A Flexible Multi - Currency Electronic Payment System (EPS)

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ABSTRACT: *This paper presents an implementation of a flexible multi-currency electronic payment system. The proposed system operates in local currency and also has the functionality of making payments in different currency. This was made possible by incorporating a currency converter module into the developed system. The technological approach adopted in this work was based on open source solutions. The system is implemented on web-based platform. Apache was used as the Web server with PHP scripting language for server side processing. Open-SSL library was used for data encryption, and role-based authentication was built into the system as security pass-mark for accessing information in the database.*

1. Introduction and Background

The issue of electronic payment system is a recent technological development in most developing countries. The most common payment system available is one that operates in single currency. In this paper, our goal is to build a multifunctional currency payment platform with advantageous features such as:

a. To bring innovation into the payment industry;

b. To Facilitate the move from cash to cashless economy;

c. Help employers of labour to accomplish their major statutory obligations, in respect to:

i. Paying their employees as at when due with ease and without delay;

ii. Paying them in their choice of currency;

iii. Paying them irrespective of their bank account domiciliation.

Maintains and keeps entire records in database for audit and reusable purposes.

2. Electronic Payment System

By definition, electronic payment also known as e-payment is a payment process carried out electronically (United Bank for Africa (UBA) Plc, 2009). In other words, it is a payment that is initiated, processed and received electronically.

Similarly, electronic payment system (EPS) is a payment application that enables monetary values to be transferred digitally.

History revealed that the commencement of electronic payment system (EPS) began with electronic commerce (e-commerce): trading of goods & services, making fund transfers, and delivery of digital contents electronically) (Vulkan, 2003). Thus, EPS has attracted many researchers throughout the globe. Success in these researches has brought about advancement in the payment system and opened new findings in restructuring their inflexibility, insecurity, and proprietary standards (Abrazhevich, 2001; Ballare *et al*, 1998; and Kuttner and McAndrews, 2001)**.**

The major challenges facing the adoption and implementation of EPS include the issue of security and trust. People wonder how payments and transactions can be made efficiently, reliably, and securely (Hsiao-Cheng *et. al*, 2002), because:

i. All electronic payments are made over a telecommunications network such as the Internet.

ii. Parties conducting e-payment transactions have usually never seen each other face-to-face, and

iii. They also have never exchange currency or hard copies of documents hand-to-hand.

Hence, the adoption of this payment mode was not initially supported. However, due to increasing demand for flexible payment integrations, there has been a continuous innovation and consolidations by different bodies and researchers across the globe, working hand in hand to improve the system (Anyanwu *et al,* 2011). The secure socket layer (SSL) technology has also played an important role in establishing trust and facilitating the adoption of e-payment system in our society today.

3. Design of a Flexible Multi - Currency E-Payment System

This section outlined the design steps taken prior to the implementation phase of the proposed payment platform. These include:

3.1 Overview of the Designed Flexible Multi-Currency E-Payment System (FMC-EPS)
The system is designed on client/server architecture, developed on the windows network groups. It comprises of two main parts, which are the User Interface Module and the Server Module. However, the work presents only the user interface module. This is shown in Figure 3.1
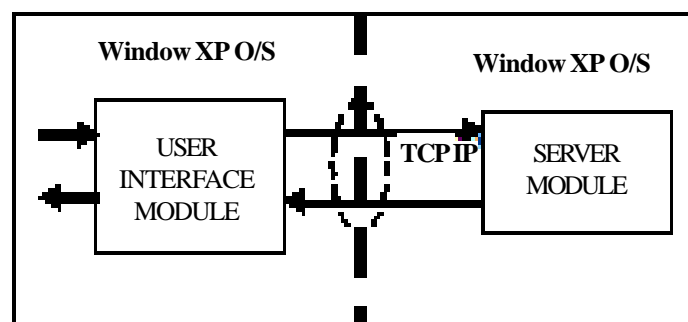

Figure 3.1. The Model of the Flexible Multi- Currency E-Payment System

The function of this module is to send request made by user to the server. The server stores all transaction-logs in a set of data files. While the communication between the user and the server is via Transmission Control Protocol / Internet Protocol (TCP/ IP). The database management system serves as a tool for storing data into the database, as well as retrieving information for all the system users.

3.2 The User Interface Module

The user interface module for the client system is a linked process between the clients and the server system (Pyae, 2008). It accepts all inputs from the user, encrypts and passes the information to the server for processing, after which, the transaction data is stored in the system database. The user case scenario is demonstrated in the user flow diagram of figure 3.2a. Also, the user interface module tasks can be controlled by the server module event. User interface module flowchart is shown in figure 3.2 b, while figure 3.3 (appendix A) shows an overview of the model system architecture.

Server Flow diagram (b)

User Flow diagram (a)

```
                                            ┌───────────┐
                                            │   start   │
                                            └─────┬─────┘
                                                  ▼
                                            ┌───────────┐
                                            │  On Data  │
                                            └─────┬─────┘
                                                  ▼
                                            ┌───────────┐
                                            │Decrypt Data│
          ┌───────────┐                     └─────┬─────┘
          │   start   │                           ▼
          └─────┬─────┘              ┌─────────────────────────┐
                ▼                    │ Extract Data and Identifier│
     ┌─────────────────┐            └──────────┬──────────────┘
     │  On user input  │                       ▼
     └────────┬────────┘     ┌──────────────────────────────────┐
              ▼              │ Branch to Function Specified Identifier│
     ┌─────────────────┐     └─────────────────┬────────────────┘
     │ Encrypt Request │                       ▼
     └────────┬────────┘     ┌──────────────────────────────────┐
              ▼              │   Update Interface appropriately  │
     ┌─────────────────┐     └─────────────────┬────────────────┘
     │Sent Request Server│                     ▼
     └────────┬────────┘             ┌───────────┐
              ▼                       │    End    │
         ┌─────────┐                 └───────────┘
         │   End   │
         └─────────┘
```
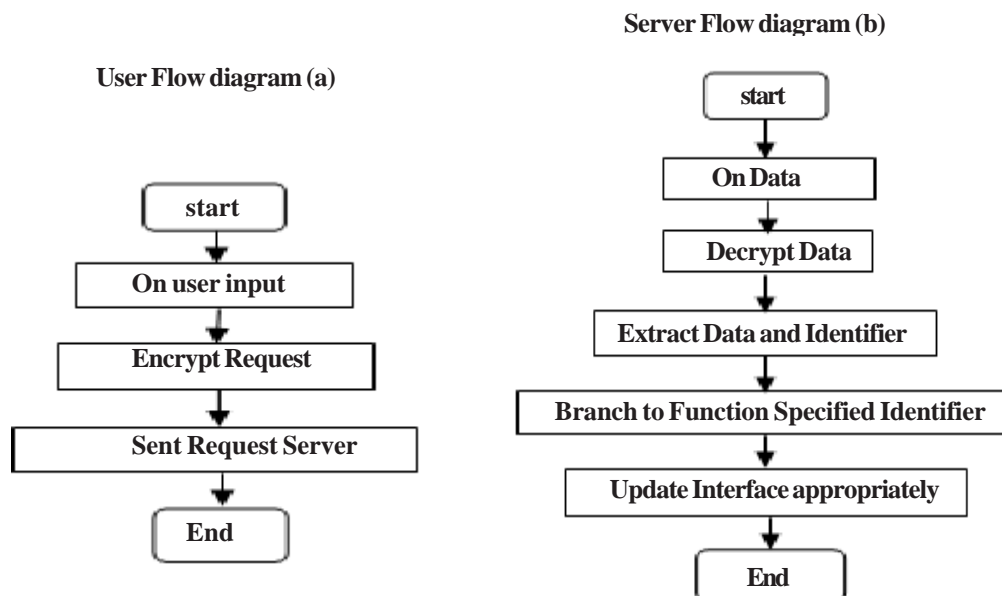
Figure 3.2. User Interface Module Flowchart

Figure 3.3 in Appendix A, depicts the proposed e-payment system architecture. The users first initiates an action by connecting to the e-payment platform to the client server through the client's Local Area Network (LAN). Data are initiated for processing while currency are converted (based on account type) with the possibility of an incorporated currency converter. The initiated data are routed through LAN to the main server (Financial Institution's server) residing in the base station. Users have access to the main server via internet connectivity. All the data from clients to the main server are housed in the Database Server, and only accessible through the backbone network. Each workstation has an installed customized payment modules that helps to access the database server via the backbone network and facilitate direct transfer of chosen monetary values to beneficiaries that maintains accounts with the financial institution's branches. While values for other banks are sent through inter-switch or NEFT (Nigerian inter-bank settlement scheme (Nibss) Electronic Fund Transfer) for onward forwarding to other banks' processes.

4. Technological Approaches

This section shows the technological approach used in the design of the Multi-Currency E-Payment System. Inherently, the design stage consists of: (a) web-based system architecture, (b) structural design, and (c) database design

4.1 Web-based System Architecture
Figure 4.1 displays the architecture of the adopted web-based application.

This architecture shows the communication pattern from the backend tier to the frontend tier. APACHE web framework (WAMP server) is used as a host (open source web server). The main purpose of the WAMP Server is to run the programs (PHP scripts) on the server, based on the user's query.

In figure 4.1, the Web browser shows the communication link with the host (Apache), which thus runs the PHP scripts, thereby enabling the script to dynamically display contents from the Database(DB) unto the user browser (web to DB connectivity). Data are retrieved to the user browser from the Database, and the output styles are also displayed on browser located at the client system. However, without the client server or browser to link data, communication will not commence, and without
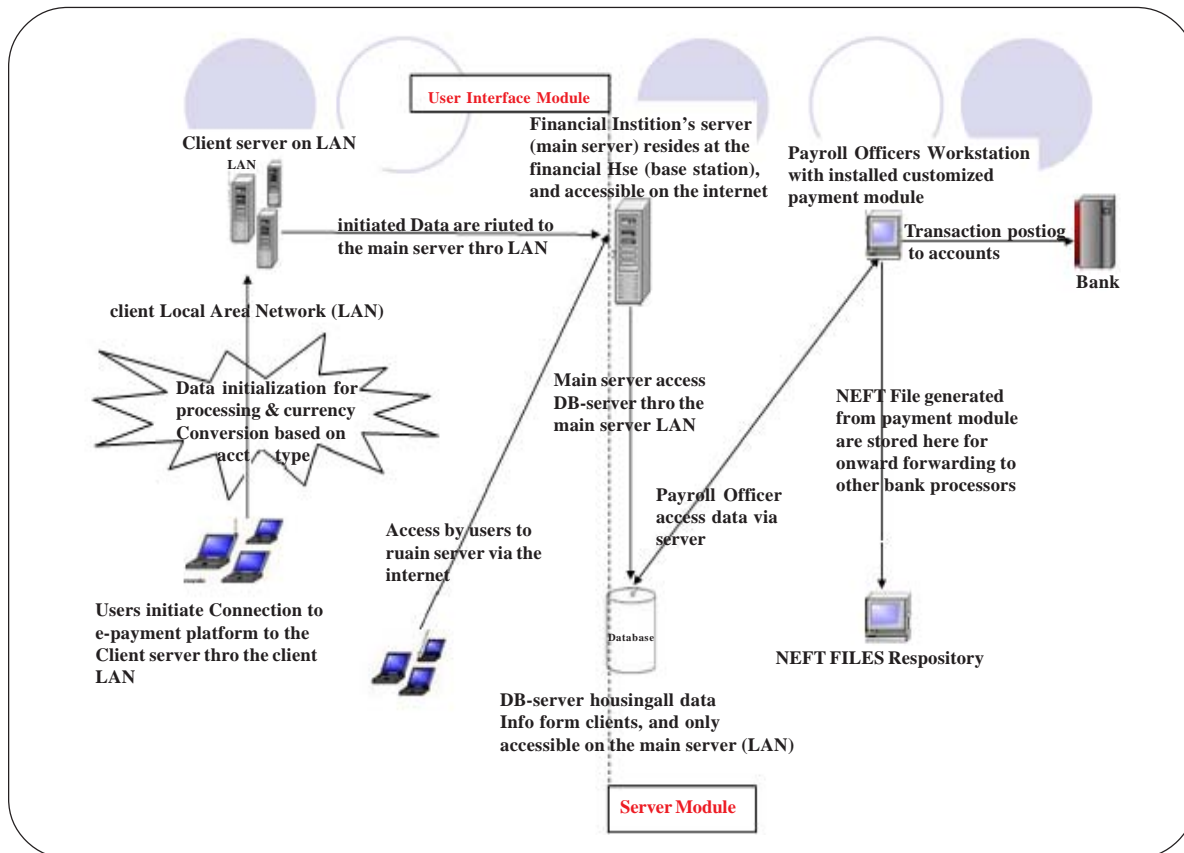
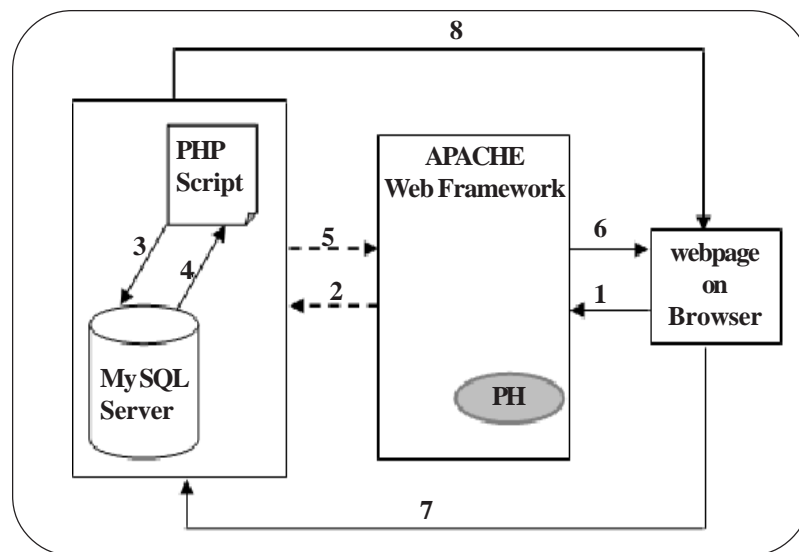Figure 3.3. Proposed E-payment System Architecture

Figure 4.1. Web-based System Architecture of the Web Application

Database and scripting language that pools the data from the server side, communication will not be completed.

4.2 The Structural Designs

Shown in figures 4.2 to 4.7 respectively are the structural designs. Where figure 4.2 shows the Administrator's activity diagram for the authorised/profiled user, figure 4.3 (appendix B) shows the System Logical Flow diagram for the proposed system. While figures 4.4, 4.5, 4.6 and 4.7 shows the data flow diagram for the sub-activities in the system. Some of these activities include:

creating a new system user, creating the employer's new bank account, creating beneficiary payment procedure, and updating of the currency rate-board, respectively.
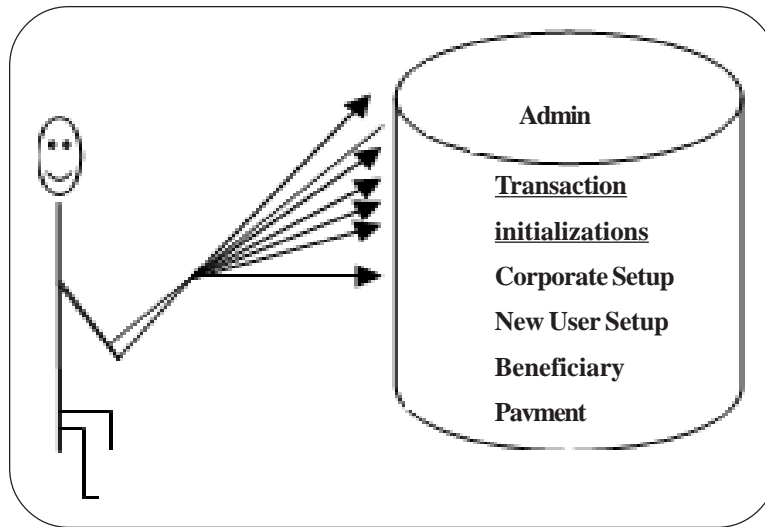
Figure 4.2. Administrator's Activity Diagram

Figure 4.2 shows the outline of activities performed by the Administrator on the e-payment system platform. These activities are initiated using web forms, which can be seen in the database design page (in figures 4.9 to 4.12).
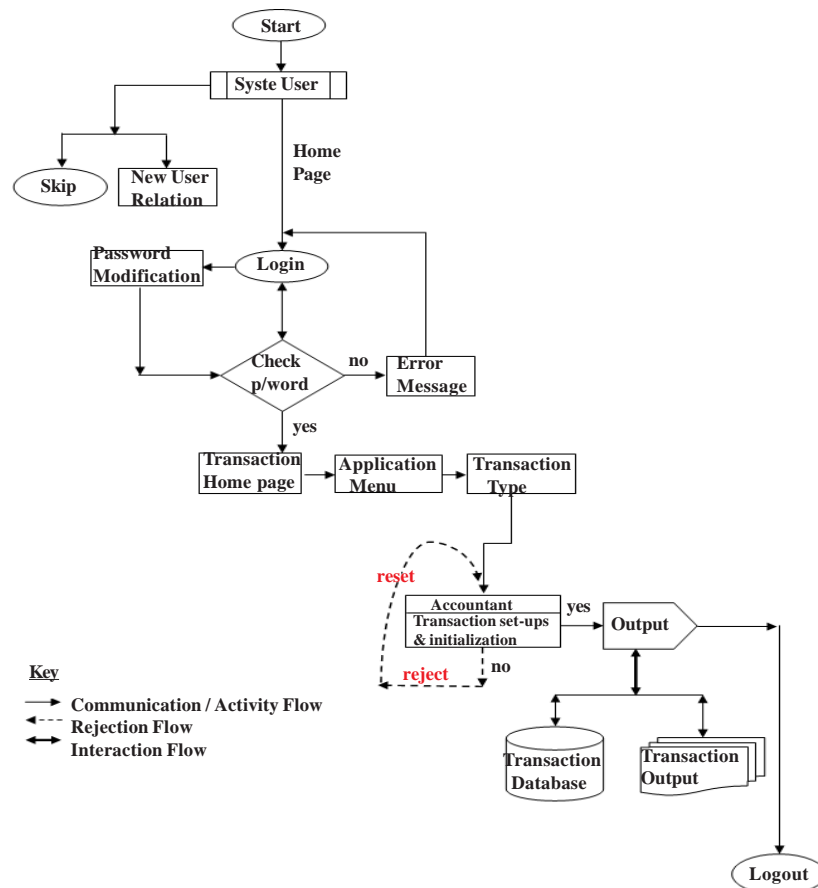

Figure 4.3 The Logical Flow Diagram of the Flexible Multi-Currency E-Payment System

Figure 4.4 shows the data flow diagram for creating new system user on the e-payment platform.
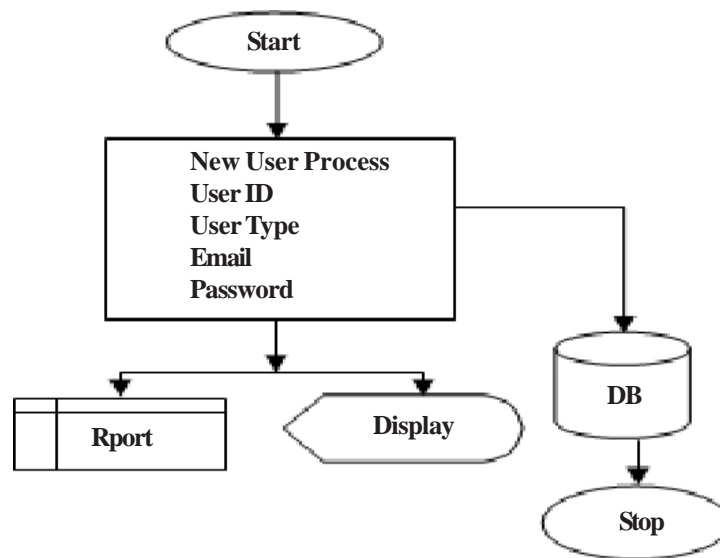
Figure 4.4. Data Flow Diagram for creating a New User Account

Figure 4.5 shows the data flow diagram for automating/registering an employer's new bank account on the e-payment platform.
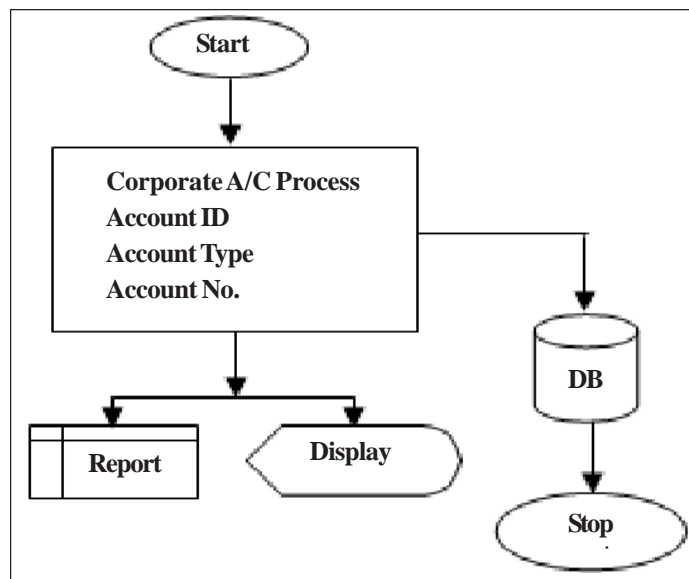

Figure 4.5. Data Flow Diagram for the Employer's New Bank Account

Figure 4.6 shows the data flow diagram for initiating and effecting payments on the e-payment system to an approved/authorised beneficiary.

Figure 4.7 shows the data process flow diagram for updating the currency rate board into the database on the e-payment platform.

4.3 Database Design
The user module contains local database which stores users' transactions.

Data and users' queries are received through the application web forms. Samples of the web forms are shown in Figure 4.8, 4.9,

4.10, and 4.11 which include the: new user creation form, corporate account setup form, currency rate-board update form, and beneficiary payment form respectively. While their corresponding local databases are shown in tables 4.1, 4.2, 4.3, and 4.4 which are: new user table, corporate account table, currency rate-board update table, and beneficiary payment table respectively.
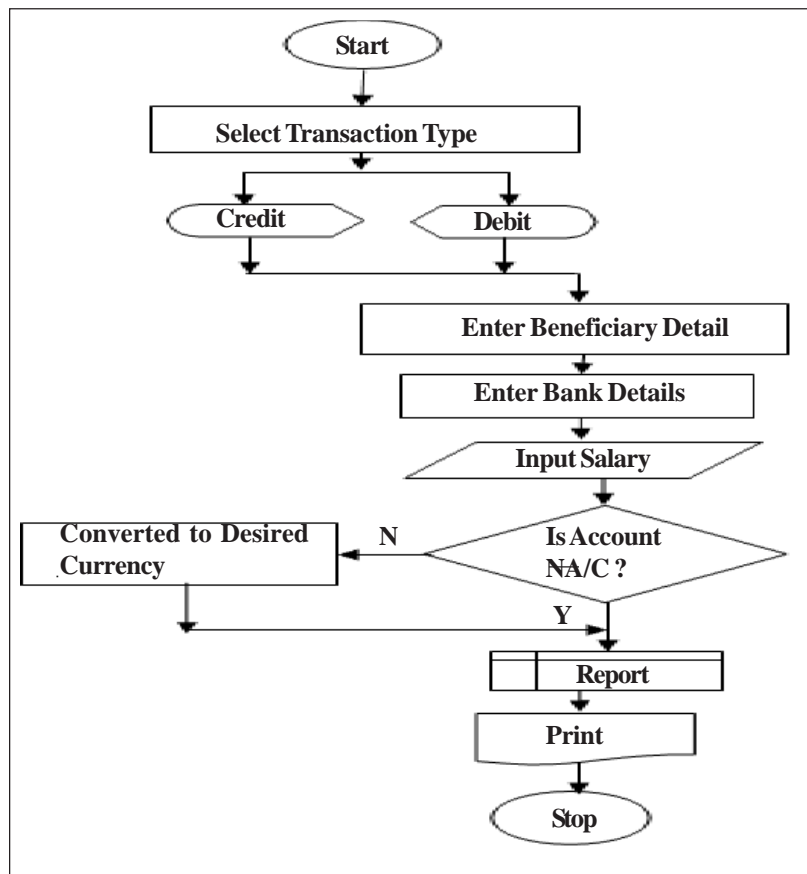
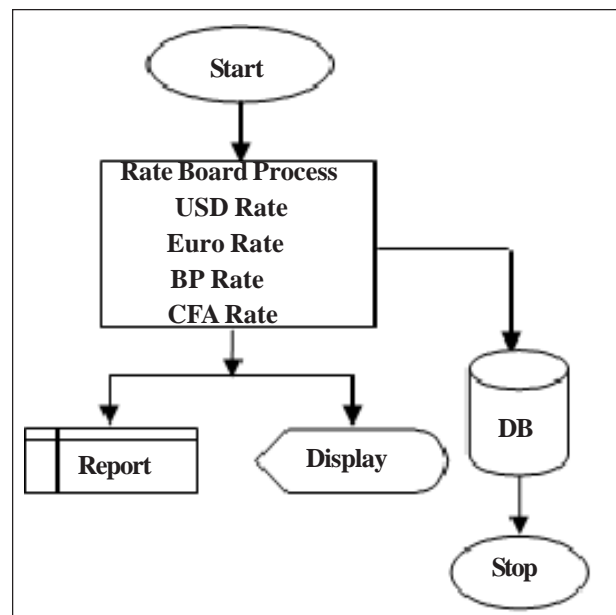Figure 4.6. Data Flow Diagram for Beneficiary Payment Procedure

Figure 4.7. Data Flow Diagram of the Currency Rate Board

```
                    NEW USER SETUP FORM
        _____
                   _____
                          __

        USER
        First Name        [_____]
        Last Name         [_____]
        User Type         [_____]
        E-mail            [_____]
        Confirm email     [_____]
        Password          [_____]
        Confirm Password  [_____]
        Phone No          [_____]

                    [ SUBMIT ]      [ RESET ]
```

Figure 4.8. New User Creation Setup Form - this form is used to create a new user account on the payment portal when the need arises.

Table 4.1 shows the database representation of a new user created on the platform using Figure 4.8.

Expected Output of the New User Creation

User ID	Password

This represents the expected output report of Figure 4.9 after a submission is made to the database.

s/n	Data Type	Field Name	Descriptions
1	varchar	First name	User's first name
2	varchar	Last name	User's last name
3	varchar	User type	Type of user
4	varchar	E-mail	User's e-mail address
5	varchar	Confirm e-mail	Confirmation of user's e-mail address
6	varchar	Password	User's preferred password
7	varchar	Confirm password	Confirmation of the User's preferred password
8	varchar	Phone number	User mobile contact

Table 4.1. New user table

s/n	Date Type	Descriptions
1	Account ID	The name given to the new opened account
2	Account type	The specified type of account, either current or USD
3	Account number	The account number
4	Account mandate	Signatories of the account
5	Authorization limit	The amount to be approved by the signatories
6	Limit flag	Display caution if limit is exceeded

Table 4.2. Corporate account table

CORPORATE SETUP FORM
Bank Account and Mandate Detail

Account

Account ID _____

Account Type _____

Acct No Linked _____

Acct Mandate _____

Authorized Limit _____

Acct Limit Flag _____

SUBMIT   RESET

Figure 4.9. Corporate account set-up form

With figure 4.9, the administrator ensures that every account opened by the employer is being registered on the e-payment platform and stored in the system database.

Currency Rate Board Update Form

Currency   Rate   Date

USD _____   _____

Euro _____   _____

GBP _____   _____

CFA _____   _____

SUBMIT   RESET

Figure 4.10. A Currency Rate-Board Update Form

s/n	Field Name	Data Type	Descriptions
1	USD	varchar	US Dollar currency value
2	EURO	varchar	Euro currency value
3	GBP	varchar	Great Britain currency value
4	CFA	varchar	CFA currency value

Table 4.3. Currency Rate Board Update Table

Table 4.2 gives the corresponding database representation of the corporate/employer's new account automated on the e-payment platform using the form on figure 4.9.

This form enables the administrator to update the currency values of the Rate board on the e-payment platform to the database.

Table 4.3 shows the corresponding database representation of the updated currency rates on the platform using figure 4.10

BENEFICIARY MANAGEMENT SETUP

A. TRNSACTION TYPE

1. Dropdown Button

CR *(DIRECT CREDIT)*
DR *(DIRECT DEBIT)*

LINK RATE

B. BENEFICIARY INFORMATION

Identification No
Employee Name
Department
Employment Date

Settlement Mode

Employment Type
Grade: Level: Step
Empl Update Setup
E-Mail
Phone No
Address
Country

Permanent
Temporary
Casual

CONTISS
I
2

Etc

C. BENEFICIARY BANK

Bank
Account No
Account Type
Acct Sort Code

1. FBN Plc
2. Access Bank Plc
....

NGN (Current or Savings A/C)
USD a/c
GBP a/c

D. PAYMENT ADDITIONS

BASIC SALARY
ALLOWANCE **(Add)**

Overtime ◇
Shift Duty ◇
Furniture ◇
Travelling ◇
Hazard ◇

TOTAL ALLOWANCE
NET PAYMENT

D. PAYMENT DEDUCTION

CORP. SAVINGS SCHEME
LOAN DEDUCTION **(Add)**

SS DUES ◇   *Salary Advance* ◇
NHIS ◇   *Housing Loan* ◇
PAYE ◇   *Staff Qtr Rent* ◇
NASU Due ◇   *Agric loan* ◇
Others ◇

TOTAL DEDUCTION
CONVERSION

FILE UPLOAD

Choose file location

BROWSE

Upload

Figure 4.11. Beneficary Management Setup Form (Transaction Page)

Also, Figure 4.11 is referred to as the transaction form. It is used to create and process payment(s) scheduled to authorized beneficiary(ies) on the e-payment platform as instructed for payments by the employer. While Table 4.4 (see appendix D) shows the corresponding database-representation of beneficiary payment transactions using the form (see form 4.12 on appendix C and figure 5.4.2). The expected sample of transaction report then serves as payslip to every employee or beneficiary.

5. System Requirements

In this design, two major requirements were used to aid a perfect testing and implementation. These requirements are:

a.Functional Requirements, and

b.Non Functional Requirements

5.1 Functional Requirements
Functional requirement describes the software environment under design (system and software requirements). It also describes what the software does, and how it is expected to perform it (specification of functions and behaviour of software under design).

System and Software Requirements:
This gives the tools required to effect a good testing on the proposed design. For example;

a. Hardware: PC compatible with an Intel Pentium-iv Processor, 512-MB RAM, and 20GB of hard disk or above.

b. Operating System: Windows and Linus Operating Systems

c. Software (Language): PHP Scripting Language (version 5.2.5), with Apache Web Framework (version 2.2.6).

d. Database: MySQL (version 5.0.45) as medium for data storage.

e. Presentation Technology: HTML and CSS (i.e. hyper text mark language and cascading style sheet).

Specification of Functions and Software Behaviour:
This shows the specific functions to be performed by the software; which include:

a. New user creation setup

b. New bank account setup

c. Currency converter updating

d. Beneficiary setup and payment in chosen currency

e. Generation of payment report

f. Printing of report, and

g. Storing data into the database for record purposes and future use.

5.2 Non Functional Requirements
These are requirements that specify the criteria that can be used to judge the operation of the system. They could be anything that a finished program needs to run, which does not relate to the actual functionality of the program. A typical non-functional requirement emphasises more on the reliability, scalability, and cost of the system. However, the non functional requirements of the proposed system are:

a. Security Requirements,

b. Implementation Requirements, and

c. Privacy Requirements.

5.3 System Interfaces

This shows the procedure to be followed for a successful use of the designed software.

S/N	Field Name	Data Type	Descriptions	Width	Constraint
1	Transaction type	varchar	crediting beneficiary account as payment	10	
2	ID number	varchar	Beneficiary identity number	10	PK
3	Name	varchar	Beneficiary name	20	
4	Department	varchar	Beneficiary unit	10	
5	Employment type	varchar	The type of employment placement beneficiary has	10	
6	Grade	varchar	Beneficiary job level	10	
7	Address	varchar	Beneficiary contact address	25	
8	Phone number	integer	Beneficiary mobile number	NN	
9	Bank	varchar	Beneficiary bank	20	
10	Account No.	integer	Beneficiary account number	NN	PK
11	Account type	varchar	Beneficiary account type with the bank	10	
12	Sort code	integer	Sort code of bank branch where Beneficiary account is domiciled	NN	
13	Basic salary	numeric	Beneficiary basic salary	Double (m,d)	
14	Allowance	numeric	Additional payment to the basic salary	Double (m,d)	
15	Total allowance	numeric	Total income payable	Double (m,d)	
16	Deduction	numeric	Reduction made from Beneficiary payment	Double (m,d)	
17	Total deduction	numeric	Total deduction	Double (m,d)	
18	Net payment	numeric	Total benefit after deduction	Double (m,d)	
19	Conversion	numeric	Conversion of the total benefit to another currency	Double (m,d)	
20					

Table 4.4. Beneficiary Payment Table

Figure 5.1. Title Page

a. Title Page: As the electronic payment portal is lunched, the user will be required to either CLICK TO REGISTER as a new user, or to SKIP SIGNUP (for already registered user) to continue to the Home Page for further activities. Sample of the title-page is shown in figure 5.1.

b. Click to Register Form (New-User Account Creation):
This form enables a new-user to be created on the e-payment platform. After a successful filling and submission of this form as displayed in figure 5.2, a system generated-username and password will automatically be sent to the new-user's e-mail box, which authorises the user to access the software from the Home Page. The user also has a provision to modify his login password for safety.

A sample of the new-user account creation form is shown in figure 5.2

Figure 5.2. New-User account creation form

C. Skip Sign-Up
This launches a registered user to the Portal Home Page. At the homepage, the registered user is required to sign-in with his system generated user-id and password for further access to transaction page. Should the user inputs wrong login details, an error message is displayed with a caption "*invalid password, retry again*". Limited chances are given to the user to successfully get the correction. Figure 5.3 shows the portal home page with the login portion.

D. Transaction Activity Page
This page enables an administrator to choose a transaction type to be performed as displayed in figure 5.4.

At the transaction activity page, other transaction functions are available. These are:

i. **The corporate setup form** which is used by the user (accountant or administrator) to register all the employer's bank accounts on the portal. The interface of the form can be seen in figure 5.4.1

ii. **The beneficiary setup form** – This is used to register and effect payment to all the approved beneficiaries in the payment schedule. Figure 5.4.2 shows the sample of the form.
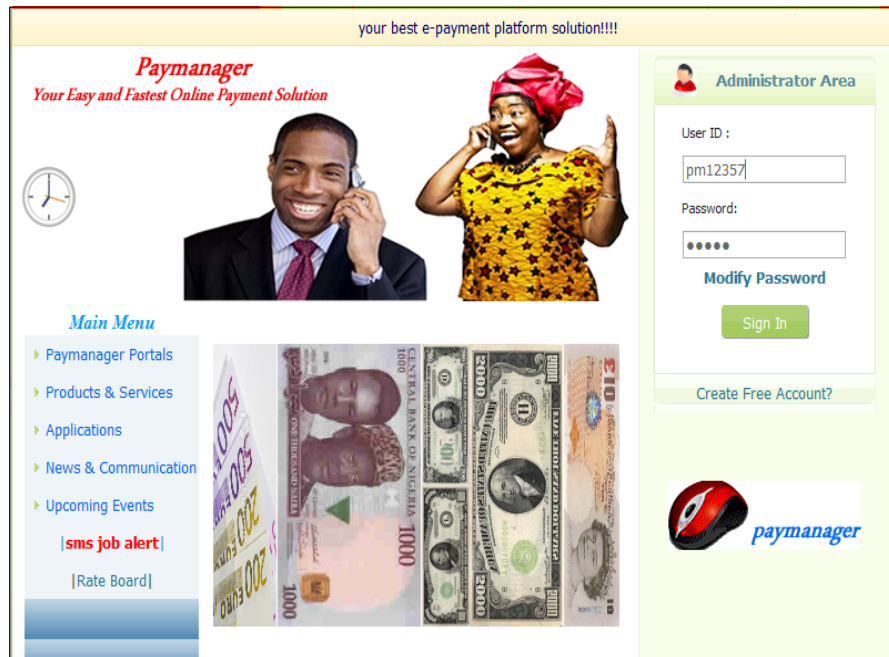
Figure 5.3. Home Page

Figure 5.4. Transaction activity page

iii. **The currency Rate-Board update form:** – this form is used to update currency rates to the database as shown in figure 5.4.3 Figure 5.5 is a transaction report from the database showing the updated currency rates as at 3rd March, 2011.

Also presented in figures 5.6, 5.7, and 5.8 are Payment Transaction Reports showing the beneficiary(ies) payment reports basedon their choices of currency (account type).

These however serve as payslips to the beneficiaries.

The designed platform has a querying option used to generate summary report of a streamlined choice. For instance:

Figure 5.4.1. The Corporate Setup Form

a. Bank Report: generating a specific number of authorised beneficiaries that were paid in a period (date) for a particular bank and the total amount paid.

b. Currency Report: generating the updated report of the currency rate-board at a specified period.

c. Department: obtaining a specified report on the total number of beneficiaries paid in a particular department, with the total amount.

Comparison Between FMC-EPS And Conventional Eps

The key features that differentiates FMC-EPS from conventional EPS is depicted in table 5.1 below:

S/No	FMC-EPS	Conventional EPS
1.	FMC-EPS is an autopay solution that has the ability to pay multi-beneficiaries with different account types at the same time.	Conventional EPS is an auto-pay solution that has the ability to pay single beneficiary with unique account type at a time.
2.	FMC-EPS has the ability to make payment in beneficiaries preferred choices of currency.	While in the Conventional EPS, payment currency is pre-determined by the national currency.

Table 5.1. FMC-EPS comparison with conventional EPS

Figure 5.4.2. Transaction Page

RATE-BOARD UPDATED

USD [   ] (Required)

GBP [   ] (Required)

EUR [   ] (Required)

CFA [   ] (Required)

Enter Code [   ] Code: 33454

Submit

Figure 5.4.3. The Currency Rate-Board Update Form

CURRENT RATE REPORT	
USD:	154.90
GBP:	261.01
EUR:	142.42
CFA:	95.47

Figure 5.5. Currency Rate Report

TRANSACTION REPORT

Name: OKENE JOYCE	Staff ID: JS1101
Dept: MATHS	Grade level /Step:
Bank: Skybank	AC /No: 222000131001
	AC Type: GBP Account
Additions	**Detuction:**
Basic Salary: 25,000.00	
Alloewance: 19, 601.00	
Gross Pay: 44601	Total Deduction: 26,008.66
NET PAY: 18, 592.00 Naira	CONVERT: 74.07 GBP

Figure 5.6. Payment Transaction Report in GBP

TRANSACTION REPORT

Name: ADAJI JOAN	Staff ID: PS 04590
Dept: MATHS	Grade level /Step:
Bank: Gurantee trust bank P/c	AC No 1200098003456
	AC Type: Current Account
Additions	**Detuction:**
Basic Salary: 400,000.00	
Alloewance: 42, 098.00	
Gross Pay: 442098	Total Deduction: 47, 198.42
NET PAY: 39400.00 Naira	CONVERT: 0.00 Cur

Figure 5.7. A Payment Transaction Report (in naira)

TRANSACTION REPORT

Name: KEYA PHIL Dept: IT DEPT	Staff ID: PZ1120
	Grade level Step:
Bank: United bank for Africa P/c	AC No 02200520112944
	AC Type: USD Account
Additions	**Detuction:**
Basic Salary: 3, 40, 000.00	
Allowance: 120, 865.00	
Gross Pay: 460865	Total Deduction: 68, 528.10
NET PAY: 3392, 337.00 Naira	CONVERT: 2483.14 USD

Figure 5.8. Payment Transaction Report (in USD)

6. Conclusion

With the emerging trends in the payment system, there has been a consistent demand for flexible payment integration applications; thus making payment market to experience continued innovation and consolidation. Obviously, a good choice in payment method greatly increases user's market potentials. Also, multi-currency fashion of payment accommodates everyone. It is therefore recommended to every workflow of an organisational structure or individual end-user permitted by law to enable them harness the benefit provided by the multi currency payment support system. Some of the benefits provided by the designed payment platform include high throughput of payment transactions, dynamic user interactive interface, robust database management, flexible services to payees, cut down cost and provision of convenient payment services in the comfort of homes or any location.

Besides, a proper training of data-entry operators and other profiled users is necessary in order to fully exploit the advantages of this new payment system.

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Appendix

Expected Output of the Beneficiary Payments

TRANSACTION REPORT

Name _____
Staff ID: _____ Dept_____ Grade
Level/Step_____ Bank_____ A/C
No._____ Account type____

Additions   Deductions
Basic Salary: _ _ _ _ _ _ _ _
Allowance _ _ _ _ _ _ _ _ _
Gross Pay_____   Total Deduction_____