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Automating School Fees Transactions in Nigerian Universities and Tertiary Institutions: A Systems Engineering and System Management Approach

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AUTOMATING SCHOOL FEES TRANSACTIONS IN NIGERIAN UNIVERSITIES AND TERTIARY INSTITUTIONS: A SYSTEMS ENGINEERING AND SYSTEM MANAGEMENT APPROACH

Loyola Marymount University,

Systems Engineering Leadership Program

Capstone Project

Abstract

This project uses system engineering and system management principles to analyze the problem of transactions in Nigerian universities and tertiary institutions. System management principles shall be used to highlight the imperfections in the transaction method currently in use especially the disconnect between the bank and the institutions using their services. It will explore other payment systems available in the country. This project will provide a recommendation of how to implement a better payment option through automating the process of school payments by using a system with a cloud-based educational software at the school bursary office and through the online payment processing on the school website. The system software will enable cashiering and payment management: centralized data, automated reports, and inventory controls. It will generate automatic invoices and receipts. This system will bridge the disconnect between the bank and the school since students would not need to deposit cash directly into the school account but into their accounts and then pay with their debit cards. The system will provide debit card encryption and protection using the Secure Socket Layer technology.

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1. Executive Summary

Before now, people/students often embraced technological changes with the fear of the unknown and as such decided to carry out activities their usual way (manually).

However, the 21st century came with a lot of challenges that only the use of computers can solve the problem effectively. Electronic/Automated payment of student school fees in any school would boost the school management morale and therefore increase productivity. Therefore, the payment of student school fees in a particular school enhance the productivity of such school for both the management and students as well, even as a computer-based system is used for such payment for the easiest and fastest mode of operation as well as accurate security and good financial management

In 1989 ATM was introduced in the Nigerian market and the central bank of Nigeria commenced the implementation of cashless policy on January 1, 2012. Over the years, the number of ATMs in the country has multiplied. ATMs are accessible to everyone who has a bank account and those who do not. Other E-banking channels namely: internet and mobile banking platforms are fully deployed in the nation's Banking industry and are available to customers; This makes it easier for universities and tertiary institutions to adopt a cashless policy in their school transactions. Most of the infrastructures needed are already available but more needs to be done to implement cashless transaction methods in our universities and tertiary institutions. Most students in tertiary institutions receive their money through bank transfers and some are giving cash to deposit into

their bank accounts to be withdrawn later and deposited into school account, so there is a need to automate payment processes to enable cashless transaction through an automated system of transaction and when this is achieved, it eliminates the disconnect between the bank and school as well as the redundancies and risks involved in the current cash method. Currently, Nigeria has:

43 Federal universities

47 state universities

75 privately owned universities

85 colleges of education

28 Federal polytechnics

41 state polytechnics,

44 privately owned polytechnics

22 Federal monotechnic

2 state monotechnic and 2 private monotechnic

57 or more institutions affiliated to universities and a host of many other schools.

In total Nigeria has more than 446 institutions in the nation.[1]\

- This Capstone project demonstrates the application of Systems Engineering to enhance an IT process.
- Within my home country of Nigeria, advanced education institutions would benefit from an enhanced tuition management system.
    - Physical safety of students (eliminate the threat of robbery/violence)
    - Minimize time lost in manual intensive transactions
    - Provide an opportunity for additional revenue for institutions (via structured payments/time value of money).
    - Mitigate the opportunity for corruption within administrators.
    - This study employs a SE methodology to define the problem, identify key stakeholders, MOEs, alternatives, AOA, requirements/verification, et al.
- The use of key concepts from lean, ethics, and architectural design are also included in this work.
- Finally, this work addresses scholarly research that revealed specialized SE processes specifically targeted at implementing IT-centric solutions.

2. Introduction

The essence for one going to school is for better survival tomorrow wherein becoming what he or she can become what he or she wants in life. And the desire of knowledge is the natural feeling of mankind and every human being whose mind is not debauched will be willing to give all that is required of him or her to get knowledge.

It is on this basic idea that knowledge-oriented organization (school) has been set up as a ground for people to go in and learn in response to paying for their acquired – knowledge for tomorrow's success.

According to the Oxford Dictionary of Current (6th Edition), the fee is defined as an amount of money that one pays for professional services.

Simply put, the school fee is that fixed interval payment made by a student or students to the school he or she attends.

From the definition, one can outline that school fee payment is supposed to be in a regular interval that is timely, although some time may not be that ready by the student due to some financial lapses.

Financial lapses pose a lot of problems to school management because of some pressing needs. However, when students refuse to pay their school fees on time the school management seems to lack money in the purse which at this render the management ineffective.

Apart from the management being ineffective financially, students also face barriers by not being allowed to write their examinations which is one of the academic frustration or setbacks. Applying systems engineering principles with a focus on automating this payment necessitated this research to help solve this problem of the disconnect between the Bank and the School which gave rise to other numerous problems addressed in this project

Creating a platform for individual students' fees indicating name, department, registration number, level/class, date of payment, amount of money paid, academic session/semester/ bank's name, account number, phone number, school name, and other personal records, etc. This will enhance prompt payment and safe delivery and automatically stop the management and students from being frustrated financially and otherwise.

3. Key problem

There is a disconnect between the bank and the schools deploying their services. No interface for communication between the two.

Background statement

- Most schools in Nigeria require tuition to be paid to the school's account at the bank.

  - Students are required to submit a receipt from the bank to the school bursary to obtain another receipt as proof of payment before taking exams
  - The school has no way of knowing when a student pays the school fees until a receipt from the bank is submitted to the bursary
  - Payments are usually be made in full, installment payments are not allowed
  - School payments are mainly tuition and accommodation. But there are other payments like SUG, Departmental fees, ICT fees, Matric fee, Excursion fee, course registration fee, etc. paid at different times through the semester
  - Each academic year has two semesters: The first semester runs from September to February and the second semester from March to July
  - School payments extend through the semester which is typically 3 to 4 months long
  - Students are not allowed to sit for exams without paying school fees, this leads to long wait times at the bank and bursary office a few weeks to the exams

Problem statement

Unlike the Universities in the US, Nigerian universities accept only a one-time payment of school fees which could be made anytime within the semester. Payments are made with cash at the school bank, in most cases, the bank is located miles away from the school. This current method of cash transactions involves a serious disconnect between the Bank and the school and which leads to the problems we are trying to address in this project.

Problems of the current method of financial transactions can be viewed from three perspectives: Bank problems, school management problems, and the student's problem.

The bank issues a receipt (or teller in the Nigerian parlance) as evidence of a transaction. Most times, human error occurs such that the actual amount paid is not what is recorded on the receipt. There are also cases where students overpay or underpay and the bank is not aware of this due to the disconnect with the school. There are also problems arising from long wait times due to network issues or so many customers and difficulty in retrieving lost receipts

The school management at the bursary office records the receipt from the bank submitted by the students and issues another receipt to confirm the payment. Chances are their wrong documentation problems that have to do with Poor documentation due to human errors and poor processes in school financial management. Long wait times at the bursary could also be caused by understaffing

The student problems on the other hand have to do with the loss or misplacing bank receipts or school receipts. When the bank receipt is misplaced before submission to the bursary students go back to the bank to get another one and this is not going to be an easy process. On the other hand, when the school receipt is misplaced or lost the student stands the chance of being driven out of the exam hall if the problem is not rectified with the bursary office before the examination. There could also be embarrassment from the bursary department, such as wasting time, a mistake made in the receipt.

Because of cash involved in this transaction at the bank most times students are exposed to armed bandits while moving money from one bank to another because cashless payment options are not available in most schools. This process causes distractions to students due to time wasted.

There is serious redundancy in this whole process leading to significant delays.

4. Value statement/Project Goals

To take advantage of innovations like artificial intelligence you must first move away from manual processes. For that reason alone, automation should be a key short-term priority for most CIOs.

Automation isn't just about saving time or money. Done well, automation reduces errors, increases employee satisfaction by freeing staff from tedious tasks, improves the customer experience, and allows you to scale up.

Automation also forces you to address hidden problems in your processes that are normally handled by staff working around the process. That kind of routine exception handling greatly reduces employee productivity. Automated systems are also self-service systems; automating the

most common tasks in a process will free up time for staff to spend on more nuanced problems that require judgment.

Automation often starts tactically, with individuals and teams automating services and processes they use and control. By making automation a strategic priority, you can deliver automated services that individuals and teams use but don't control, thereby spreading the benefits beyond a single department. Automated, self-service systems, such as password resets and expense submissions, can be used broadly throughout the company to great benefit[2]. Automating school, the transaction will lead to**:**

Conveniences: The convenience of using an automated fee payment system is the major advantage derived by both students and management. There shall be reduced wait times.

Speed: Using an automated payment system is very fast and less prone to human errors than the manual method.

Security: Security has to do with the ability of automated systems to safeguard financial transactions and customers' information/data.

Productivity**:** Reduces workload for the bursary office

- boosts work morale
- Increase students focus on instruction

Integrity and transparency of the financial process: Automating the school transaction will ensure integrity and transparency. It will be less prone to abuse and corrupt practices.

5. Operational concept (OpsCon)

- This automated transaction system will be designed to eliminate cash transactions for students.
- The system will bridge the disconnect between the Bank and the institution
- The system will provide accuracy and security for all school transaction
- The system will provide more transparency in the school transactions
- The system will provide an easy accounting and management of school financial database

6. Review of some literary works

Some relevant literature on this project was reviewed, it intends to consider the suggestion, ideas, citations, and comments of various authors and professionals on the concept and implementation of Automated Students School Fees Payment System.

Automated Students School Fees Payment: An Overview

According to Tamuno (2003)[3], change is inevitable especially in a rapidly evolving world but as the growth, pace, and structure of an economy change so do the payment systems required to facilitate transactions in that economy. This is in line with Nigeria push to keep its payment system far with international practices and standards by leveraging on technology.

To meet up with developed nations, automated payment becomes the answer. According to Nwankpa (2009)[4], automated or electronic payment is defined as a subset of e-commerce or computerized transaction to include machine payment for buying and selling of goods and services offered through the internet.

Generally, people think of automated payment as referring to online transactions on the internet, these are forms of e-payments. As technology is developing the range of devices and processes for electronic transactions continues to increase while the percentage of cash and cheque continues to decrease.
Andrian (2008)[5] posits that in the US, for example, the cheque has declined from 85% of non – cash payment in 1979 to 59% in 2002, and automated or e- payments have grown to 41%. The internet has the potentials to become the most active trade intermediary within a decade. Also, internet shopping revolutionizes by allowing customers to sit in their homes and buy an enormous variety of products and services from all over the world.

Commenting on automated payment system; Adeyinka (2008)[6] postulates that automated payment system intermediation in Nigeria has continued to make steady progress towards ensuring full banking transaction automation with the value of automated payment system rising to N 360 million in 2008. He noted that the increase in the adoption of the electronic model is not only driven by the need for electronic services but also by the core and speedy update of new technologies by Nigeria.

Experts say that with the mass market in Nigeria constituting about 70 percent of the nation's gross domestic product (GDP) the impact of deploying cards and other electronic modes of banking operation in the country has led to increased reach, as customers can now have access to their bank account even at the location where banks are not located through electronic banking models.

According to Eboh (2009)[7], the introduction of various electronic models has led to low operational costs, increased operation efficiency, removing the cost of cash transactions, multi-card, and multiplication availability reduced congestions in banking halls amongst others.
Speaking to business day in an interview Mitchel Elegbe, managing director, Interswitch, a payment solution platform provider with Nigerian banks on its platform confirmed that, the network has witnessed increased transactions with the high level of adoption of technology by Nigerians.

In payment of school fees, an automated system has also been one of the immense benefits in that through the school's bank account, money (student fees paid) are automatically transferred irrespective of the school bank. Here, there is no physical involvement of cash which makes it safer and dependable.

According to Oduyemi (2009)[8], automated payment of student's school fees showcases the joy over the trends in that the student has been relieved of the stress of having to visit bursary and queue to pay their school fees. Now, the trends are just the transport to the bank location to pay their fees and taking the teller to the bursary to exchange for a receipt which will properly indicate evidence that the fee has been paid by the student.

7. Types of Automated Payment

The following types of automated payments are most common today. It is important to realize that new payment types are continually being discovered and these are additional methods that exist or are being developed continuously.

7.1 Cards**:** Credit cards, debit cards, and prepaid cards currently represent the most common form of the consumer or the business most often uses a plastic card, commonly with a magnetic stripe. The cardholder gives his or her number to a merchant who stripes the card through a terminal or enters the data to a PC. The terminal transmits data to his or her bank account. The acquirer transmits the data through a card association to the card issuer who decides on the transaction and relay it back to the merchant, who gives goods or back to the cardholder. Funds flow later for settlement with credit cards and debited immediately for debit or prepaid cards.

7.2 Mobile Payment**:** According to Nwankpa (2009), mobile phones are currently used for a limited number of electronic transactions. However, the percentage seems likely increased as mobile phone manufacturers enable the chip and software in the phone easier electronic commerce. Consumers can use their mobile phones to pay for transactions in several ways. The consumer may send an SMS message, transmit a PIN, use WAP to make online payments, or perform other

segments of their transactions with the phone. As phones develop further, consumers are likely to be able to use infrared, Bluetooth, and other means more frequently to transact full account data to make payment securely and easily from their phone.

7.3 Financial Service Kiosks**:** Companies and service providers in several countries including Singapore and the US, have set up kiosks to enable financial and non – financial transactions. These kiosks are fixed stations with phone connections where the customer usually uses a keyboard and television as a screen to transact or to assess information. Andrian (2008).

7.4 Biometric Payments**:** Automated payment using biometrics is still largely in their

infancy trials and is underway in the united states, Australia, and a limited number of other countries. Most biometric payments involve using fingerprints as the identification and assessment tool, companies like visa international are piloting voice recognition technology and retina scans are also under consideration.
Essentially, a biometric identifier such as a fingerprint or voice could replace the plastic card and more securely identifies the person undertaking the transaction. The automated payment is still changed to a credit card or other account, with the biometric identifier replacing the card, check for other transaction mechanisms.

7.5 Automated Payment Networks**:** Various countries have automated payment networks that consumers can use to make payments electronically. ACH (Automated Clearing House) in the US, domestic networks enable automated payment between business and between individuals. The consumer can go online, to a financial service kiosk, or use other front-end devices to assess their account and make payment to business or other individuals.

8. Key Stakeholders

The major stakeholders have been identified as the Institution namely the university or tertiary institution, the Bank, and the students.

List of other stakeholders

- The Institution which comprises of:
    - ❖ School Bursary department
        - ➢ Responsible for all students' financial transactions
    - ❖ The ICT department

- Responsible for developing, implementing, and supporting information systems and applications that support the academic and administrative processes of the university.

- The university administrative body
  - Responsible for the overall governance of the institution. from the Vice-chancellor, registrar down to the lecturers.

- The students
  - Responsible for paying all the school fees. They include current and prospective students.

- Students Families
  - Sponsors students' payments

- The Bank
  - Handles the institution's finances.

- Government
  - Regulatory policies

- National Universities Commission (NUC) which is part of the Federal ministry of education

  - Regulates the operation of the various institution.

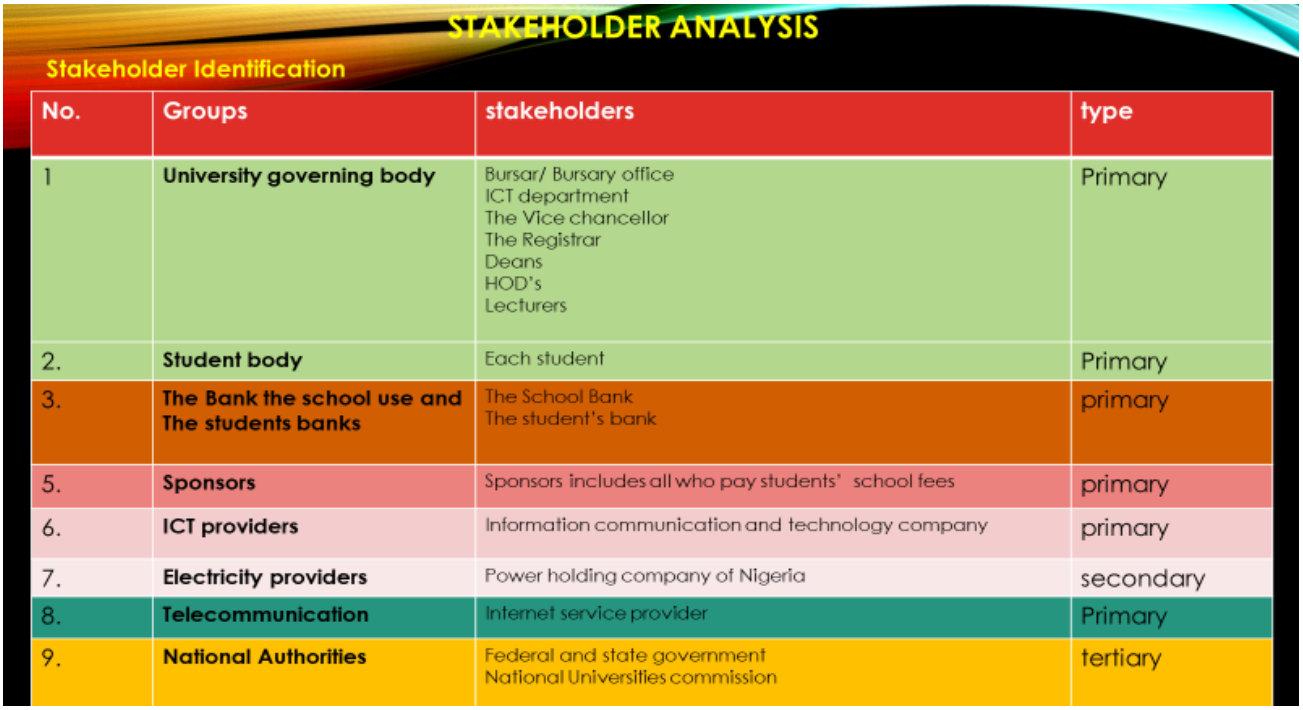
- IT providers
  - provides technical support to school ICT

8.1 Stakeholder Analysis

Here we are going to discuss all those who have a vested interest in this project. Those who will be positively or negatively impacted by this automation of school payments. We identified the following stakeholders through research and experience from being a student of a university and a principal of an institution in Nigeria. In this analysis we are going to follow the following steps:

1. Stakeholder identification
2. Stakeholder interests
3. Stakeholders' importance and influence.

8. Stakeholder identification



No.	Groups	stakeholders	type
1	**University governing body**	Bursar/ Bursary office ICT department The Vice chancellor The Registrar Deans HOD's Lecturers	Primary
2.	**Student body**	Each student	Primary
3.	**The Bank the school use and The students banks**	The School Bank The student's bank	primary
5.	**Sponsors**	Sponsors includes all who pay students' school fees	primary
6.	**ICT providers**	Information communication and technology company	primary
7.	**Electricity providers**	Power holding company of Nigeria	secondary
8.	**Telecommunication**	Internet service provider	Primary
9.	**National Authorities**	Federal and state government National Universities commission	tertiary

Table 8.1 stakeholder identification

8.1.1 Stakeholder categorization

STAKEHOLDER CATEGORIZATION			
CATEGORIZATION	GROUP	STAKEHOLDERS	TYPE
INTERNAL	University governing body	Bursar/ Bursary office, ICT department, The Vice chancellor, The Registrar Deans, HOD's, Lecturers	Primary
	Student body	Each student	Primary
EXTERNAL	The bank the school uses/ The bank student uses	The school Bank	Primary
	Sponsors	Includes all those paying students' school fees	Primary
	ICT providers	ICT provider	Primary
	Telecommunication	Internet Service provider	Primary
	Government authorities	Federal/ State government	Tertiary
		National universities commission	
	Electricity providers	Power holding company of Nigeria	Secondary

Table 8.1.1 Stakeholder categorization

8.1.2. Stakeholder interests and concerns

STAKEHOLDER INTERESTS VS CONCERNS			
Primary stakeholders			
No	Stakeholders	Interests/ positive impacts	Concerns/Negative impacts
1.	University governing body	Wants a more efficient and timely payments. Much more efficient work flow. Enhanced confidence of revenue stream	Debts or untimely payments/ losing the students. Fear of impacting staff levels
2.	Student body	Wants stress free payments and timely feedbacks on their payments. Accounting visibility of financial status	Delay in getting feedbacks on payment or not getting feedbacks.
3.	The Bank the school uses/ The bank the student uses	Wants customers and money for investments. Want Cash liquidity . More efficient financial transaction. Positive experience of having students as customers	loosing their customers due to poor services
4.	Sponsors	Wants more manageable, convenient payment for their wards.	Additional charges for school payments
5.	ICT providers	Wants continuous subscription to their services such as maintenance and updating of school payment services etc. Future business opportunities	Hackers compromising data interigrity or insider threats
6.	Telecommunication company	Needs to provide internet services	Poor weather conditions and geographical

Table 8.1.2 Stakeholder interests and concerns

8.1.3 **Stakeholder importance and influence**

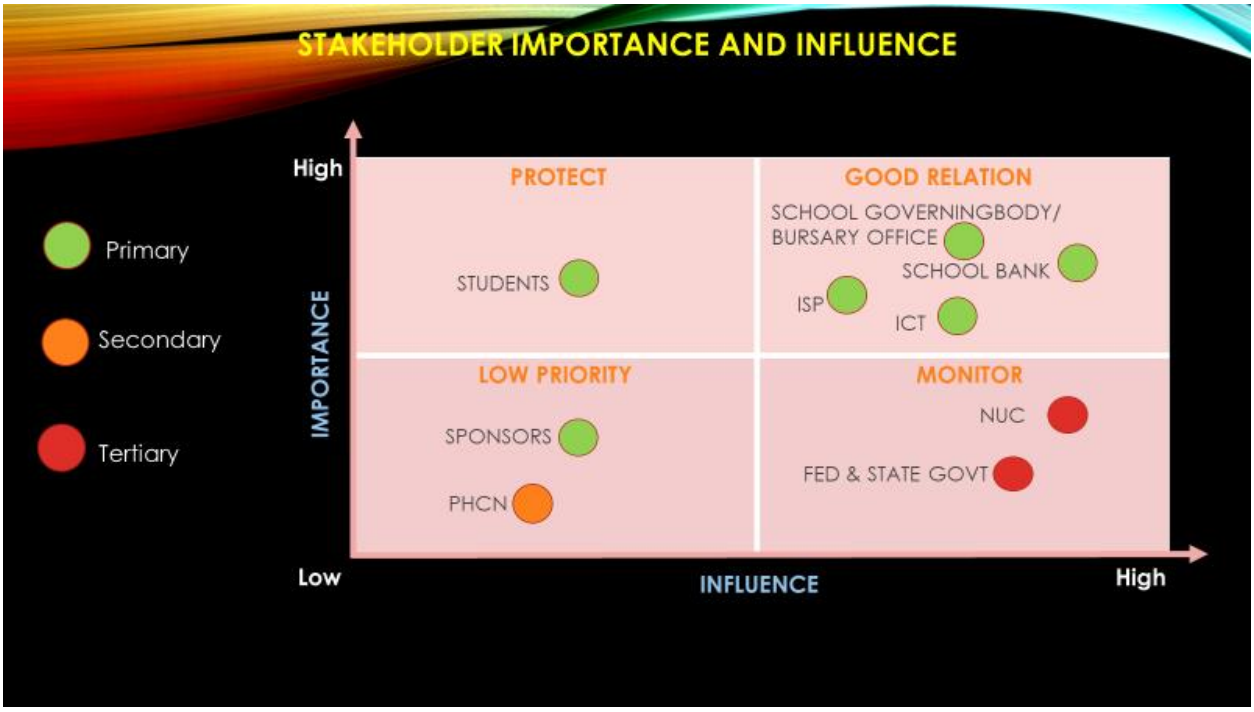


Table 8.1.3 Stakeholder importance and influence

9. Measures of effectiveness MOE'S

The system's effectiveness shall measure according to these parameters.

- Accuracy and security
- The integrity of the financial process
- Speed of transaction
- Cost
- Students safety
- Stakeholder buy-in
- Operational feasibility
- Technological readiness
- Economic benefits

10. Alternatives

An analysis which considers the alternatives available for automating school fee transactions in Nigerian universities and tertiary institutions.

1. Do nothing – Maintain the status quo.
2. Add bank branch to University Campus - Establish on-campus branch/satellite office to manage the school's payments
3. Payments in University Bursary Office - Enable automated payments in the bursary office
4. Payments via University Website – Enable online payments through the school website with Interswitch Quickteller – COTS software online payment processing
5. Develop a customized Mobile application- For mobile payment
6. Remittal Payment Channel – COTS software / Systemspec Remital payment channel

10.1 The first alternative is to maintain the status quo which is the current school payment method of cash transaction at the bank

In this current method, Students withdraw cash from their bank account and proceed to the school bank for payments.

Weaknesses

- The disconnect between bank and school – no handshake
- Multiple receipting – from bank and school
- Delays at the bank and school
- Corrupt practices and lack of transparency
- Poor management practices and poor processes

Strengths

- No processing fees

No opportunities

Threats

- Corrupt practices

- Armed Banditry

This is the current method that shall be used as a baseline in trade-off analysis.

10.2 The second alternative is to add **a** Bank branch to the university campus

Many universities in Nigeria are in remote areas and don't have a good population of students for the university to consider bringing a bank inside the school. Besides, many Banks are established in locations where there are commercial activities that will sustain the banking job, so the university may not serve this need. This consideration is reasonable because students pay their school fees only once in a year and after that, they may not have anything to do with the bank apart from withdrawing money for their needs. The bank can manage school funds, but it needs to generate more income to sustain its business and pay the personnel working with it. It becomes feasible to establish a bank in a university only where the bank also serves other commercial activities in the location where it is established. There a regulatory policy that is imposed on the establishment of bank branches which would also be a problem in establishing banks in schools. Security concerns also militate against establishing Banks in schools. Banks are generally established in locations where there is a good security network, so if the location of a university is insecure, banks can hardly establish their branches there.

Establishing a bank branch in a school will not address the main problem of this project which aims at automating payments since students can still walk into the banks with cash. The bank and school disconnect might be partially solved as the bank holds the transaction data and not the school.

Strengths

- This system enables students and the university at large to have access to cash for other business transactions.
- University staff can receive their salary through direct deposit at the bank
- Students have access to deposit funds if they bank with the bank in school

Weaknesses

- This system is akin to the current one. It does not address the problem of disconnect between the bank and the school
- This system does not provide other financial services to students like notification of payments or management of the student account.
- Geo-challenges to attract bank

Opportunities

- This system has a lesser opportunity of being implemented and is not feasible in many locations
- The university would invite the university's commercial bank allowing the bank to be introduced to customers.

Threats

- This system is very vulnerable to armed robbery attacks in unsecured locations
- Prone to Human errors

10.3 The third alternative is payment at the bursary office

Making payments in the bursary office in an automated system could offer a better solution to this problem and would save costs. A financial software collects and documents the data supplied by each student during payment and automatically backs up data in the cloud server. This data could be accessed from multiple locations in the school making the whole process more transparent. The vice-chancellor, deans, and heads of department can have authorized access to each student's financial status. Students would also access their payment history from their accounts on the school website from their phones and computers. This system would use a POS to connect to the Bank. In this alternative, the school holds the payment data while the payments and card authorization will be handled by the POS network. From a survey of 40 students in a college of health science in Nigeria, 8 among 32 students who did our survey reported having been robbed on the way to the bank to pay their school fees. So, cash transactions are not allowed in this alternative solution hence robbery and physical attacks on students are minimized. Optional auto-renewal of school payments yearly can be set up on this system by providing the debit card to be debited yearly or by semesterly, in which case notifications for authorization will come 2 weeks before the account is debited.

Strengths

- Enables payment with debit card transaction thereby minimizing robbery
- Eliminates deposit slips and long queues at the bank
- Manages the school financial database minimizing errors
- Automates school payments eliminating fraudulent practices
- Enables access to the student account on the school website

- Enables an optional auto-renewal of school payments yearly

Weaknesses

- This system may be impacted by network issues
- The system may be down for maintenance from time to time
- Debit card processing issues
- Must dedicate square footage for facilities
- Additional bursary office tasks- potential possible staff increase

Opportunities

- The system will enhance students' IT skills and greater involvement in information technology
- School financial officials may obtain enhanced revenue stream e.g. perhaps required one-third payment at registration and one third at mid-term and one third at final

Threats

- Software vulnerabilities
- Cybersecurity threats
- Database compromises

10.4 The fourth alternative is to develop as school mobile payment application

Developing a school mobile application with an embedded payment option could be very costly to develop. This alternative could be a possible second choice that could work together with the second alternative. Many considerations come into play in deploying a mobile application payment option in Nigerian universities. Firstly, most students don't have phones that could support the application platform. Secondly, they need data and a fast network to be able to carry out transactions. Thirdly many students don't have the IT mindset to update their apps regularly and this could lead to security vulnerabilities in the application making the student's transactions insecure. The security of mobile applications is an issue of serious concern in our world of cyber-attacks.

Strengths

- Accessible from various platforms
- It is accessible everywhere

- Very convenient

Weaknesses

- Software vulnerabilities
- May not be supported in many platforms
- Non-recurring cost: development cost. Recurring costs: support, maintenance, enhancement.

Opportunities

- Mobile and web payments are good in more tech advanced countries but not in Nigeria
- School financial officials may obtain enhanced revenue stream e.g. perhaps required one-third payment at registration and one third at mid-term and one third at final

Threats

- Cybersecurity issues
- Malicious code injection on the web page
- Bugs on application software

10.5 The fifth alternative is payments on the school website via Interswitch Quickteller payment processing

Quickteller is a financial service application that allows you to purchase airtime, pay bills, send and receive money via the web. All transactions performed are final and cannot be recalled except in the case of proven fraud. Quickteller is owned my Interswitch a payment processing company headquartered in Lagos and founded in 2002. Interswitch uses a 'switching' infrastructure to connect the different banks in Nigeria and provides technology for ATM cards.[9] The company has over 11,000 ATMs on its network. Quickteller accepts only verve debit cards

Integrating Your Systems with the Quickteller Platform
Quickteller provides some ways of integrating your application with Quickteller. This provides a way for Quickteller and your application to exchange information as required. This includes customer data validation, customer data upload, payment notification, and Book on Hold.

- **Customer data validation**: This has to do with verifying a payer's details need be before payments are accepted. This is required is scenarios such as bill payment.

- **Customer data upload:** Customer data can be uploaded on the bill payment platform and customer validation can be done against the uploaded customer details.
- **Payment notification**: The Payment notification involves notifies your billing or invoicing systems that payment has just been made via the Interswitch Bill payment platform for a service you provide.
- **Book on Hold**: This service allows your customer to make reservations for payments for your service that can be fulfilled through any of the Interswitch Quickteller channels.

Setup Costs

The setup costs for becoming a Quickteller Merchant is dependent on your requirements.
If you would NOT be implementing real-time notification you would have to pay N200,000.00
If you would be implementing real-time notification you would have to pay N500,000.00
If you would like ATM screens modified to bear your business name, man & material cost for the development and deployment of new ATM screens to selected banks would be handled by you separately[10].

Strengths

- Fast payment processing
- Can be integrated into any platform; web, mobile app, ATM
- Support payments from any bank branch on the Interswitch network

Weaknesses

- All transactions performed are final and cannot be recalled in case of error

Opportunities

- Supports any form of online bill payment and school payments
- School financial officials may obtain enhanced revenue stream e.g. perhaps required one-third payment at registration and one third at mid-term and one third at final

Threats

- Third-party Fraud
- Security breaches

10.6 The Sixth alternative is the Remita e-payment solution

Remita is an innovative way to manage electronic payments, collections, employees' payrolls, and schedules, which encompasses all the commercial banks. It is very powerful, and it allows people and organizations to process intricate and complex financial operations while being intuitive and simple. Nowadays, many Nigerians, both individuals, and organizations use this convenient platform to process their transactions. Each month, more than ₦500 million goes through the Remita system. Introduced by the Nigerian Federal Government and implemented by the CBN (Central Bank of Nigeria), the system is recognized by all the Nigerian commercial banks and more than 400 small banks. So far, it has been a revolutionary instrument for electronic payments in Nigeria. It was created by a company called SystemSpecs and has received numerous wins in the category Software of the Year in Nigeria[11].

Remita can be used by individuals or organizations. Most schools are using the remita payment channel. The school generates the RRR for their students to make payment at any bank and submit the teller to the bursary after the transaction. The RRR is Remita Retrieval Reference. It contains all the available information on the transaction, which saves time and reduces the chance of an error. It is not reusable, but it does not have an expiration date if it has not been processed through the Remita system yet.

Remita School fees - how to pay any school fees through Remita

1. visit the website www.remita.net

2. Click on the link Pay a Biller

3. Who Do You Want to Pay: Type in the remita account details of the school.

4. Name of Service/Purpose: Select the service/purpose of payment

5. Description: Enter more detail about the purpose of payment (example, if you are paying for school fees, you can type in (i) school fees for ss2 (ii) school fees for 1st semester, etc.)

6. Amount to Pay: Input the Amount

7. Payers Name: Type in the Student Name

8. Payers Phone: Type in the student Phone number

9. Payers Email: Type in a valid email address

10. How do you want to Pay: select your preferred payment

-Internet Banking

-Paga/Pocketmoni

-Bank branch

In one of the schools using Remita payment surveyed in the course of this project, Remita payments at the bank follow the manual method of cash transactions because students cannot use their debit cards to make payments. Of 40 students who were surveyed in a school using remita payment, 20 reported spending 30 minutes to 1 hour at the bank. The remita does not add any value to their payment experience. They still submit the tellers to the bursary and spend time before they are attended to. Remita payment benefits more the biller which is the school than the students or any other stakeholder.

Strengths

- Favors the federal government treasury single account TSA objectives
- Enables organizations like schools to compute staff allowances, loans, taxes, and allowances Without hassle.
- Licensed by Federal Bank of Nigeria CBN
- Enable payments from any bank in Nigeria

Weaknesses

- Offers no benefits to students as such
- Akin to the current method; delays at the bank

Opportunities

- Enables organizations like schools to compute staff allowances, loans, taxes, and allowances
- School financial officials may obtain enhanced revenue stream e.g. perhaps required one-third payment at registration and one third at mid-term and one third at final

Threats

- Potential poor banking processes and long wait times at the bank
- Security threats

11. Trade Study

To analyze the capabilities of the 5 alternative approaches to resolving the problem statement, a trade study was conducted. The 5 alternatives were reviewed against the measures of effectiveness

A qualitative analysis and quantitative analysis were done. To translate the qualitative into quantitative for easy analysis we used we used Pugh decision analysis method which is a multiple criteria decision analysis method (MCDA)to evaluate the different alternatives.

Our baseline in the Pugh chart represents the current manual method of transaction. All the alternatives were judged against this baseline using the **CONCEPT SELECTION LEGEND: BETTER = +1 SAME = 0 WORSE = -1.**

Decision analysis flow chart

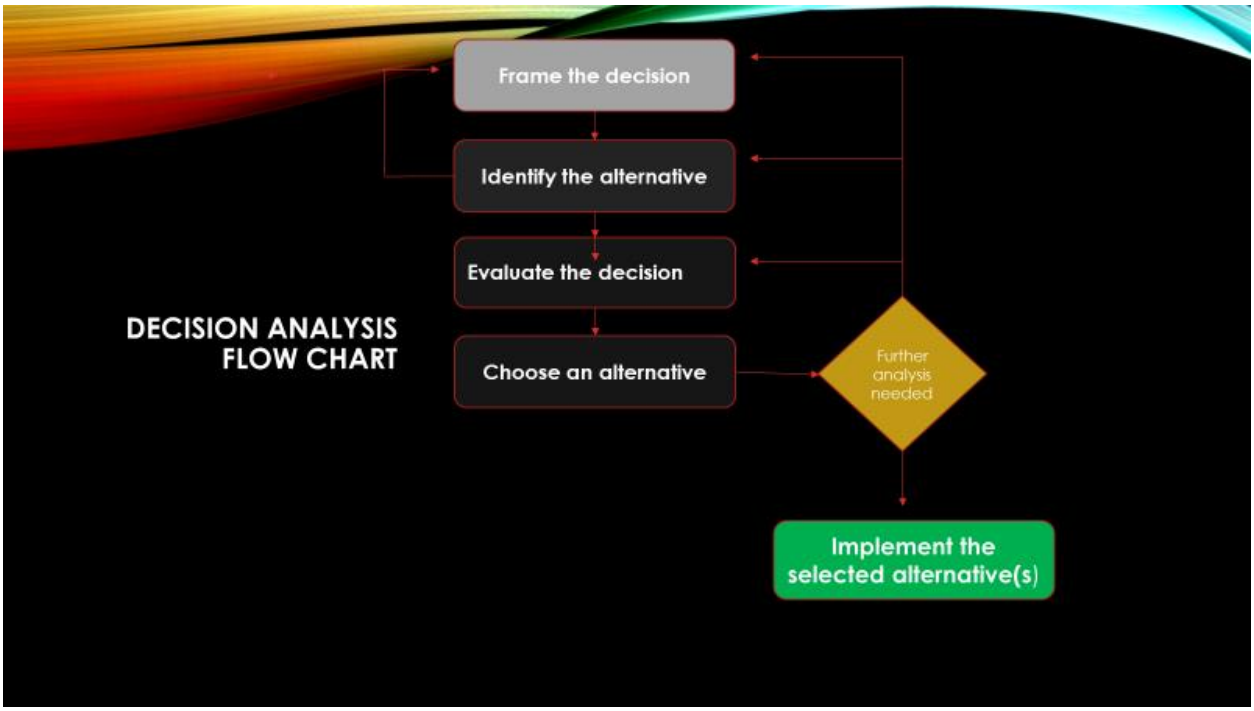
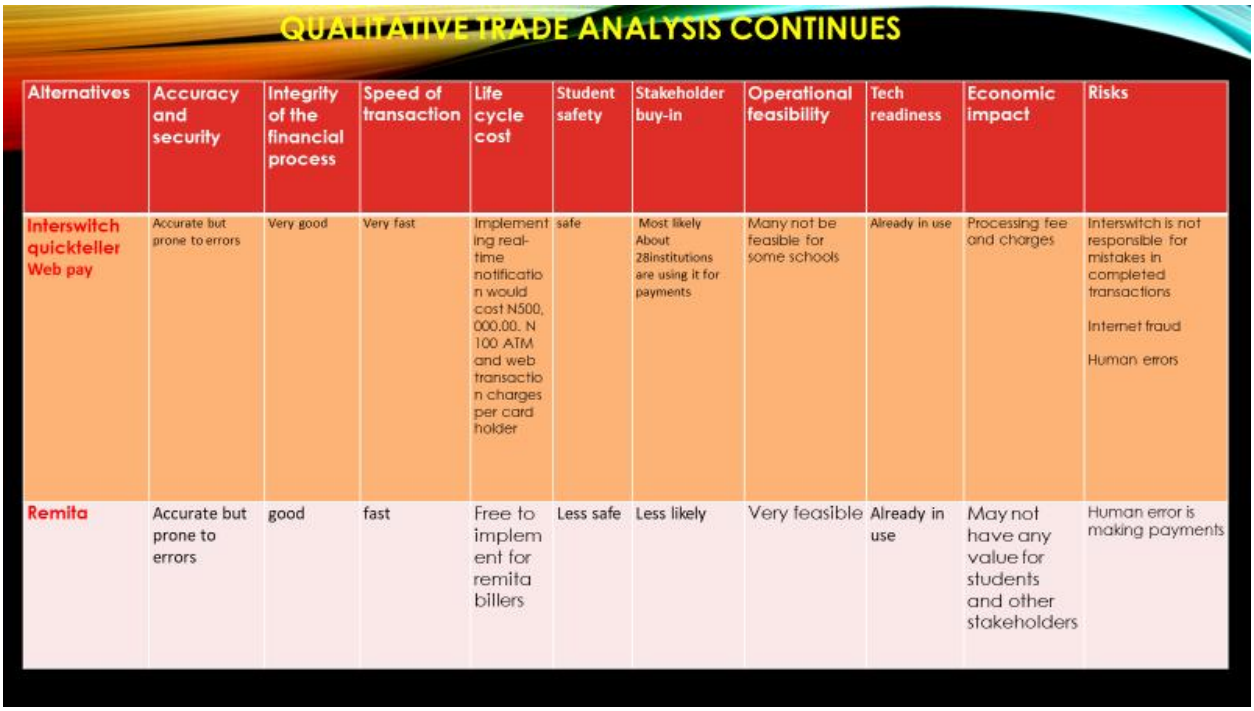


Figure 11. Decision flow chart

11. Qualitative analysis chart

QUALITATIVE TRADE ANALYSIS

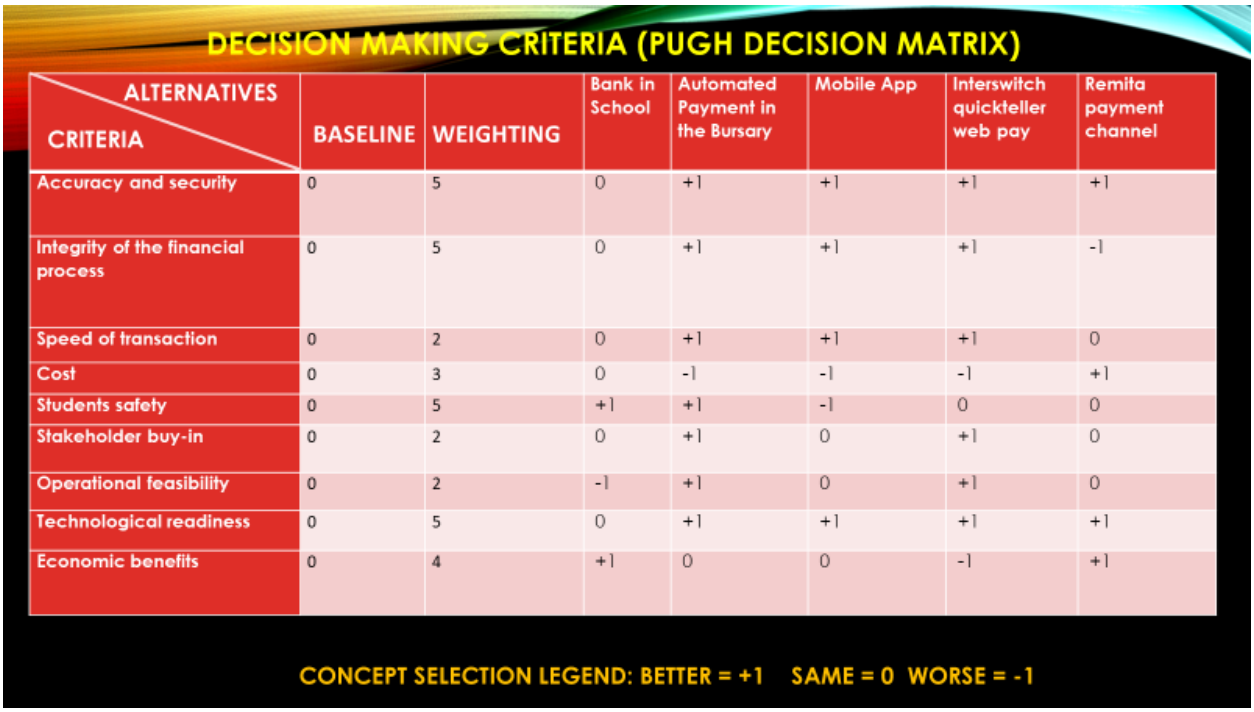
Alternatives	Accuracy and security	Integrity of the financial process	Speed of transaction	Life cycle cost	Student safety	Stakeholder buy-in	Operational feasibility	Tech readiness	Economic impact	Risks
Bank in school	Accurate but less secure	yes	Slow. Speed is impacted by the manual process of transaction	Requires costly infrastructures and maintenance # 15 to 20 million naira	not very safe	less likely	Not feasible in certain locations	yes	Eliminates transportation fee to bank outside the school No debit card charges	Security break-ins Does not support debit card school fees payments Students don't have access to payment history Human errors in documenting payments
Payment at bursary office	more secure and accurate	Very good	Very fast. Speed might be impacted by network	5 million naira or less	Very safe	Mostly likely	Feasible in every location	Yes . Educational payment software and facilities are available	There may be processing fees and charges	Poor internet connectivity Debit card processing error Security vulnerabilities in payment software Cyber attack
Mobile app payment	May be accurate but less secure	good	May be fast or slow depending on many factors	Building moderate apps with payment futures will cost around	Not really safe due to security issues	likely	Limited to students with computers or mobile phones that support application	Yes already in use	May be too expensive to deploy a mobile app with payment capabilities or add a payment portal to the	Poor app design, configuration or corrupt app Mobile device ID



Alternatives	Accuracy and security	Integrity of the financial process	Speed of transaction	Life cycle cost	Student safety	Stakeholder buy-in	Operational feasibility	Tech readiness	Economic impact	Risks
Interswitch quickteller Web pay	Accurate but prone to errors	Very good	Very fast	Implementing real-time notification would cost N500,000.00. N 100 ATM and web transaction charges per card holder	safe	Most likely About 28institutions are using it for payments	Many not be feasible for some schools	Already in use	Processing fee and charges	Interswitch is not responsible for mistakes in completed transactions Internet fraud Human errors
Remita	Accurate but prone to errors	good	fast	Free to implement for remita billers	Less safe	Less likely	Very feasible	Already in use	May not have any value for students and other stakeholders	Human error is making payments

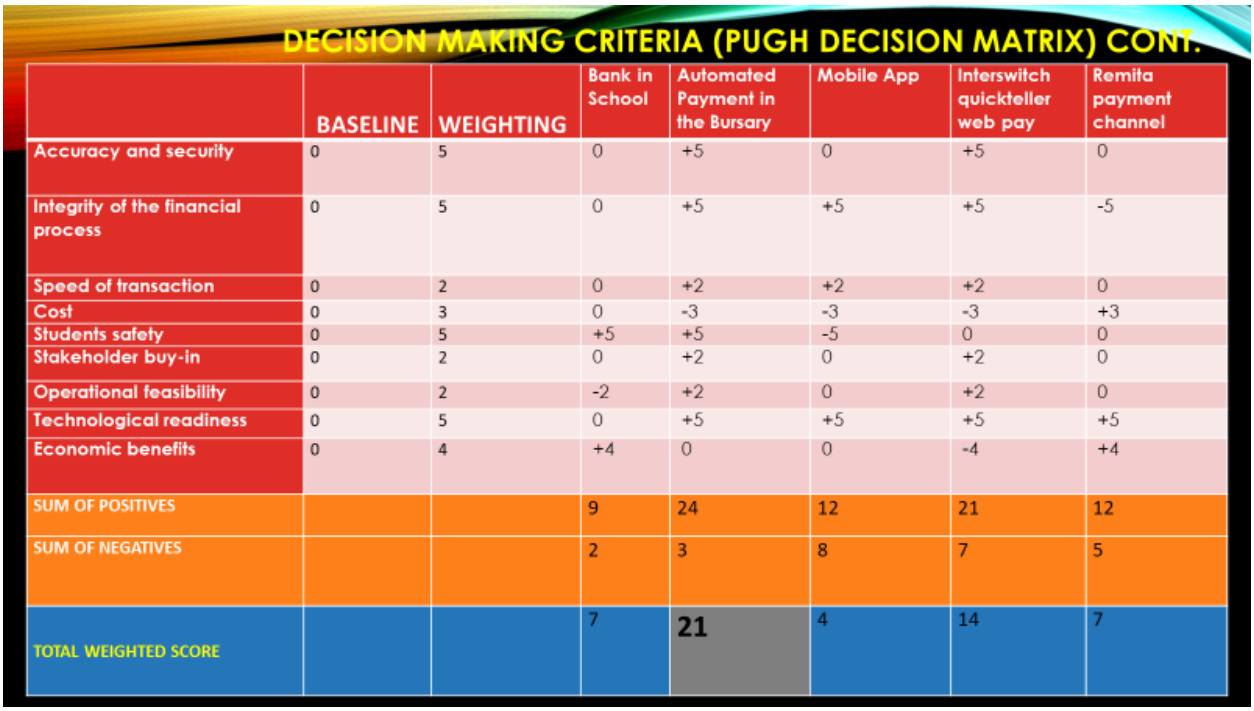
Table 11.1 Qualitative analysis

11.2 Quantitative Analysis using Pugh decision



ALTERNATIVES / CRITERIA	BASELINE	WEIGHTING	Bank in School	Automated Payment in the Bursary	Mobile App	Interswitch quickteller web pay	Remita payment channel
Accuracy and security	0	5	0	+1	+1	+1	+1
Integrity of the financial process	0	5	0	+1	+1	+1	-1
Speed of transaction	0	2	0	+1	+1	+1	0
Cost	0	3	0	-1	-1	-1	+1
Students safety	0	5	+1	+1	-1	0	0
Stakeholder buy-in	0	2	0	+1	0	+1	0
Operational feasibility	0	2	-1	+1	0	+1	0
Technological readiness	0	5	0	+1	+1	+1	+1
Economic benefits	0	4	+1	0	0	-1	+1

CONCEPT SELECTION LEGEND: BETTER = +1 SAME = 0 WORSE = -1



	BASELINE	WEIGHTING	Bank in School	Automated Payment in the Bursary	Mobile App	Interswitch quickteller web pay	Remita payment channel
Accuracy and security	0	5	0	+5	0	+5	0
Integrity of the financial process	0	5	0	+5	+5	+5	-5
Speed of transaction	0	2	0	+2	+2	+2	0
Cost	0	3	0	-3	-3	-3	+3
Students safety	0	5	+5	+5	-5	0	0
Stakeholder buy-in	0	2	0	+2	0	+2	0
Operational feasibility	0	2	-2	+2	0	+2	0
Technological readiness	0	5	0	+5	+5	+5	+5
Economic benefits	0	4	+4	0	0	-4	+4
SUM OF POSITIVES			9	24	12	21	12
SUM OF NEGATIVES			2	3	8	7	5
TOTAL WEIGHTED SCORE			7	21	4	14	7

Table 11.2 Pugh quantitative analysis method

11.3 Findings from the five alternatives considered for automating school fee transactions

Findings from the Trade study are listed below. These were then used to create the Concept of Operations, Requirements, and High-Level Design.

- From five alternatives considered using the Pugh decision matrix, the automated payment in the bursary office scored highest as the most suitable option, so we selected it as the overall winner as it best satisfied our highly weighted criteria.
- All the alternatives have their merits and demerits
- No alternative satisfied fully the whole criteria

- The selected alternative could work together with the second-ranked alternative the Interswitch quickteller web pay for online payment processing.

12 Concept of Operations (ConOps)

To deploy this system, Students must first create an account with the school registration number on the school website students' account management portal. This management portal is linked with the payment software running on a cloud server and accessed through the networked computers at the bursary office. The operation of this automated payment system will begin when students go to the bursary with their debit cards (having been credited at their bank). Students will log in to the system and fill the details of their payments. At checkout, they will use the Pos (or any online payment processing). Details of the transaction are automatically backup on the server and forwarded to the student account management portal on the school website. Personnel working at the bursary office shall be trained to manage the payment software and assist students during payments, while the ICT company that provides the software sees to its upgrade and maintenance. The registrar, Heads of departments, and Deans shall have a limited authorization to access the financial status of students. The Bursar and Vice-chancellor shall have the full authorized access into the system. The payment software will manage the school financial accounting, keeps track of students' payment status, and perform routine audits.

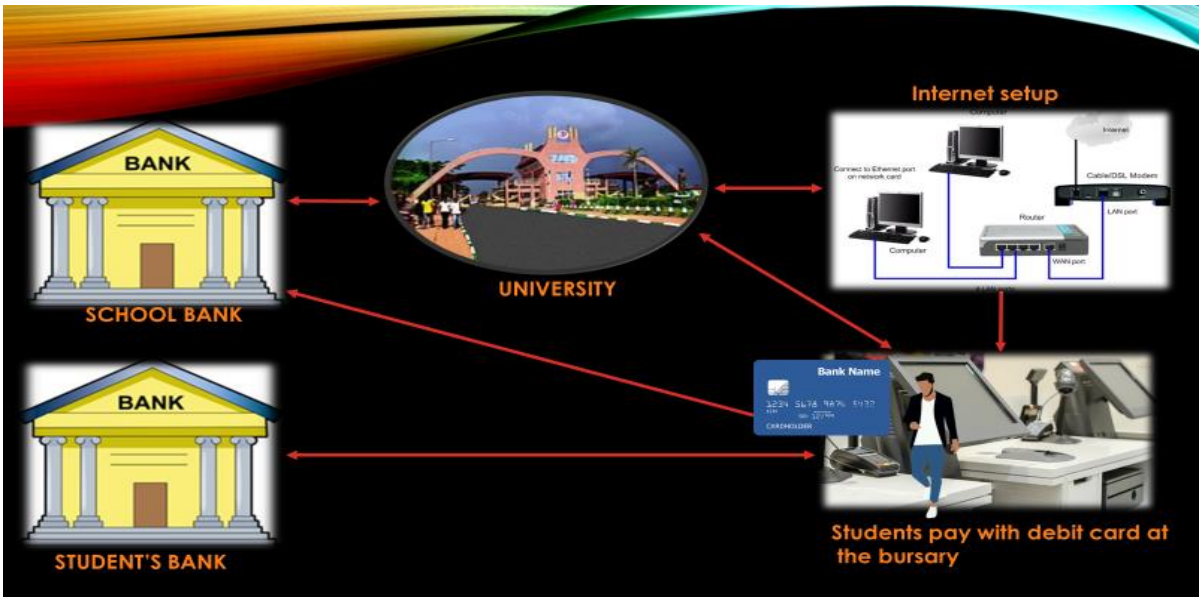


Figure 12. shows the concept of operations of automating school payments.

13. System Requirements[12]

The requirements for this system are adopted by the information technology infrastructure library ITIL best practices. ITIL is a widely accepted approach to IT Service Management (ITSM), which has been adopted by individuals and organizations across the world. It provides a cohesive set of best practice, drawn from the public and private sectors internationally.

ITIL advocates that IT services are aligned to the needs of the business and support its core processes. The ITIL approach guides organizations and individuals on how to use IT as a tool to facilitate business change, transformation, and growth.

IT service management (ITSM) is a concept that enables an organization to maximize business value from the use of information technology.

ITSM positions IT services as the key means of delivering and obtaining the value, where an internal or external IT service provider works with business customers, at the same time taking responsibility for the associated costs and risks. ITSM works across the whole lifecycle of a service, from the original strategy, through design, transition, and into live operation.

ITIL is organized around a service lifecycle which includes service strategy, service design, service transition, service operation, and continual service improvement.

The lifecycle starts with service strategy– understanding who the IT customers are, the service offerings that are required to meet the customers' needs, the IT capabilities and resources that are required to develop these offerings, and the requirements for executing them successfully. Driven by strategy throughout delivery and support for the service, the IT service provider must always try to ensure that the cost of delivery is consistent with the value delivered to the customer.

Service design ensures that new and changed services are designed effectively to meet customer expectations. The technology and architecture required to meet customer needs cost-effectively are an integral part of service design, as are the processes required to manage the services. Service management systems and tools to adequately monitor and support new or modified services must be considered, as well as mechanisms for measuring the service levels, the technology, and the efficiency and effectiveness of processes.

Through the service transition phase of the lifecycle, the design is built, tested, and moved into production to enable the business customer to achieve the desired value. This phase addresses managing changes: controlling the assets and configuration items (the underlying components such as hardware, software, etc.) associated with the new and changed systems; service validation; and testing and transition planning to ensure that users, support personnel, and the production environment have been prepared for the release to production.

Once transitioned, service operation then delivers the service on an on-going basis, overseeing the daily overall health of the service. This includes managing disruptions to service through rapid restoration after incidents; determining the root cause of problems and detecting trends associated with recurring issues; handling daily routine end-user requests, and managing service access.

Enveloping the service lifecycle is continual service improvement (CSI). CSI offers a mechanism for the IT organization to measure and improve the service levels, the technology, and the efficiency and effectiveness of processes used in the overall management of services[13].

13.1 ITIL lifecycle for requirements definition

ITIL is organized around a service lifecycle which includes service strategy, service design, service transition, service operation, and continual service improvement.

The requirements for this system are identified following the ITIL lifecycle processes mentioned above.

In the service strategy, the users and the service offering required to satisfy their needs were identified. The IT capabilities and resources that are required to develop these offerings and the requirements for executing them successfully were also considered.

In the service design, the technology and architecture required to meet customer needs cost-effectively were considered.

In the service transition, we considered how to manage changes: controlling the assets and configuration items (the underlying components such as hardware, software, etc.

In the service operation, we considered how to manage disruptions to service through rapid restoration after incidents; determining the root cause of problems, and detecting trends associated with recurring issues.

And finally, we considered how improvements can be made by a continuous improvement of services.

13.1.1 System functional requirements

- **Service strategy**

Requirements by primary stakeholders

- Student perspective
  - The system shall enable students to input their data during payments
  - The system shall enable students to manage their account on the school website
- Bank perspective
  - The system shall enable payments through the bank POS or the Interswitch payment processing on the school website
- School/Bursary perspective
  - The system shall be available payments through the bank POS or the Interswitch
  - The system shall be accessible online on the school website 24/7

- **Service Design**

  - **Infrastructure requirements**
    - The system shall require a cots software with customization
    - The system shall be in a wireless local area network (WLAN)with other computers connected to an access point
    - The system shall require a wireless modem and a router
    - The system shall require broadband internet @20 to 30mbps
    - The system shall require a minimum of twenty windows 20 desktop computers with the minimum hardware configuration of 6GB ram, 500GBhard disk, and Core i3 processor speed running on windows 10 Operating system.
    - The system shall be situated in a location in the university as an extension of the bursary office
    - The system will require a minimum of 10 Point of sale POS debit card readers

❑ Service transition

- ❖ **Pilot**
  - This system shall be tested a small group of students
- ❖ **Roll-out**
  - The system shall Transition to the whole university
  - The system shall be adopted by other universities
- ❖ **Plan for SME**
- ❖ Support
  - The system shall be back up by a steady supply of electricity: solar power, standby generator, or the commercial power supply.
  - The system shall be supported by the school ICT office, virtual server provider, and cots software provider
- ❖ **Maintenance**
  - The system shall be schooled for maintenance from 12am to 3 am once monthly.
  - The system shall also be down for maintenance in an emergency.

Preventive maintenance

- ➢ **Enhancement**

❑ Service Operation

- ❖ Backup plan
  - The system data shall be automatically backup in the cloud(virtual) server
- ❖ Failover

- In the event of server failure, the system shall failover to another virtual server in a different location from the primary server

❖ Security provision

- The system shall be properly secured with security software
- The system shall secure transactions by protecting students' login credentials and debit card details with the best encryption available
- The system shall secure the payment database from interference or manipulation of system data to maintain data integrity, confidentiality, and non-repudiation

The security requirements for this system will follow the standard of ISO/IEC 27001 which is the best-known standard in providing requirements for an information security management system (ISMS)

❑ Continuous improvement

These metrics shall provide the benchmark for tracking and continuous improvement. Key performance parameters KPI's

- ✓ **Number of payments made-** Number of students that made payments in a month compared to the old method
- ✓ **Frequency-** The frequency of daily payment alerts
- ✓ **Economic benefits- Profit**: an increase in a revenue stream for the school
- ✓ **Stakeholder satisfaction**: Number of negative complaints received on system performance and processes/ percentage of students "very" or ''extremely''
- ✓ **Students adoption of unassisted transactions** on their phones and/or laptops versus in house bursary assisted transactions
- ✓ **Bank authorization rate:**
- ✓ **Processor data speed – POS processing speed in the bursary and Interswitch processing speed on the school website**

➢ The system shall be use scheduled time for maintenance for upgrades when new software updates become available

➢ Kaizen shall be proactively applied to the continuous improvement of this system

13.2 Capability Maturity Model

What is the Capability Maturity Model? (CMM)

Capability Maturity Model (CMM) broadly refers to a process improvement approach that is based on a process model. CMM also refers specifically to the first such model, developed by the Software Engineering Institute (SEI) in the mid-1980s, as well as the family of process models that followed. A process model is a structured collection of practices that describe the characteristics of effective processes; the practices included are those proven by experience to be effective.

CMM can be used to assess an organization against a scale of five process maturity levels. Each level ranks the organization according to its standardization of processes in the subject area being assessed. The subject areas can be as diverse as software engineering, systems engineering, project management, risk management, system acquisition, information technology (IT) services, and personnel management.

Levels of the CMM

There are five levels of the CMM:

Level 1 - Initial

Processes are usually ad hoc, and the organization usually does not provide a stable environment. Success in these organizations depends on the competence and heroics of the people in the organization and not on the use of proven processes. Despite this ad hoc, chaotic environment, maturity level 1 organization often produce products and services that work; however, they frequently exceed the budget and schedule of their projects.

Organizations are characterized by a tendency to over-commit, abandon processes in the time of crisis, and not be able to repeat their past successes.

Software project success depends on having quality people.

Level 2 - Repeatable

Software development successes are repeatable. The processes may not repeat for all the projects in the organization. The organization may use some basic project management to track costs and schedules.

Process discipline helps ensure that existing practices are retained during times of stress. When these practices are in place, projects are performed and managed according to their documented plans.

Project status and the delivery of services are visible to management at defined points (for example, at major milestones and the completion of major tasks).

Basic project management processes are established to track cost, schedule, and functionality. The minimum process discipline is in place to repeat earlier successes on projects with similar applications and scope. There is still a significant risk of exceeding cost and time estimates.

Level 3 - Defined

The organization's set of standard processes, which is the basis for level 3, is established and improved over time. These standard processes are used to establish consistency across the organization. Projects establish their defined processes by the organization's set of standard processes according to tailoring guidelines.

The organization's management establishes process objectives based on the organization's set of standard processes and ensures that these objectives are appropriately addressed.

A critical distinction between level 2 and level 3 is the scope of standards, process descriptions, and procedures. At level 2, the standards, process descriptions, and procedures may be quite different in each specific instance of the process (for example, on a project). At level 3, the standards, process descriptions, and procedures for a project are tailored from the organization's set of standard processes to suit a project or organizational unit.

Level 4 - Managed

Using precise measurements, management can effectively control the software development effort. In particular, management can identify ways to adjust and adapt the process to projects without measurable losses of quality or deviations from specifications. At this level, the organization sets a quantitative quality goal for both software processes and software maintenance.

Subprocesses are selected that significantly contribute to overall process performance. These selected subprocesses are controlled using statistical and other quantitative techniques.

A critical distinction between maturity level 3 and maturity level 4 is the predictability of process performance. At maturity level 4, the performance of processes is controlled using statistical and other quantitative techniques and is quantitatively predictable. At maturity level 3, processes are only qualitatively predictable.

Level 5 - Optimizing

Focusing on continually improving process performance through both incremental and innovative technological improvements. Quantitative process-improvement objectives for the organization are established, continually revised to reflect changing business objectives, and used as criteria in managing process improvement. The effects of deployed process improvements are measured and evaluated against the quantitative process-improvement objectives. Both the defined processes and the organization's set of standard processes are targets of measurable improvement activities.

Process improvements to address common causes of process variation and measurably improve the organization's processes are identified, evaluated, and deployed.

Optimizing processes that are nimble, adaptable, and innovative depends on the participation of an empowered workforce aligned with the business values and objectives of the organization. The organization's ability to rapidly respond to changes and opportunities is enhanced by finding ways to accelerate and share learning.

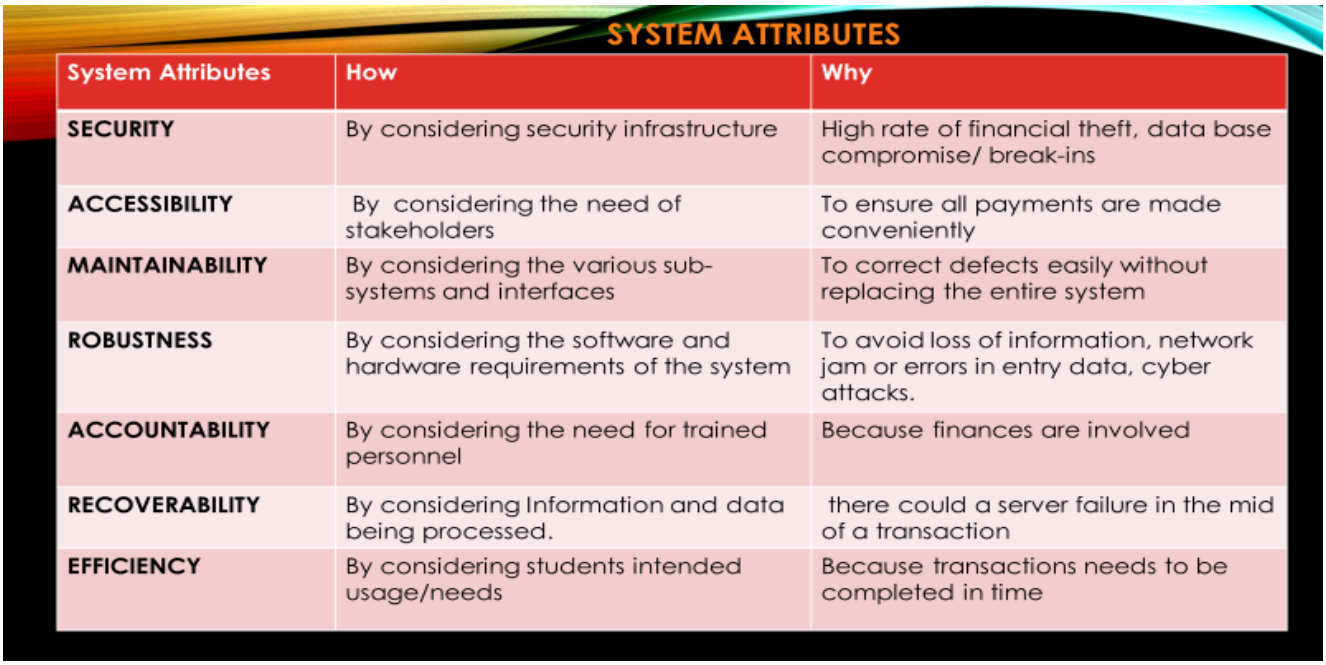
A critical distinction between maturity level 4 and maturity level 5 is the type of process variation addressed. At maturity level 4, processes are concerned with addressing special causes of process variation and providing statistical predictability of the results. Though processes may produce predictable results, the results may be insufficient to achieve the established objectives. At maturity level 5, processes are concerned with addressing common causes of process variation and changing the process (that is, shifting the mean of the process performance) to improve process performance (while maintaining statistical probability) to achieve the established quantitative process-improvement objectives.

From a software perspective, assessed on these levels, the Bank and Bursary current software in Nigeria are defined. However, this rating is not indicative of the whole process given the possibility of robbery and corruption (outside of the SW)

CMM will assess the CMM rating of potential COTS vendors as this spread to their ability to provide quality SW systems

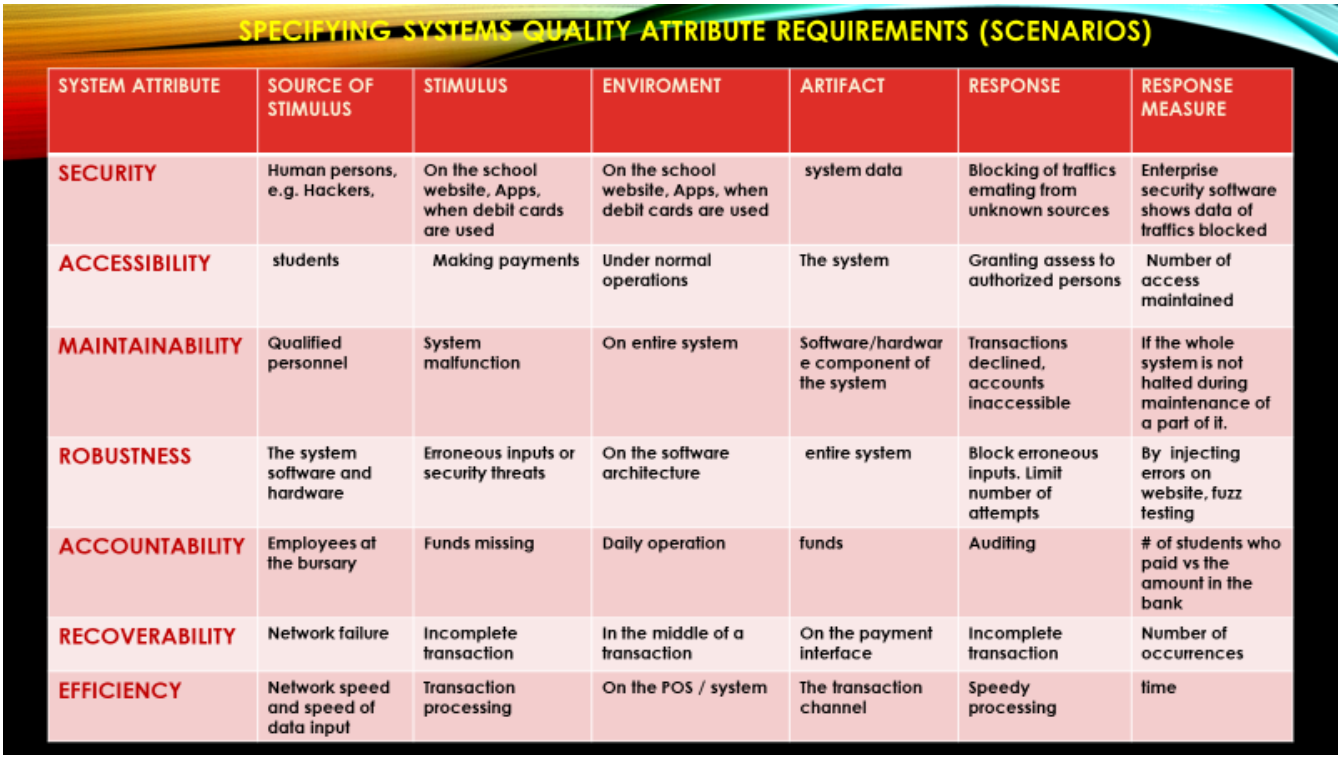
13.3 Non-functional requirements or system attributes

The figure below shows a table of nonfunctional requirements the system must satisfy to be accepted**.**



System Attributes	How	Why
SECURITY	By considering security infrastructure	High rate of financial theft, data base compromise/ break-ins
ACCESSIBILITY	By considering the need of stakeholders	To ensure all payments are made conveniently
MAINTAINABILITY	By considering the various sub-systems and interfaces	To correct defects easily without replacing the entire system
ROBUSTNESS	By considering the software and hardware requirements of the system	To avoid loss of information, network jam or errors in entry data, cyber attacks.
ACCOUNTABILITY	By considering the need for trained personnel	Because finances are involved
RECOVERABILITY	By considering Information and data being processed.	there could a server failure in the mid of a transaction
EFFICIENCY	By considering students intended usage/needs	Because transactions needs to be completed in time

Figure 13.3: System attributes



SYSTEM ATTRIBUTE	SOURCE OF STIMULUS	STIMULUS	ENVIROMENT	ARTIFACT	RESPONSE	RESPONSE MEASURE
SECURITY	Human persons, e.g. Hackers,	On the school website, Apps, when debit cards are used	On the school website, Apps, when debit cards are used	system data	Blocking of traffics emating from unknown sources	Enterprise security software shows data of traffics blocked
ACCESSIBILITY	students	Making payments	Under normal operations	The system	Granting assess to authorized persons	Number of access maintained
MAINTAINABILITY	Qualified personnel	System malfunction	On entire system	Software/hardware component of the system	Transactions declined, accounts inaccessible	If the whole system is not halted during maintenance of a part of it.
ROBUSTNESS	The system software and hardware	Erroneous inputs or security threats	On the software architecture	entire system	Block erroneous inputs. Limit number of attempts	By injecting errors on website, fuzz testing
ACCOUNTABILITY	Employees at the bursary	Funds missing	Daily operation	funds	Auditing	# of students who paid vs the amount in the bank
RECOVERABILITY	Network failure	Incomplete transaction	In the middle of a transaction	On the payment interface	Incomplete transaction	Number of occurrences
EFFICIENCY	Network speed and speed of data input	Transaction processing	On the POS / system	The transaction channel	Speedy processing	time

Table 13.3.1 Specifies the quality attributes with use cases

13.4 Priority Quality attributes

- Security: The system should detect intrusions, resist them, react, and finally recover transaction history if a network failure or cyber-attack occurs.
- Robustness: The system would be robust to resist unfavorable conditions or faulty input without crashing the entire system.
- Accessibility: The system would be accessible to students, minimizing the wait times at the bursary office.
- Accountability: The system would accept only approved fees, so any manipulation of figures from an insider would be visible during auditing.
- Efficiency**:** The system will be very efficient**.**

13.5 Reasons for the priority quality attributes

Security

The system shall satisfy security attributes because there is a need to secure transactions by protecting students' login credentials and debit card details with the best encryption available. The payment database needs to be secured from interference or manipulation of system data to maintain data integrity, confidentiality, and non-repudiation. The security requirements for this system will follow the standard of ISO/IEC 27001 which is the best-known standard in providing requirements for an information security management system (ISMS)

Robustness

- The system shall satisfy robustness quality because the whole system infrastructure will be will so networked to withstand unfavorable conditions and would have a cloud backup server

Accessibility

- The system shall satisfy accessibility it becomes easy for students to make transactions anytime anywhere. The transaction interface will be easy for navigation as important details needed for the transaction are already provided.

Accountability

- The system shall satisfy the accountability attributes because the transaction interface of the system shall only accept the designated fees, no more, no less. So,

no manipulation of figures by insiders at the bursary or the system managers would be hidden during audits.

Efficiency

- The system shall satisfy efficiency because the hassles and delays in making school payments at the bank will be eliminated.

14. System Verification

14.1 Definition of methods used for verification

NA = Not Applicable

I = Inspection

The confirmation that equipment conforms to design documentation. The inspection may be in the form of visual examination, measurements, or examination of records.

A = Analysis

A technical review to determine if equipment meets requirements based on engineering calculation and/or mathematical models validated by empirical data, reference material, or engineering data.

T = Test

A technical activity that subjects the equipment to controlled stimuli/environments and measures response/performance with instrumentation.

D = Demonstration

Non-instrumented technical activity that subjects the equipment to controlled stimuli/environments and determines functional success qualitatively or on a pass/fail basis.

	Requirement	**Verification method**
1.	students to input their data during payments	This will be verified by demonstration
2.	students account management on the school website	Verified by inspection and demonstration
3.	payments through the bank POS or the Interswitch	Verified by testing and demonstration
4.	Daily payments availability	Verified by demonstration
5.	Online accessibility	Verified by testing and demonstration
6.	Customized Cots software	Verified by analysis and testing
7.	Wireless local area network (WLAN)	Verified by inspection and testing
8.	Wireless modem and a router	Verified by inspection and testing

9.	Broadband internet @10 to 30mbps	Verified by inspection and testing
10.	Computer hardware: 20 desktop computers.6GB ram, 500GBhard disk, and Core i3 processor speed.	Verified by inspection and testing
11.	Computer software: operating system Windows 7 to 10	Verified by inspection
12.	10 Point of sale POS debit card readers	Verified by inspection and testing
13	Pilot with a small group of students	This is going to be demonstrated
14.	Roll out to university and other institutions	Verified by demonstration
15.	Electricity backup	Verified by inspection and demonstration.
16.	Support from the school ICT office, virtual server provider, and cots software provider	Verified by a demonstration of their support
17.	Scheduled and emergency maintenance	Verified by demonstration
18.	Other enhancements	Not determined yet
19.	the system shall failover to another virtual server in a different location from the primary server	Verified by analysis, testing, and demonstration
20.	Security requirements	Verified by analysis, fuzz testing, and demonstration
21.	Continuous improvements and upgrades	Verified by demonstration

Table 14.1: Requirements and verification table

15. Architectural views

Architectural decision and attributes that drove them

The current architecturally significant decisions I made for this automated financial system was influenced by the disconnect between the school and the bank,

We considered the student first who is the most architecturally significant stimulus source. The student needs the system to be **efficient** (**Efficiency**)

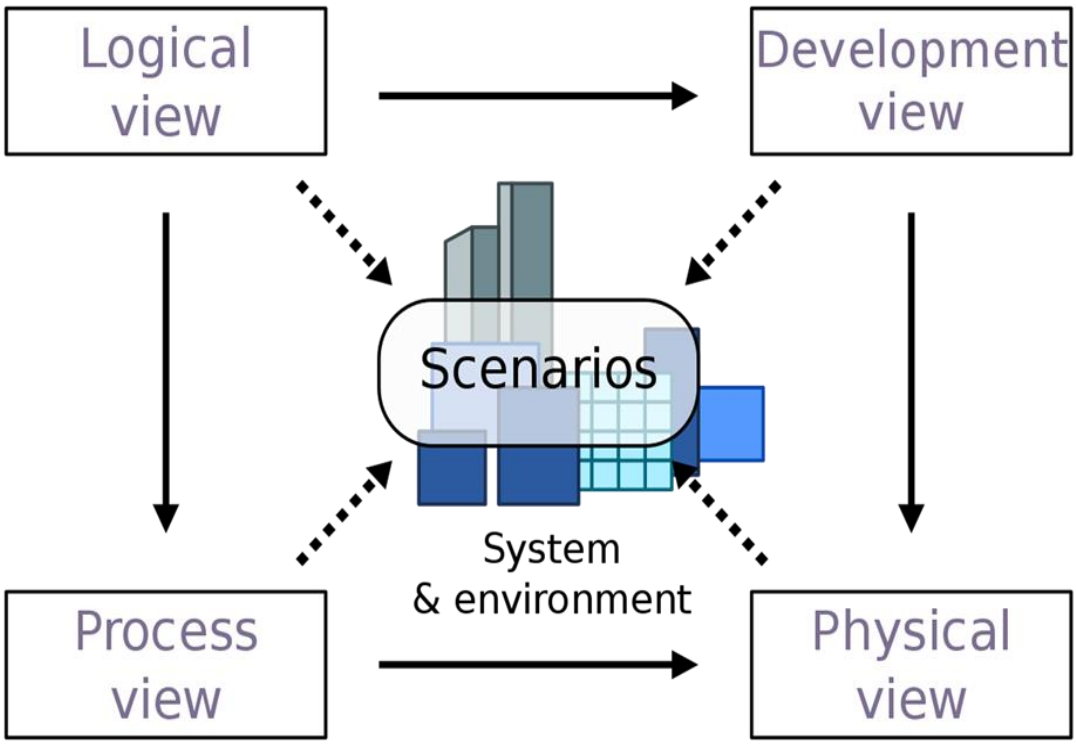
In developing a component diagram, we considered it architecturally significant to interface the bank and the school through the POS. This interface needs to be very **Robust (Robustness**)as it is very important to the systems' architecture.

Security was very significant and that is why we choose to use the POS.

Because most students only receive money directly in their bank account and have Debit cards, we considered it architecturally significant to include the POS component for the debit card transactions at the bursary and quickteller online payment processing on the school website. These will make the system to be more **accessible (Accessibility)** at all times.

4+1 Architectural view Diagrams

We adopted the 4+1 Architectural view Diagrams to explain the different architectural views of this system. 4+1 is a view model designed by Philippe Kuchen for "describing the architecture of software-intensive systems, based on the use of multiple, concurrent views".[14] The views are used to describe the system from the viewpoint of different stakeholders, such as end-users, developers, and project managers. The four views of the model are logical, development, process, and physical view. Besides, selected use cases or scenarios are used to illustrate the architecture serving as the 'plus one' view. Hence the model contains 4+1 views.[15]



15.1.1 Logical view: State Diagram

The logical view is concerned with the functionality that the system provides to end-users. We shall illustrate the logical view of the state diagram.

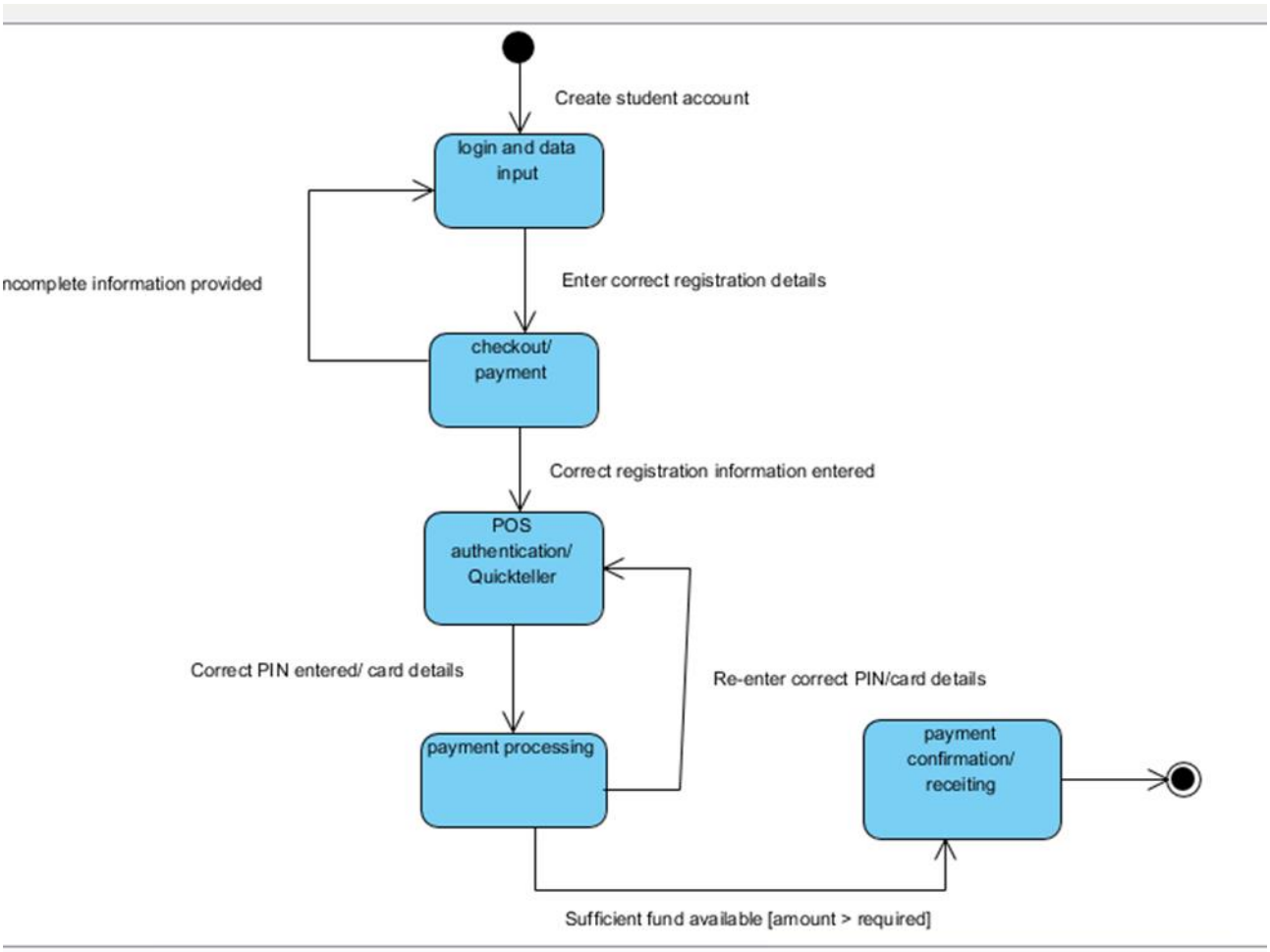


Figure 15.1.1: State diagram of the system

15.1.2 Process View: Activity Diagram

The process view deals with the dynamic aspects of the system, explains the system processes, and how they communicate, and focuses on the runtime behavior of the system. We shall illustrate the process view with the "Make payment" activity diagram.

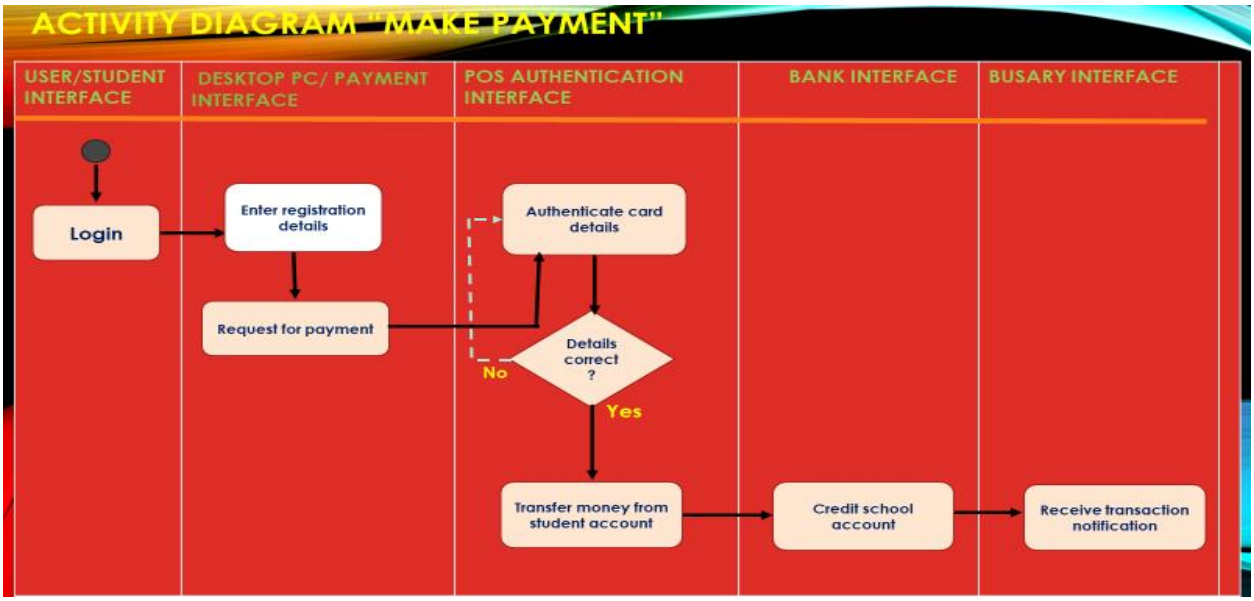


Figure 15.1.2: Activity Diagram

15.1.3 Development view: Component diagram

The development view illustrates a system from a programmer's perspective and is concerned with software management. This view is also known as the implementation view. We shall illustrate the development view with the component diagram. Figure below

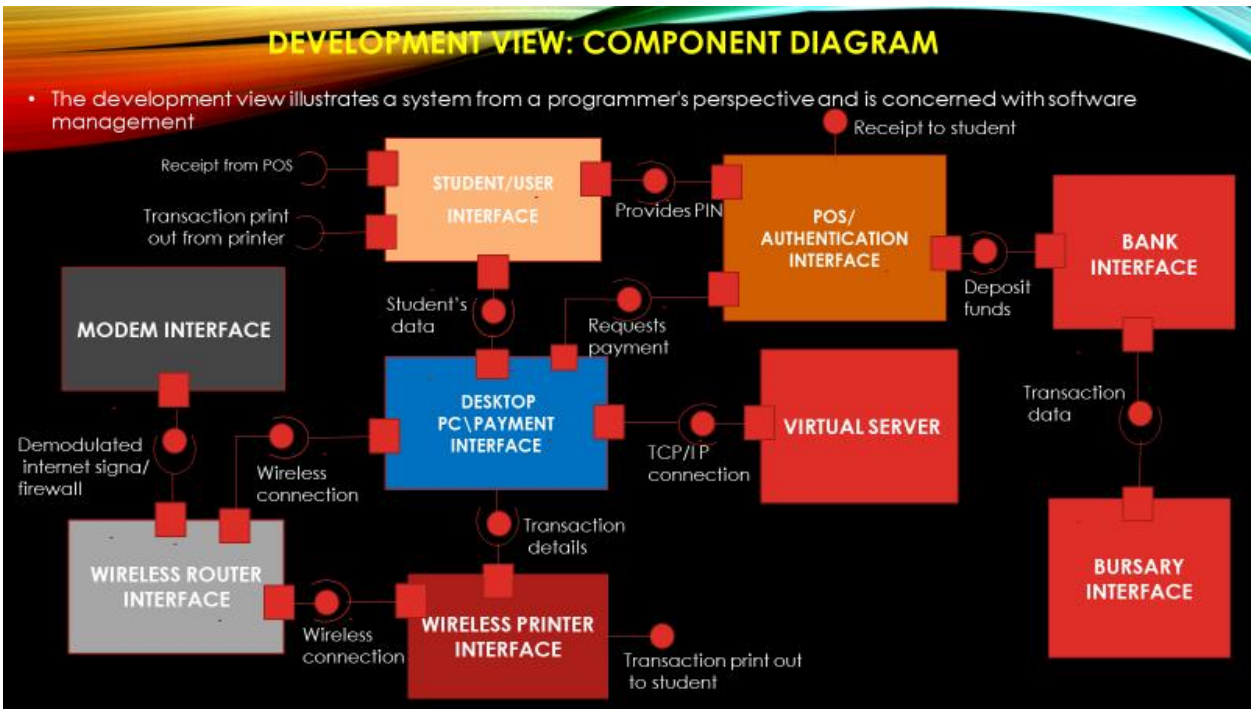
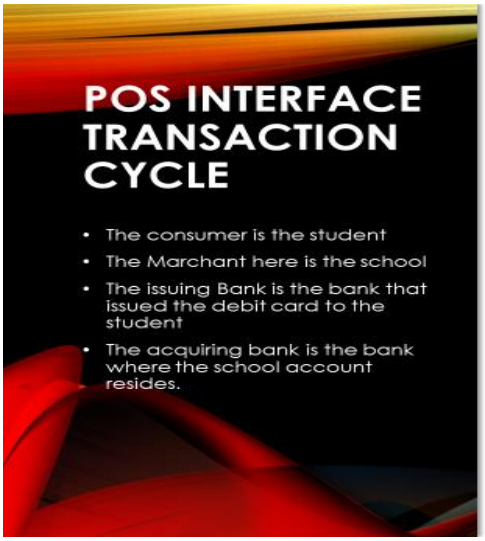


Figure 15.1.3: Component diagram



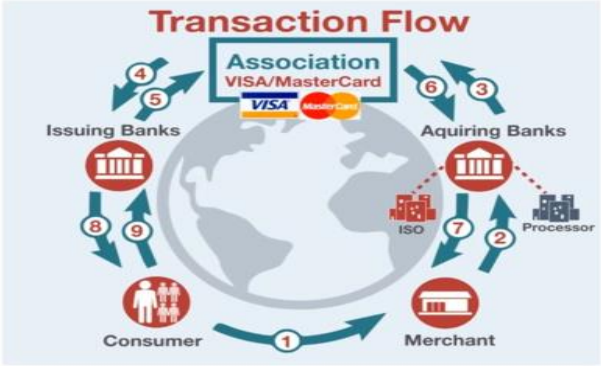


Figure 15.1.3.1: POS payment processing cycle

POS transaction Cycle

- The consumer is the student
- The Marchant here is the school
- The Issuing Bank is the bank that issued the debit card to the student
- The acquiring bank is the bank where the school account resides.

15.1.4 Physical view: Deployment diagram

The physical view depicts the system from a system engineer's point of view. It is concerned with the topology of software components on the physical layer as well as the physical connections between these components. We shall illustrate the physical view with the deployment diagram

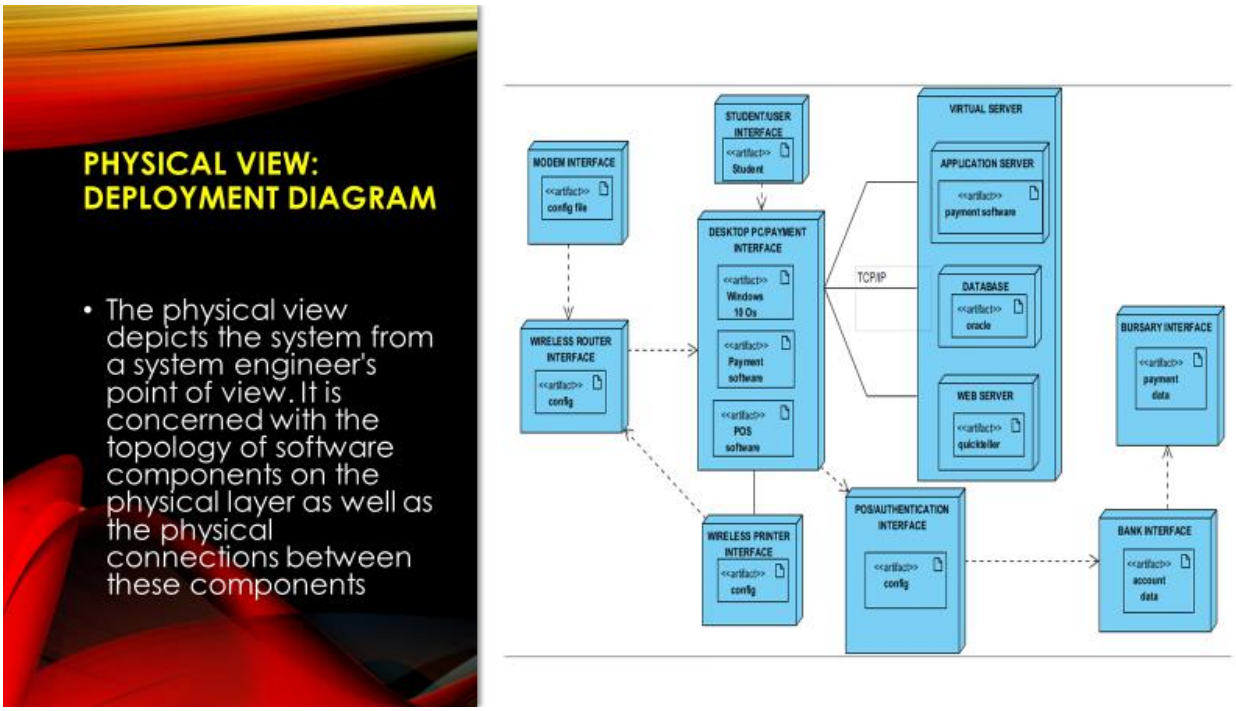


Figure 15.1.4: Deployment diagram

15.1.5 Scenarios

The description of the architecture is illustrated using a small set of use cases, or scenarios, which become a fifth view. The scenarios describe sequences of interactions between objects and between processes. They are used to identify architectural elements and to illustrate and validate the architecture design. They also serve as a starting point for tests of an architecture prototype. This view is also known as the use case view. The figure is a use case Diagram of making payments.

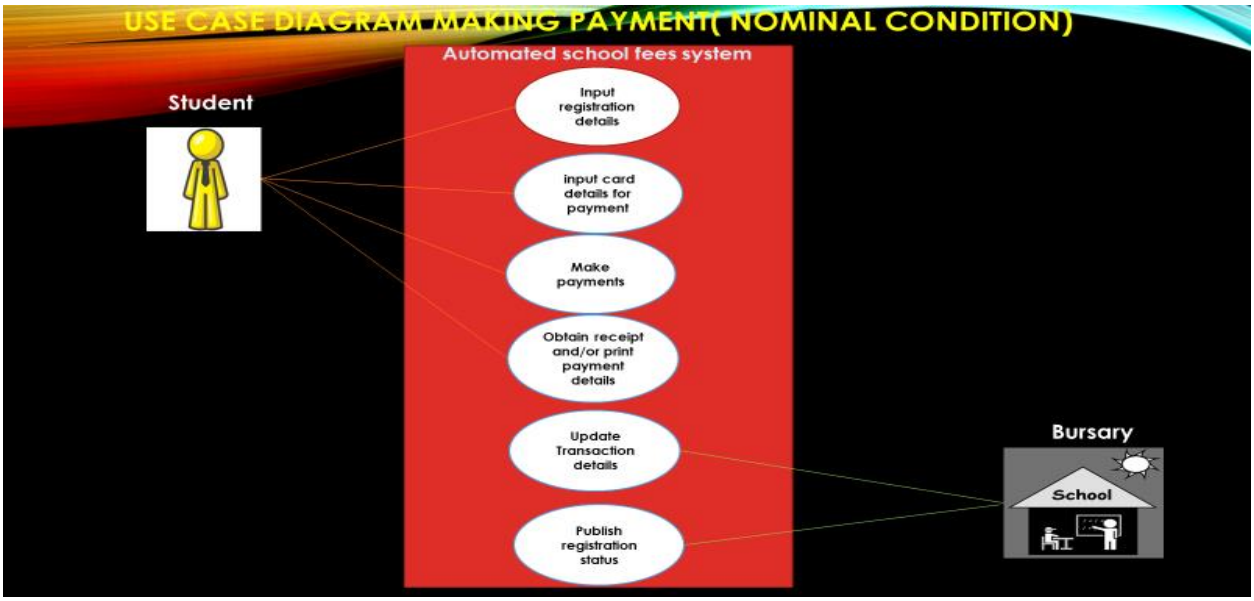


Figure 15.1.5: use case diagram

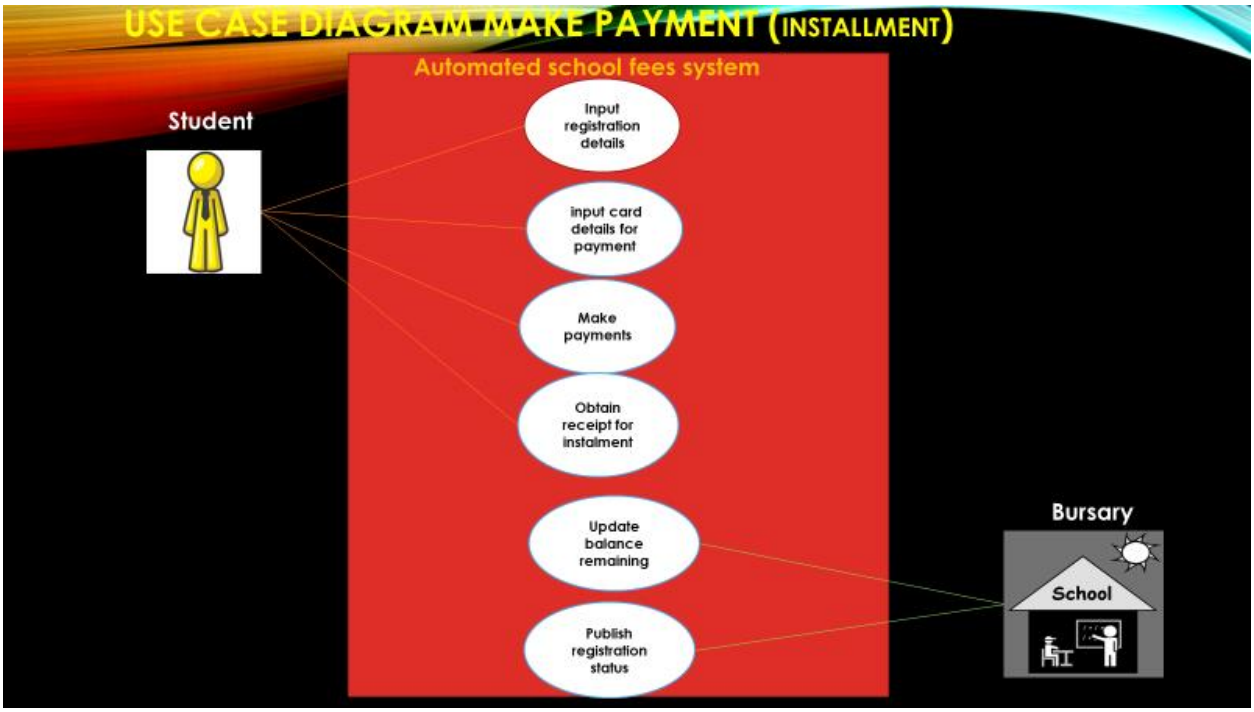


Figure 15.1.5.1: Use case diagram (installment payment)

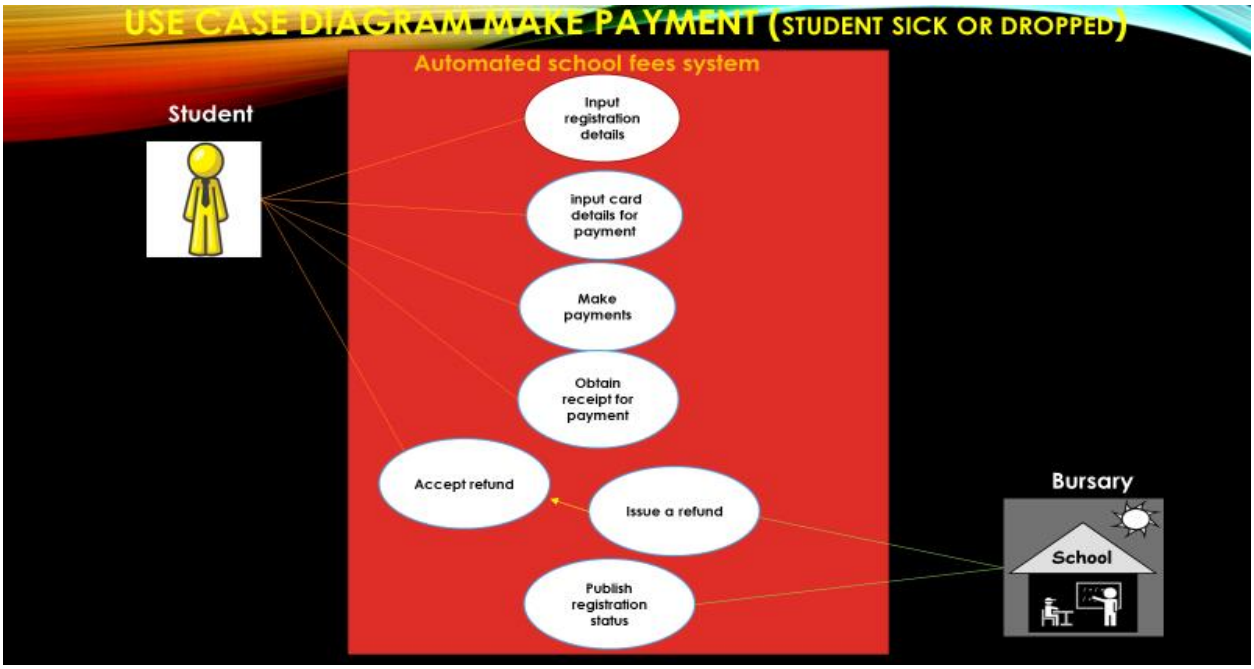


Figure 15.1.5.2: Use case diagram (sick leave / drop)

16. System Design

This project is proposing an automated school fee transaction system that will be situated in the school bursary office enabling students to make payments by logging in and electronically filling out information or details required for the transaction. This system will also be accessible through the school website. The design of this educational payment software shall be done by IT experts and customized for the school's needs.

Here we give insights into what the design will look like

This system will accept input from the keyboard and displays the output on a report from which could be viewed and printed. The logical steps and procedures are listed below:

- Input Design
- Output Design
- Flowchart

Input Format

This system will get data from the keyboard and using forms.

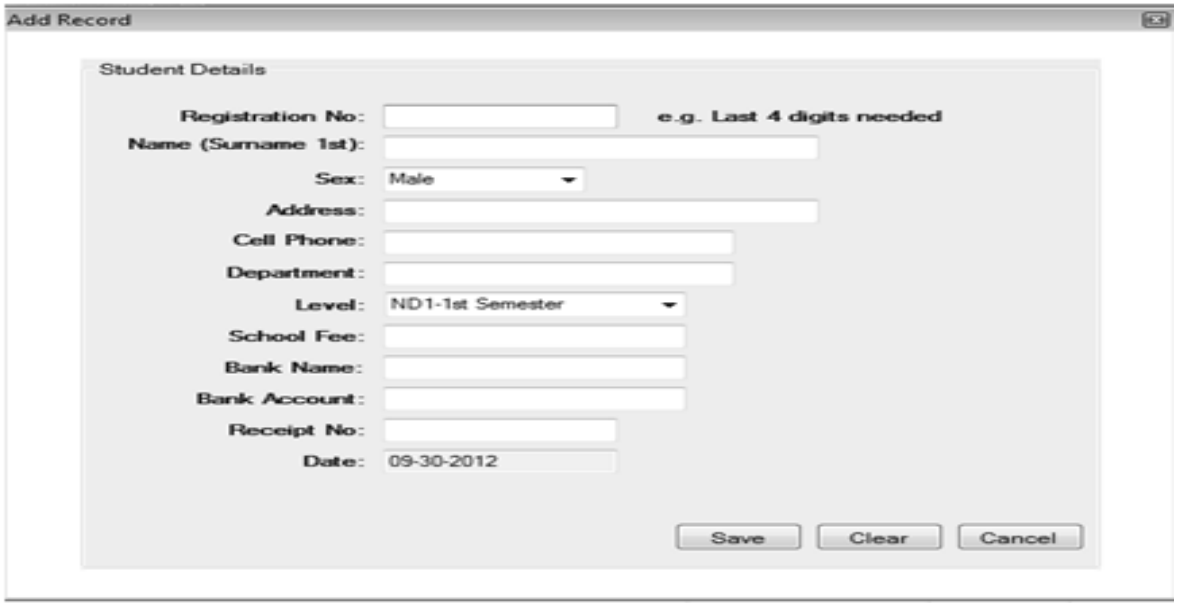


Figure 16: Input design

Output Design

The system will display a printable receipt in this format:

- REG. NO:
- SURNAME:
- SEX:
- ADDRESS:
- DEPARTMENT:
- LEVELS:
- FEES:
- BALANCE:
- BANK
- ACCOUNT NO:
- RECEIPT

The system will display the output in a tabular form which could be viewed and printed

16.2 Output design format

Our description here is simply a design description of how the automated system software will run.

16. 3 System design flow charts

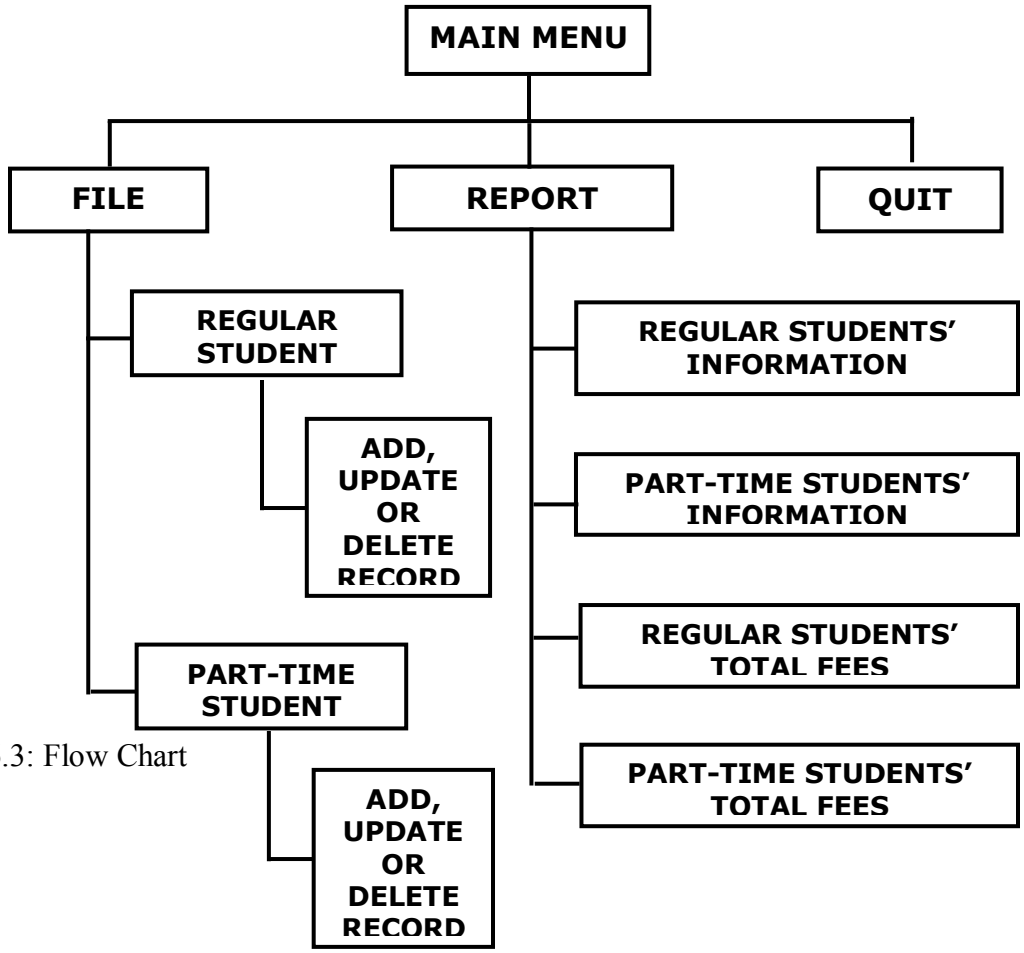


Figure 16.3: Flow Chart

17. Lean approaches and principles

A look at the current System

A look at the current system will help us to appreciate the need for a system that will satisfy the attributes mentioned above. We are going to use the OV-1 AS IS and Value stream mapping to capture the current steps involved in the current manual transaction method while laying out the processes and steps that will be involved in the future system.

Value stream mapping of the current system

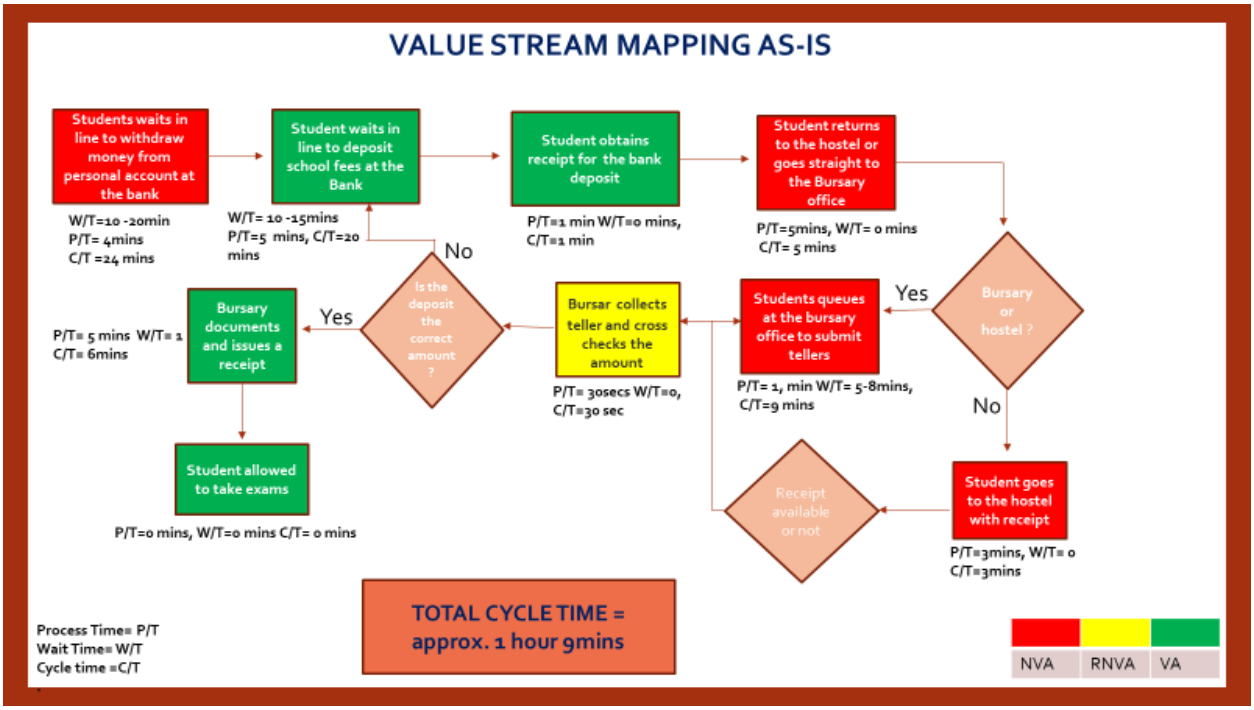


Figure 17: Visual stream mapping AS-IS

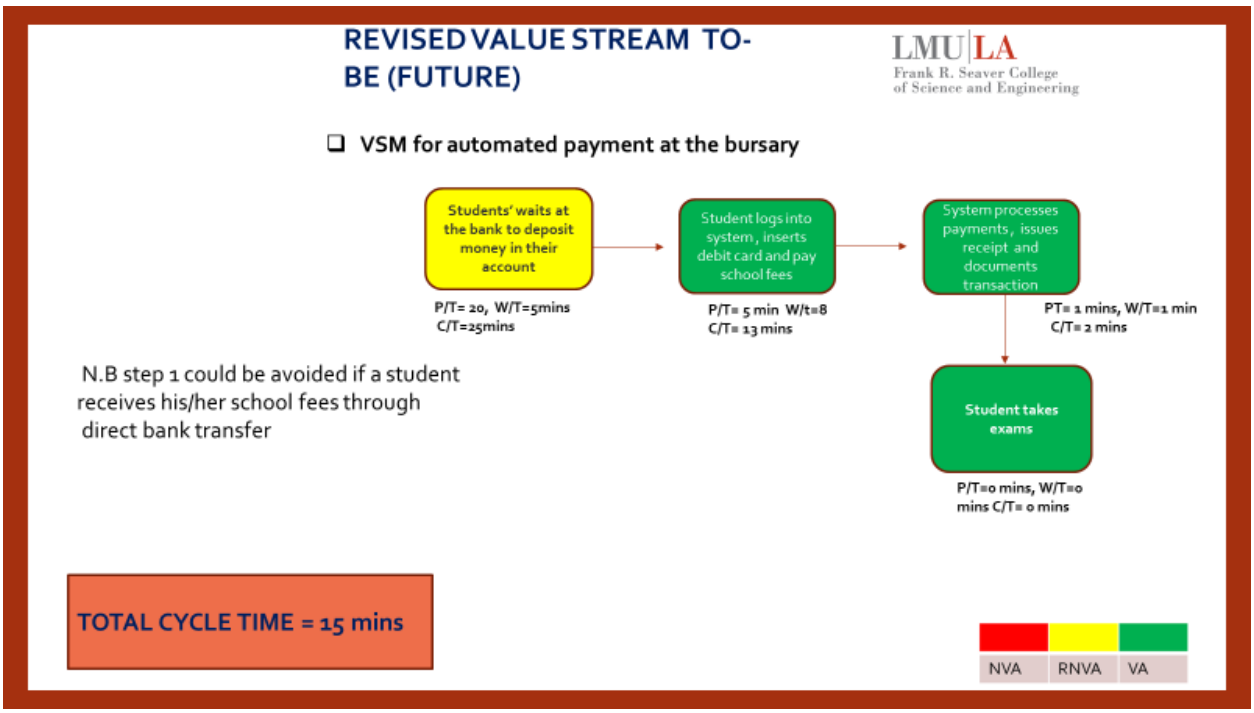
Applying the theory of constraint:

A careful look at the current system of school fee transactions highlights several non-value-added steps in the systems that the future system will address for improvement to be made. The major constraint identified in this system is the disconnect between the Bank and the school that leads to double receipting; one from the Bank and another from the school. To apply the theory of constraint in this problem, we need to exploit this constraint by introducing a system that will interface the school and the bank making thereby eliminating the step of waiting at the bursary to submit receipts from the bank. Once the constraint is exploited, then we are going to subordinate every other step involved in the school transaction to the new system while elevating it by taking

whatever actions are needed to eliminate the constraint. Finally, we keep making improvements by going through the various steps employed in elevating the constraint.

17. 2 Visual stream mapping future system

The future system will eliminate most of the non-value-added steps and the cycle time will be drastically reduced. This future system will include an on-campus and a mobile application payment channel. The transaction data will be held by the school payment system while the POS links the payments with the school bank.



17. 2 Figure Visual stream mapping future system

Value Stream Mapping (To-B) Web Payment

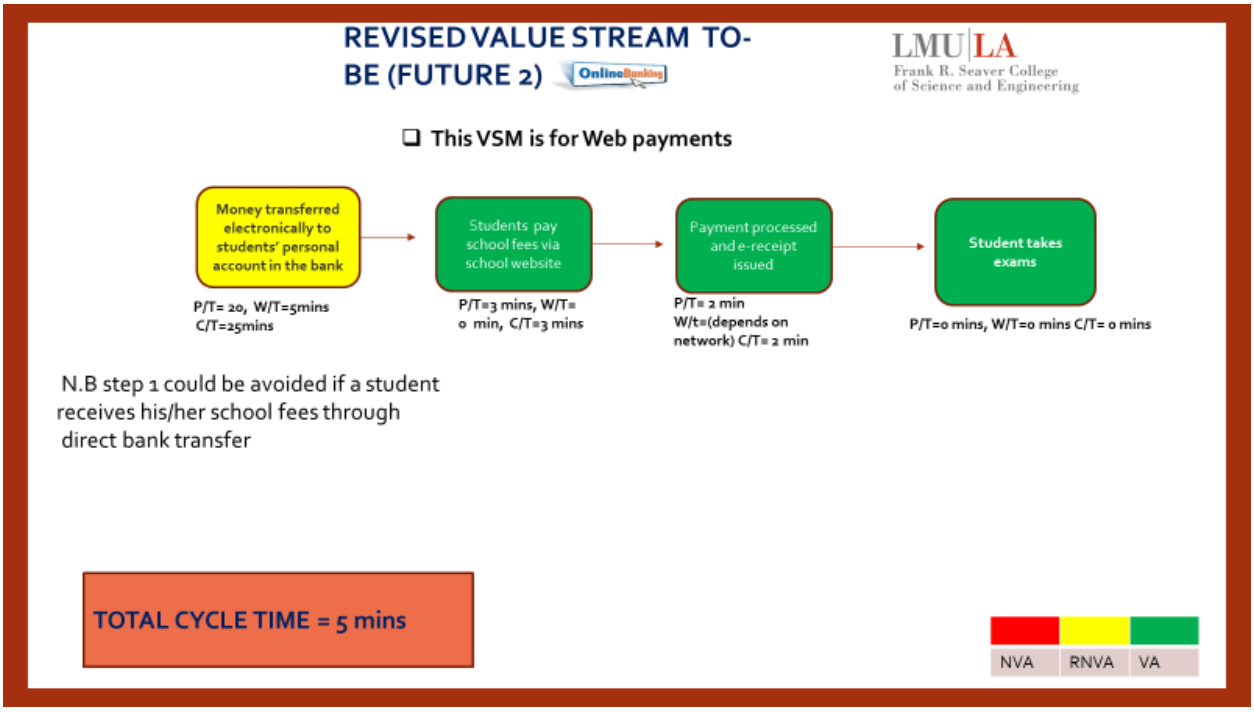


Figure 17.3: Value Stream Mapping future system (Web Payment)

17.4 Flow Streamlining

- Value Stream Map the existing process
  - Identify the Value-added and Non-value-added activities
  - Identify the bottleneck/constraint in the system
- No interface between Bank and School, a serious disconnect
- Exploit the constraints through an improved automated transaction system
- Subordinate every other process in the transaction to the improved new system

17.5 How to make imperfections visible and eliminate the future problem

17.5.1 Improved communication

- The automated payment system will ensure
- Emails and Messaging service (SMS) to students
- Access to students account portal on the school website

17.5.2 Improved processes

- Clear guidelines on how to make a transaction with Andon visuals.
- The system will request for a doublecheck on the information entered before proceeding to payments.
- Erroneous inputs or missing information will be declined to proceed to payments or when the incorrect amount is entered (Poka-yoke- mistake proofing)
- Emailed and printed receipt as evidence of a completed transaction. Used as proof of payment during exams.

17.5.3 Improved Bursary processes

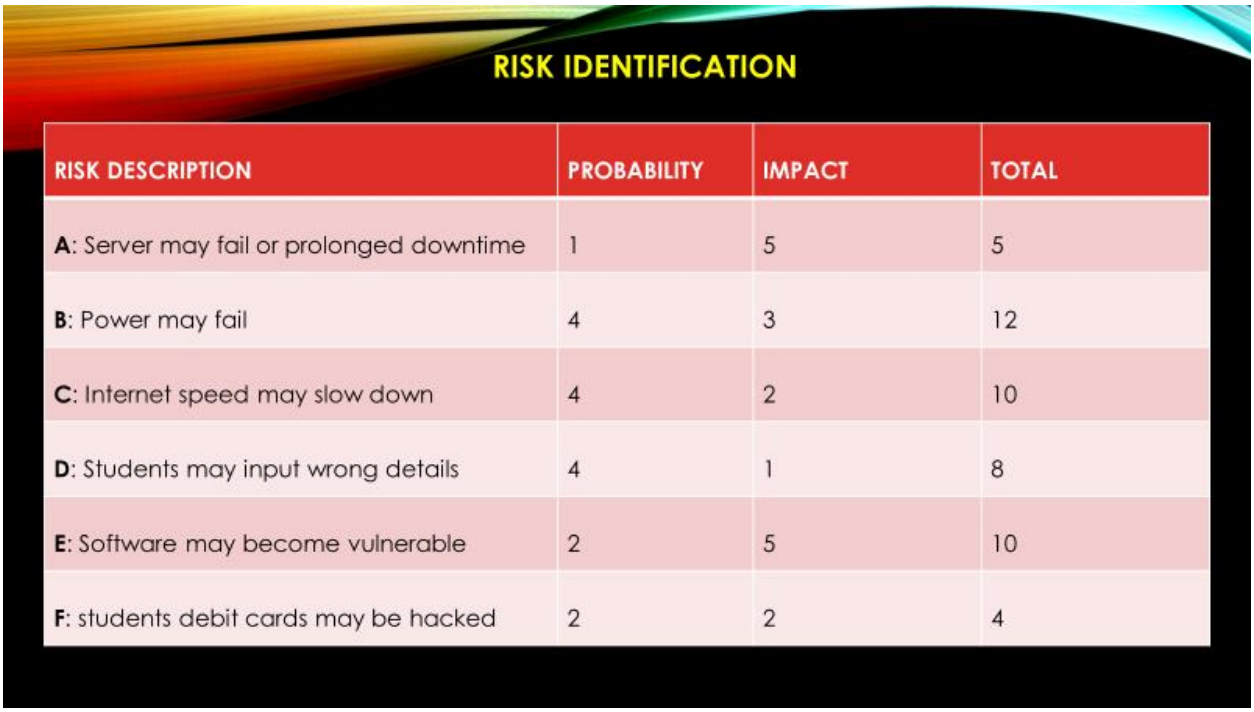
Trained personnel to manage the automated system and assist students in resolving issues regarding payments

18. Risk identification and mitigation

This section will delve into the risks encountered in automating payments through the in-house bursary office and the school website.

Seven risks that may influence the automation of the school fee payment process in Nigeria are listed below in Table ... They were also evaluated on a scale of 1-5 on Probability and Impact, with 1 being very low and 5 being very high. The Total score for each risk was found by multiplying Probability times Impact. These risks were then plotted on a Risk Matrix (Figure…). This Risk Matrix shows that most of the risks have high probability and impact and there need to be some steps towards risk mitigation.

18.1 Risk identification



RISK DESCRIPTION	PROBABILITY	IMPACT	TOTAL
A: Server may fail or prolonged downtime	1	5	5
B: Power may fail	4	3	12
C: Internet speed may slow down	4	2	10
D: Students may input wrong details	4	1	8
E: Software may become vulnerable	2	5	10
F: students debit cards may be hacked	2	2	4

Table 18.1: Risk identification

18.2 Risk Matrix before Mitigation

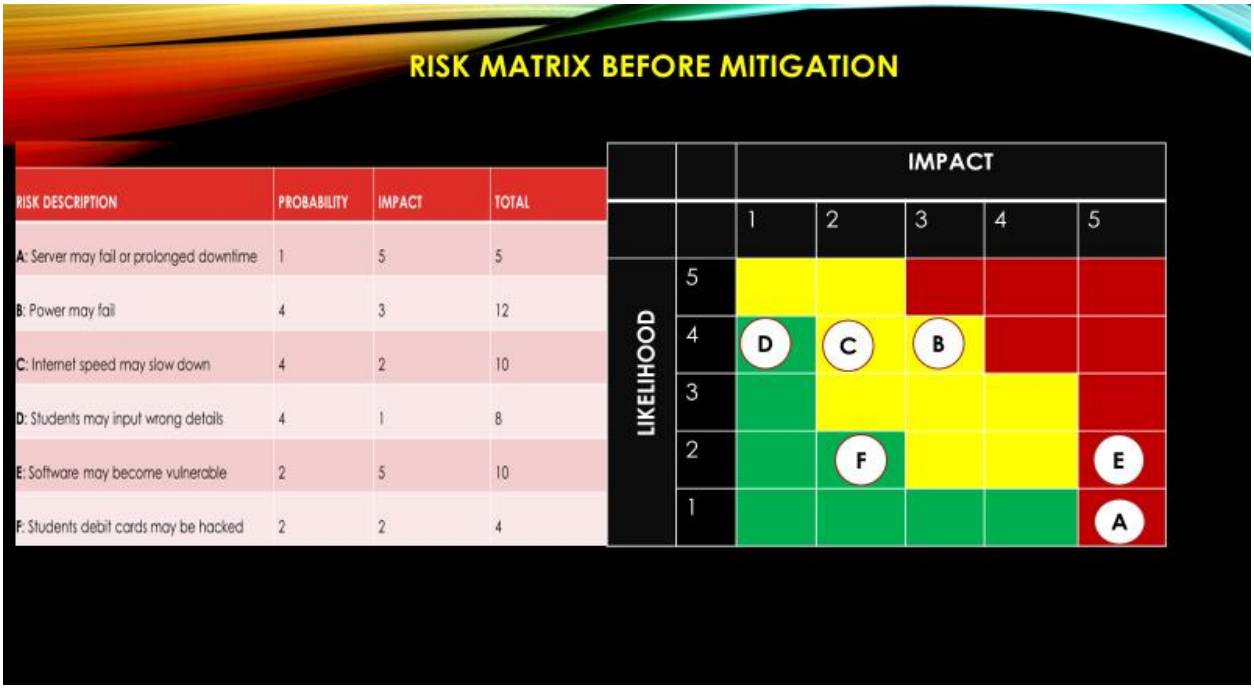


Figure 8.2: Risk Matrix before Mitigation

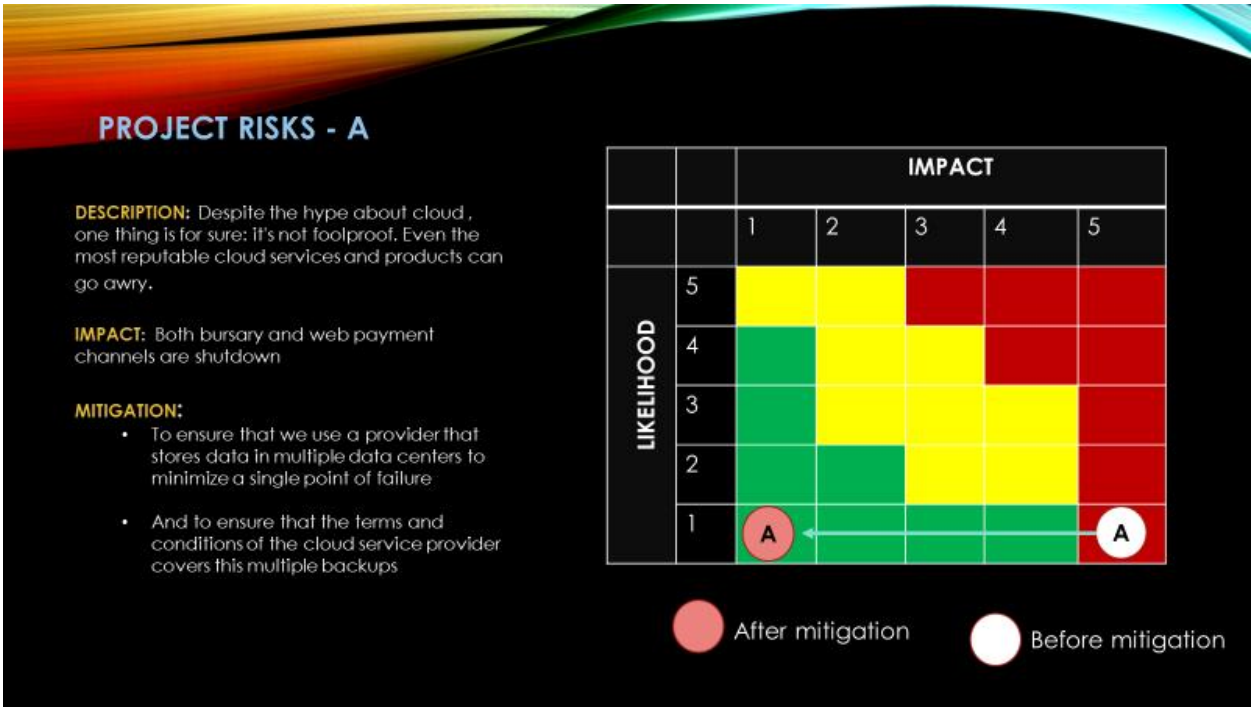


Figure 8.2.1: Project Risk A (Server may fail or prolonged downtime)

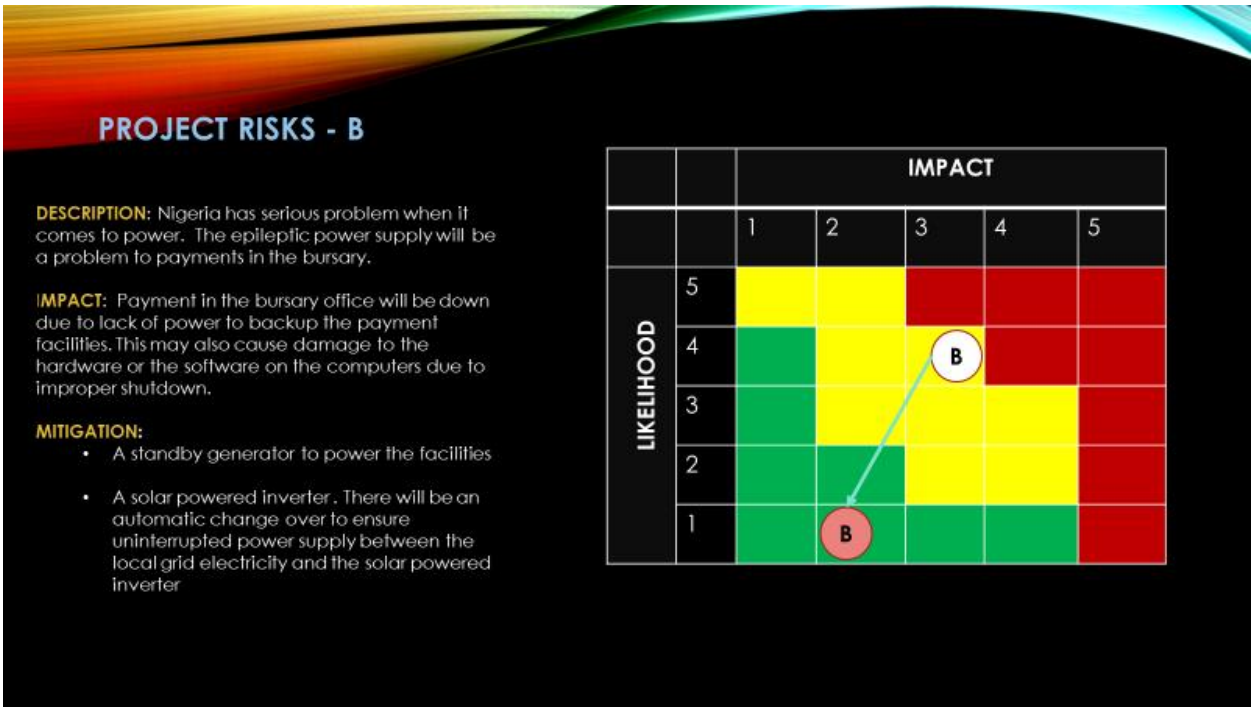


Figure 8.2.2: Project Risk B (Power may fail)

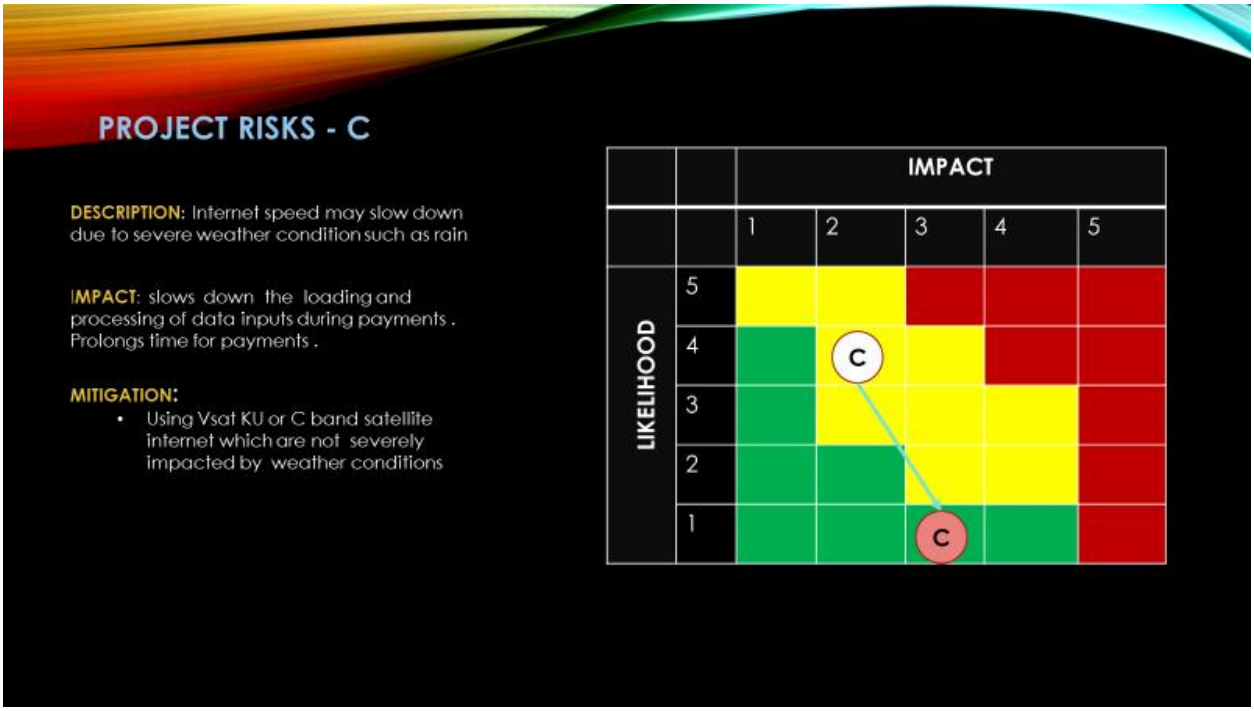


Figure 8.2.3: Project Risk C (Internet speed may slow down)

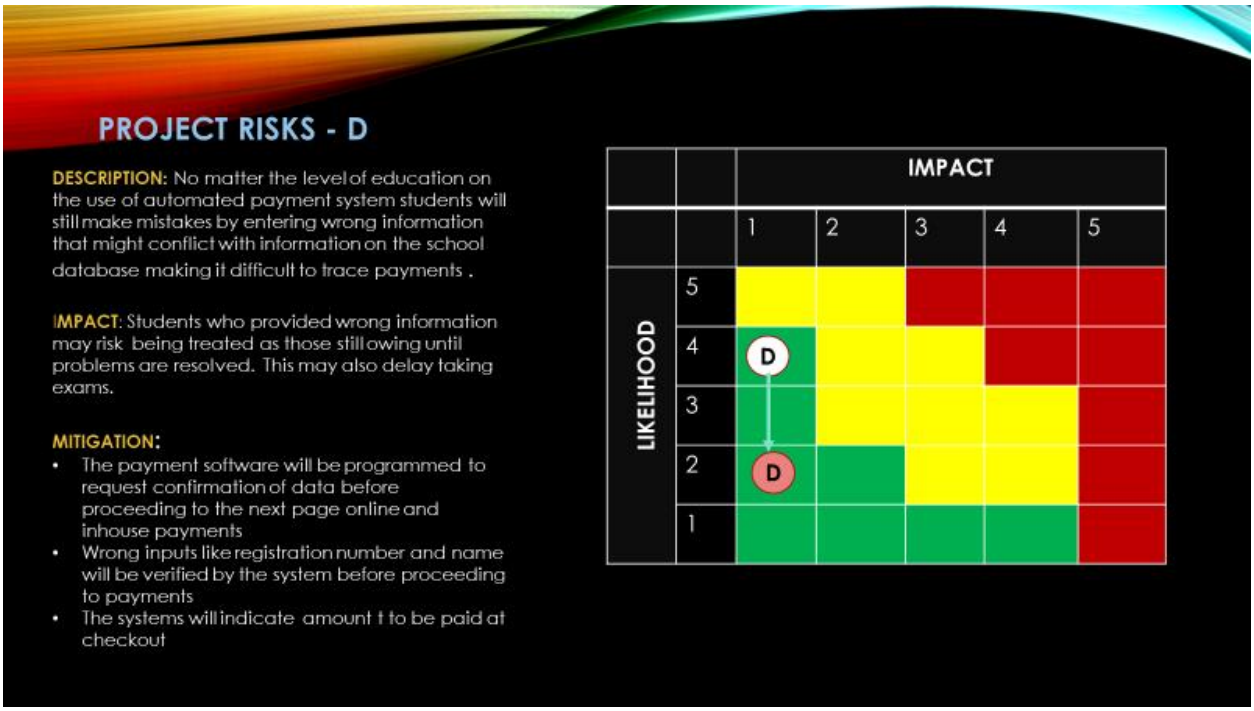


Figure 8.2.4: Project Risk D (Students may input wrong details)

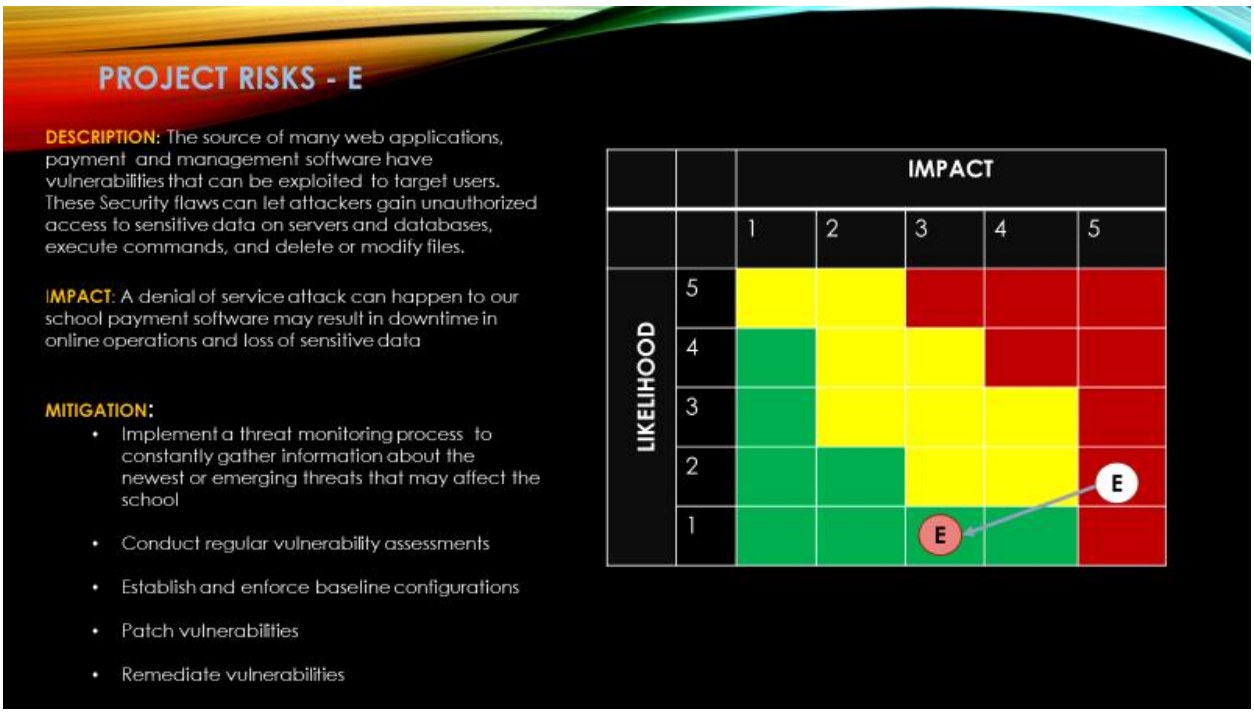


Figure 8.2.5: Project Risk E (Software may become vulnerable)

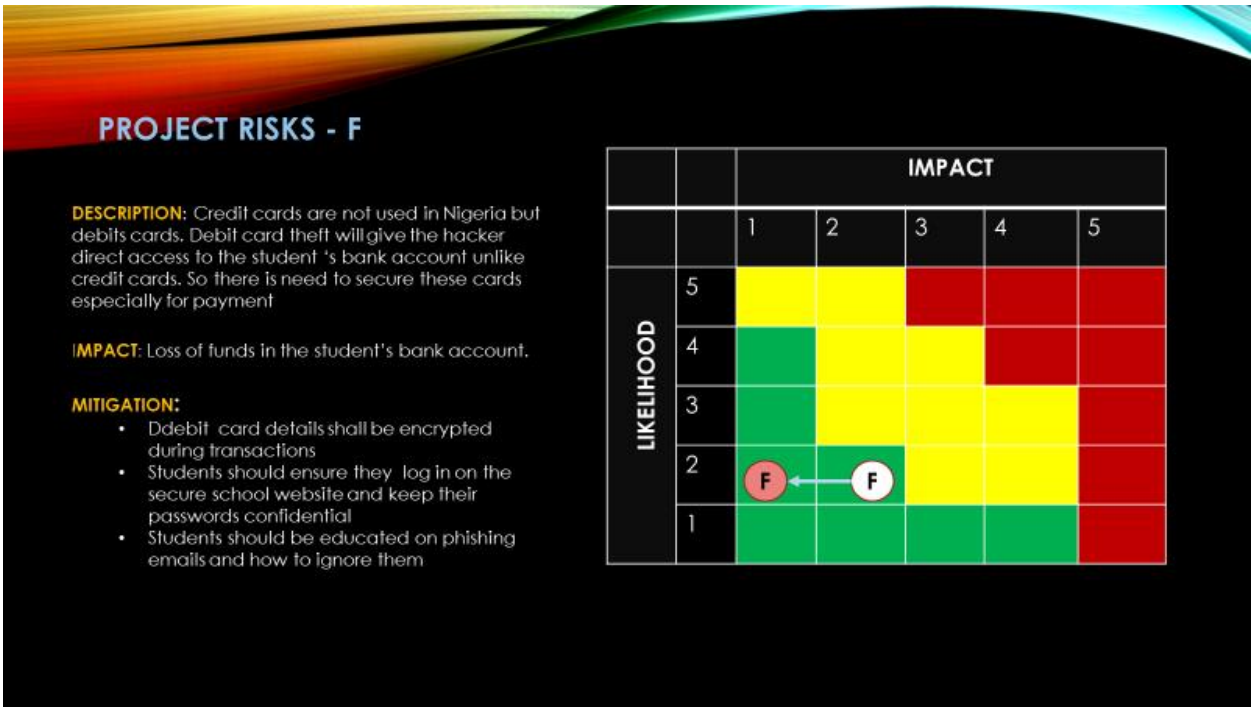


Figure 8.2.6: Project Risk F (Students debit cards may be hacked)

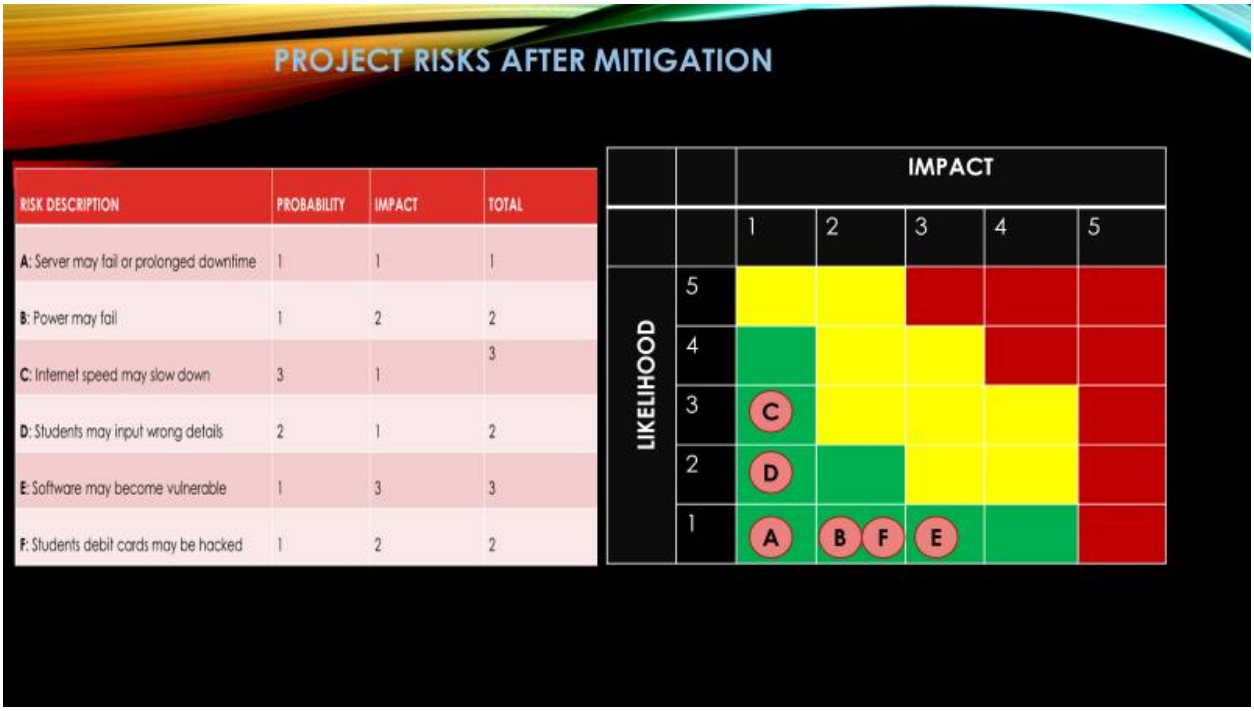


Figure 8.4: Risk Matrix After Mitigation

19. Change management/ communication plan

Reasons for the change

Nigerian universities and Tertiary institutions are plagued with lots of problems among which is the method of transacting school payments. The current dysfunctional method brings with it several redundant factors and constraints inhibiting the proper organizational management system. The disconnect between the schools and the banks which is the major militating factor exposes Nigerian students to untold difficulties and exposure to armed banditry and promotes insecurity and corrupt practices in the bank and school bursary.

A time has come for a new approach to be adopted in the light of new technological advancement in payment automation, information security, and database management. Manual payments involving students moving from bank to bank and carrying multiple receipts around should be a thing of the past. The new automated payment system we are proposing will give both parents, students, and the school greater flexibility and easy management of finances. While encouraging the use of debit cards for payment to mitigate the risk of armed banditry, time-wasting, and greater accessibility for students to manage their payments. We propose an automated payment in the bursary and on the school, web using Interswitch payment processing. An educational payment software will handle the overall database management, while a cloud service provider backs up every data in the cloud.

Type and scope of change

The change involves moving from the manual method of school payments or transactions to an automated payment system, which will be limited to the official fees paid every year in the school such are tuition and boarding. This change will affect mostly those working in the bursary office who will not lose their jobs but redeployed to other services and some others trained to work with the new system. This change will require some changes in the school payment policies and will involve some structural reforms to the bursary office. The school ICT office will be integrated as part of the new system to ensure interoperability between to two.

Stakeholder support.

Early on in this project, we identified the university, the student and their sponsors, and the primary stakeholders but we also have other stakeholders like the government, the Bank, the ISP and ICT providers, etc.

This change will be sponsored by the university with support from the budget allocation from the federal or state government. Students would also be asked to contribute a token to their support through their sponsors. ICT fees collected from students every semester shall be dedicated to running the entire system yearly since the school ICT and the new payment system will share the same internet facilities as the Vsat Ku or C band internet service. The Bank the school uses shall provide POS machines. Other stakeholders will provide their respective support.

Communication with stakeholders (RASIC communication matrix)

R-The school / the federal or state government shall be responsible as project sponsors

A- Approve: The senate that is the university governing body will approve the need for the change.

S-Support: Student through their sponsors and possibly interested NGO's will support

I- Informed: The students and their sponsors and the bank are directly impacted by this change and should therefore be informed.

C- Consult: The Internet service provider (telecommunication company), the information communication and technology provider (cloud service and COT's software) the Power company (solar power backup), and the Bank must all be consulted.

Communication Plan: A communication plan shall be created to communicate with each stakeholder. Emails, face to face meetings, or video conferencing tools shall be used to achieve effective communication. The communication will come from the ICT director of the university or the bursar signed by the duo and the vice-chancellor. These I believe have the trust of other stakeholders.

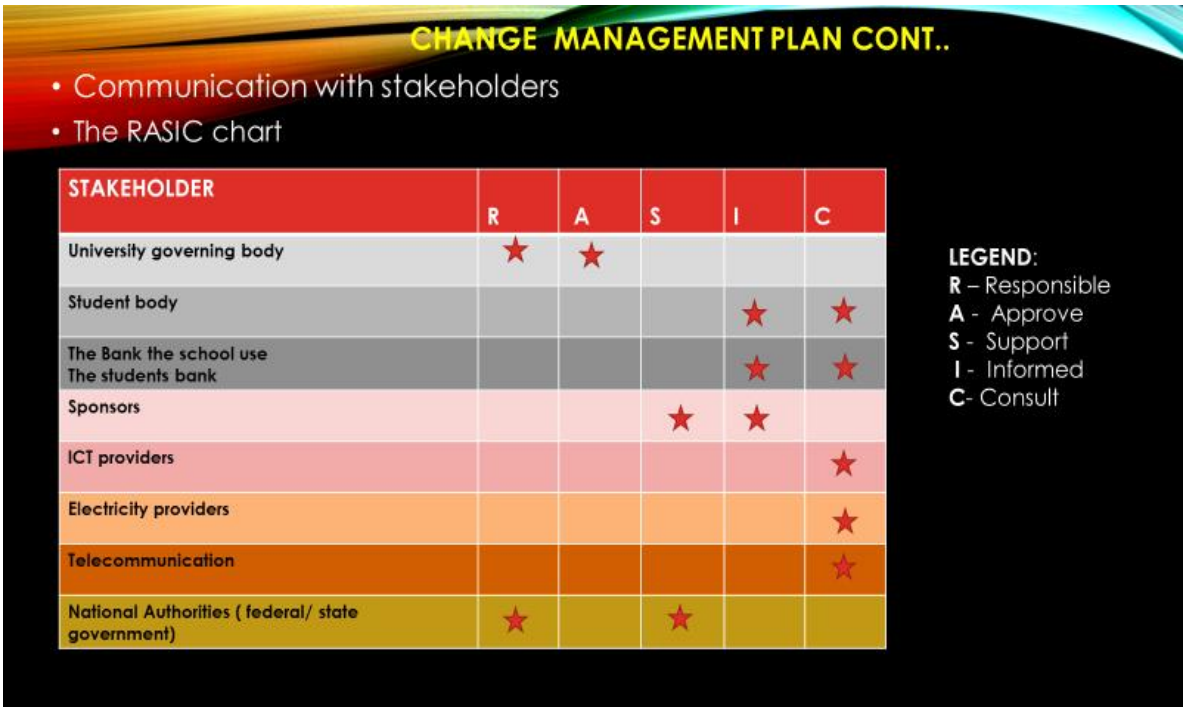


Table 19: Rasic communication matrix

Change management team: This will include the school Bursar and some members of the bursary department, ICT director, Vice-chancellor, Registrar, and someone from the federal or state ministry of education. (change sponsor)

Organization management approach: Other senior academic and nonacademic staffs shall be allowed to provide feedback on the change and enable each to participate actively in championing the change.

Plan for each stakeholder: The change management team shall address the concerns and risks assessed by each stakeholder, including those who will support the change.

Track resistance: We know that this change will never come without serious resistance especially from those who take advantage of the poor process to exploit students and rob the school. So, we shall monitor the resistance coming from different stakeholders and communicate with them directly to address their concerns and try to convince them of why the change is necessary and to understand the future benefits of the new system.

Roadblocks addressed.

Possible roadblocks will be addressed. Among them are to ensure timely delivery of the infrastructural requirements and structural changes when the students are at home during a long vacation.

For the start, a small group of students shall be used to test the new system that the beginning of a new academic year while it is gradually rolled out to the entire students.

Personnel from the bursary office shall be trained before the beginning of the new system of payments. This training will be undertaking by the Software provider who will also support the system too.

20. Ethical considerations.

Nigeria as one of the most populated countries in Africa is divided along with multicultural and multi-ethnic groups and with a relatively short history of democratic governance, has not found its feet in technological advancements when compared to the Western world. Technologically speaking, she is still at the cradle of development. Most of the things that would ordinarily not be a problem in western society are serious problems to deal with in Nigeria; electricity, for instance, is one such.

We considered Some of these ethical issues affecting the project as it pertains to automation payments in Nigerian universities and Tertiary institutions.

Insecurity

From a survey, we conducted in the course of this project in two universities 8 out of 40 students reported of having been robbed on their way to pay their school fees in the first school likewise in the second school, 10 out of 40 reported of having been robbed on their way to the bank to pay their school fees. This is the current unfortunate situation and it is happening because students must pay cash into school account, and often must move money from one bank to another. In a country that has serious security challenges, Students should not be encouraged to move money around and any system that makes this possible should be a welcome one. This issue of insecurity would be addressed by implementing a cashless automated system of transaction that is incongruent with the Country's policy of cashless transactions which came into effect on July 1, 2014. The life of students cannot be jeopardized because of a lawless and insecure system. The life of our students must be protected, that is why we need to automate payments.

Corrupt practices/ insider fraud

The major reason why things are not working well and why this project will encounter a lot of resistance is because there are many bad eggs in government and in the university system who make their living trading on corrupt practices, extorting money from students in a bid to help facilitate or make up of for the inadequacies and poor processes in the current system of transaction. Both the banks and schools benefit from this. Students from our survey reported having been charged extra money to rectify a missing receipt at the bank and the school. This system that aids those corrupt leaders is what this new automated system will scrap completely, making payment processes transparent and eliminating sources of conflicts and extortion as experienced in the old method. Since no one will pay with cash, no one in the bursary would ask the student to pay any extra token with cash for whatever reason and at the bank, no one will charge them any extra to reproduce a lost receipt since there would not be any need to submit any receipt to the bursary office in the school.

Students duping their sponsors

Not only are there corrupt school administrators but many students have been influenced by these corrupt eggs in the system.
Before now many sponsors don't have access to the payments they make for their children in school. This creates an atmosphere and an opportunity for most students to lie and exploit their educated or non-educated sponsors by demanding more than what is required for school payments. If this automated system is implemented, the sponsors would have access (if request) for the payment history of students they are sponsoring. They will have the opportunity to pay directly with their debit cards online for the students they are sponsoring, hence greater transparency is achieved.

Poverty alleviation

While we believe that this system can be implemented, we are also concerned about how this system can contribute positively to reducing the level of poverty in the country. In a country where government scholarships, grants, and loans are inexistent, a child cannot go to school if the parents cannot afford to pay. The government does not help, the leaders are insensitive. We strongly believe that if funds are secured by way of automating the transaction system and thereby increasing the revenue stream of a school if funds are judiciously managed by the university, many students will have the privilege of obtaining merit-based scholarships to study. Finally, the government needs to shun its insensitivity and leaders shun corruption and embrace new developments that will improve schools in Nigeria. The federal government must list education among its top priority in the country's annual budget. This will bring the needed change that will drive technological advancements like this automated payment solution.

Unemployment

Automating payments might encounter serious challenges especially from employees at the bursary administrative unit because of fear of losing their jobs. In a country that has up to a 60% unemployment rate, the resistance becomes much stronger. This human factor shall be put into consideration. Rather than dismiss workers, they shall be redeployed to other administrative works

Modest transaction fee

It is presumed that the Bank and the school will be charged reasonable/modest fees for transactions and not hijack it for unreasonable gain

21. Summary and conclusion

In an age of technological advancements and where artificial intelligence is taking over the workspace especially in those areas that require repeatable tasks and logical reasoning, standardizing administrative processes to enable them to be automated in the future becomes the ideal. Change is one constant thing, though humans may be resistant to change due to perceived dangers, when finally embraced, brings about unimagined improvements to administrative processes. Automating school payments not only increases the revenue stream but brings along aside with it an improved and more efficient way of handling payments and managing them. In the course of this research, we considered and analyzed a different alternative to automating payments based on earlier defined stakeholder needs and concerns. After a successful trade study, we adopted an in-house bursary payment with automated customized (COTS) payment software that is cloud-hosted, together with a web-based payment processed by Interswitch which an indigenous payment processing company is. These two alternatives will provide the needed improvement from the manual and inefficient process of making school payments. Various risks that might affect this project were discussed and mitigation strategies proposed.

The requirement for this system was carefully defined following stakeholders' needs.

Architectural views of the system helped in a greater appreciation of the hardware and software requirements and data flows within the system.

This project involves an organizational change in management so we equally looked into how this change will be managed at the organizational level. Ethical considerations were not left out as they are so vital to the motivation of this change.

The lean management principles we applied to this research helped to highlight what is value-added and what is not in the annual method and how we can streamline value flow in the automated system and expose imperfections hence making the necessary continuous improvement in the system.

Conclusion

Society has changed. More efficient ways of making payments continue to evolve. Repetitive and standardize operations like making payments can be automated. Automating school payments is ideal for any institution that wants to grow in this age of technological innovation.

Payment automation is a mature technology that is feasible even in developing countries like Nigeria. The infrastructural requirements and payment processing technologies are readily available making it economically and technologically feasible to implement. Organizational change management will be the greatest hindrance to actualizing this project.

21.1 Proposed Implementation Plan

The implementation of an automated payment system as proposed in this project will span through a period of 1 semester which is 4 to 5 months. A limited pilot shall be done within the last week to the end of a semester while full rollout will commence at the beginning of a new semester. Here is the implementation plan:

1. Infrastructure Definition / Stand Up (e.g. development environment, test environment, production environment)

2. Develop the system back up and failover capabilities

3. Develop Verification Test Data Sets (e.g. functionality, security, stress testing, back up, failover, et al)

4. Execute Verification Testing

5. Develop Stakeholder / User Training and Reference Materials

6. Conduct Stakeholder / User Training

7. Define and stand up stakeholder/user support resources (e.g. real-time, on-line, off-line, etc).

8. Limited Pilot (e.g. perhaps summer session for a given college/university)

9. Full implementation roll out (first institution)

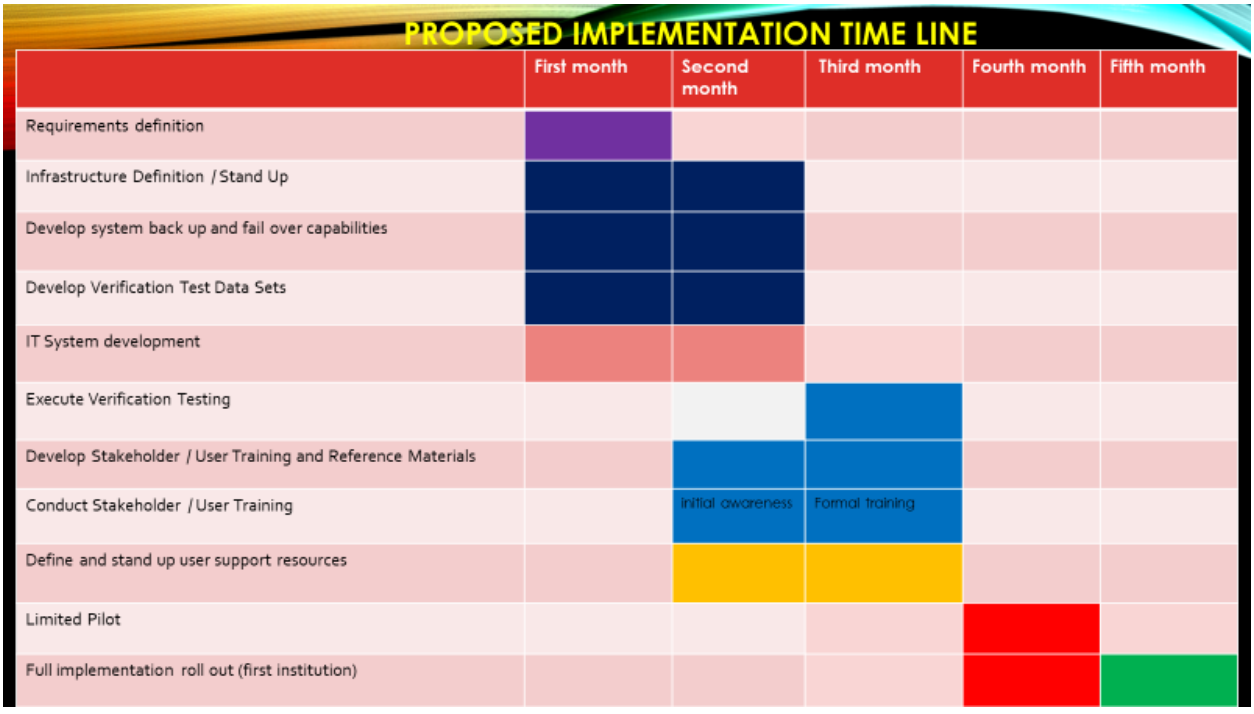


Table 21.1: Proposed Implementation timeline.

22. Application of Lessons Learned

- Stakeholders: who they are, their needs and concerns were defined
- A survey conducted in two institutions helped to understand the problem and motivated this project
- Alternatives were first considered before the solution. The most feasible alternative (because no alternative satisfies the entire stakeholders' needs) after a trade study
- The entire life cycle of the system was kept in focus
- Lean principles helped to define value, and make value flow by eliminating non-value-added activities or steps
- Continuous improvement of the system was kept in focus
- ITIL helped to define our requirements and will provide best practices in IT management suitable for this system
- Research on the capability maturity model (CMM) helped to understand the maturity level of the current system and the ideal level for the future system
- Pugh multi-criteria decision analysis method enhanced our quantitative trade-off studies

2. Acknowledgments

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24. References

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