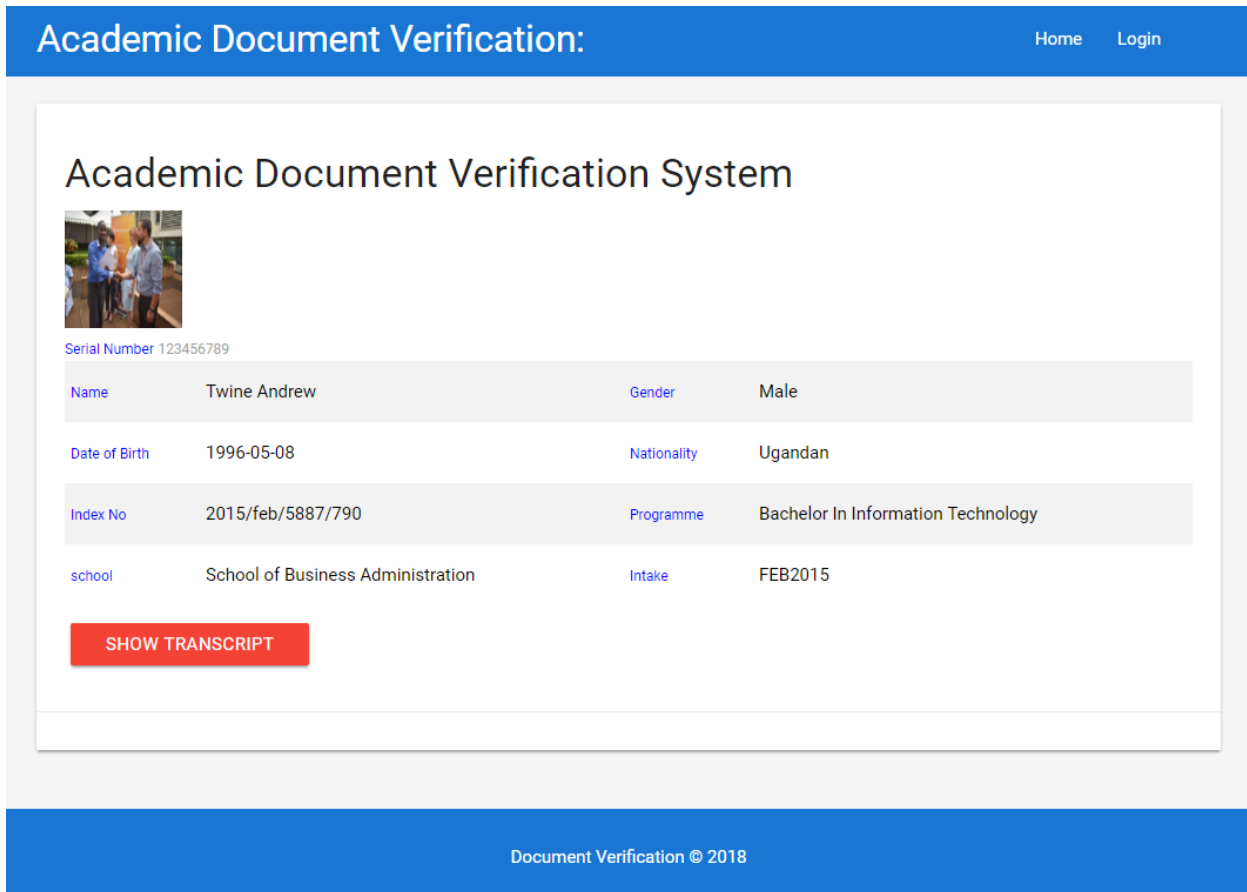
System Results Page

Figure, shows results of a verified academic transcript. On entering a valid serial number, details of the document in question are displayed on the screen.

Figure 10: Screen Shows verification Tests results

CHAPTER FIVE:

CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter presents the conclusion and recommendations derived and drawn from the research after having presented, analyzed and discussed the findings of the study and also suggests future work/ research.

5.2 Achievements

The following were achieved as per the objectives set in chapter one

To investigate the current verification system of academic documents at Nkumba University

The researcher collected enough data about the old manual system through questionnaires and interviews. Observation was also used to see how officers handled the verification of documents. From the data collected, it was found out that the verification officer had to always go through archives to trace for stored copies of the documents awaiting verification. The collected data was used in designing a secure academic document verification system.

To examine the relationship between implementation of various security levels in the verification process and the public

From the gathered data, it was found out that no-matter the various security levels integrated in different papers used to print academic documents, anything can be forged. The design of a

secure academic document verification system is an alternative security level to harden the security and eliminate the forging of university documents.

To enable verification system accessibility to the public

The designed prototype is a web-based online system which makes it accessible from anywhere as long as one has an internet connection. The system has two interfaces; User and Administrator. Apart from the Administrator interface, the user interface does not require one to login in order to verify academic documents and certificates.

5.3 Finding

According to the evaluation and tests carried out it was concluded that verification of academic certification is necessary and can eliminate fake academic documents and certificates if adopted by Nkumba University and all other institutions of learning in Uganda and in other East African states. The results suggested that the prototype was helpful in verification of academic documents. It showed that organizations attitude and perceived usefulness both directly drive the usage intention. The finding highlighted that institutions of learning, organizations and employers have the ability and willingness to use this technology to protect their quality and image.

5.4 Challenges and limitations

The main challenge was unwillingness of some officers in the verification process to provide information on how they verify academic documents / certificates. The information was considered very sensitive and confidential. Others included the following:-

Limited resources to acquire different technologies and to host the system for online testing, the researcher had to use open hosting services to test the system.

The researcher also had limited time to develop and test the system for accuracy, consistency, and efficiency.

In spite of all the setbacks, the study was carried out and the best possible solutions were adopted to ensure that it is completed for instance unwillingness to reveal secrets of the verification process to a student.

5.5 Recommendations

The researcher recommends that a more elaborate and extensive research be done on the developed document verification system on how it can be advanced. Research can be made on how some cryptographic protocols like multi-signature and trusted federated identity can be integrated into the system to advance its security.

The multi-signature scheme most notably increases the difficulty of forging owing to the fact that each issuing progress is obliged to be signed by the majority of the academic committee members. On the other hand, Trusted federated identity innovatively proves the authenticity of the certificate through the trusted path and federated identity

A series of security assessments should be conducted from the perspective of operational safety, network security, data security, and protocol security since the system has to be deployed on the public network for public access. Basing on the assessment report, it will be determined whether the system is secure enough to meet the university's security standards.

After successfully testing, the researcher recommended that the prototype be adopted by Nkumba University and other institutions of learning. The system can also be integrated with the institutions' Students Records Management System or Academic records system for better results and direct update of the database.

5.6 Future Work

To advance and to increase the usability of the system in learning institutions and organization, the following may be considered for future implementation;

More research on different security and cryptography technologies in the related field should be conducted.

More development on a wider scope should be incorporated into the whole project to ensure that the solution is all rounded to handle the verification process for different institutions.

5.7 Conclusion

From my research, I clearly state that fake academic documents are produced everyday targeting different institutions of learning in Uganda. This tarnishes the reputation of these institutions and Uganda's education system whenever they are identified or not. I have no doubt that my research has as well contributed positively towards controlling if not eliminating the fake academic documents. Recruiting firms and employers will not only base on the presented documents to recruit the document bearer but will also be in position to verify and authenticate these documents themselves by a single click. It is hoped that when the developed system is implemented, the occurrence of counterfeit certificate will be greatly reduced.

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APPENDICES

APPENDIX 1: INTERVIEW GUIDE

Interview Guide

The following are the Interview guide Questions

1) How is the academic document verification process handled?

2) What is involved in the verification process?

3) What are the requirements to have a document verified at Nkumba University?

4) How long does it take to have documents verified at Nkumba University?

5) How do you rate the security of the produced transcripts with the current verification system?

6) What do you think about the current verification system?

7) How accessible is the officers responsible during verification process?

8) Do you have any suggestions on how to enhance the security of the produced transcripts?

APPENDIX 11: OBSERVATION CHECKLIST

Observation Checklist

- ❖ How the academic document verification process handled and what is involved

- ❖ Who handles the verification process and when

- ❖ What is involved in the verification process?

- ❖ Requirements for transcript verification

- ❖ How long does it take to have documents verified at Nkumba University?

- ❖ How is the security of the current verification system

APPENDIX 111: SAMPLE CODE

```html
<html>

<head>

 <!--Import Google Icon Font-->

        <link href="https://fonts.googleapis.com/icon?family=Material+Icons" rel="stylesheet">

 <!--Import materialize.css-->

        <link type="text/css" rel="stylesheet" href="css/materialize.min.css" media="screen,projection"

        />

         <link type="text/css" rel="stylesheet" href="css/main.css" />

 <!--Let browser know website is optimized for mobile-->

        <meta name="viewport" content="width=device-width, initial-scale=1.0" />

        <title>Document Vefication</title>

</head>

<body style="background-color:#d1e3ec;" class=" lighten-3">

        <nav class="blue darken-2">

        <div class="container">

         <div class="nav-wrapper">

        <a href="index.html" class="brand-logo">Dcument verification </a>

    </div>

   </div>

 </nav>

<section class="section section-login">

  <div class="container">
```

```html
<div class="row">

  <div class="col s12 m8 offset-m2 l6 offset-l3">

    <div class="card-panel login blue darken-2 white-text center">

      <span style="width:100;height:100px; "><img class=" bordered responsive-img" src="img/logo.png"style="width:100;height:100px;"  ></span>

      <form action="log.php" method="post">

        <div class="input-field">

          <!--<i class="material-icons prefix">email</i>-->
<label class="black-text" for="email">User Name</label><br>

          <input type="text" id="email" name="username">

        </div>

        <div class="input-field">
<label class="black-text" for="password">Password</label><br>

          <!---<i class="material-icons prefix">lock</i>-->

          <input type="password" id="password" name="password">

        </div>

        <input type="submit" value="Login" class="btn btn-large btn-extended red lighten-4 black-text" name="login">

      </form>

    </div>

  </div>

 </div>

</div>

</section>
```

```html
<!-- Footer -->

<footer class="section blue darken-2 white-text center">

  <p>Document Verification&copy; 2018</p>

</footer>

<!-- Preloader -->

<div class="loader preloader-wrapper big active">

  <div class="spinner-layer spinner-blue-only">

    <div class="circle-clipper left">

      <div class="circle"></div>

    </div>

    <div class="gap-patch">

      <div class="circle"></div>

    </div>

    <div class="circle-clipper right">

      <div class="circle"></div>

    </div>

  </div>

</div>


</body>


</html>
```