

PROCESS MAP FOR ICT-BASED POST UNIFIED TERTIARY MATRICULATION EXAMINATION (PUTME) ADMINISTRATION SYSTEM

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ABSTRACT

Every year, the growing large population of candidates that are seeking admission into the tertiary institutions in Nigeria, present running challenges to the tertiary institutions. Particularly, the tertiary institutions are faced with the difficulties of using the existing partly manual and partly Optical Character Recognition (OMR)-based methods for the administration of the Post Unified Tertiary Matriculation Examination (PUTME). As such, some institutions have opted for computerized PUTME administration system. However, many of the tertiary institutions are outsourcing the solutions and by doing so the integrity of the results are questionable. This paper presents annotated process map (otherwise known as process flow diagram) for the two PUTME administration processes. In this case, a process is a series of steps and decisions involved in the way work is accomplished. Also, a process map is defined as a standardized approach that uses a common language that combines both simple graphics and few words to describe processes. The annotated process map is developed so that the processes can be managed and improved in such a way that key stakeholders can afford to contribute to the management and improvement efforts. That invariably means describing a process from a human perspective rather than from mere logic, or computer perspective. The process maps presented in this paper are meant to provide a better understanding of the PUTME processes with a view to improving the processes and to facilitate the development of in-house solution in the various tertiary institutions in Nigeria.

Keywords: PUTME; AFCIBES; Process Maps; Optical Character Recognition; Examination System.

INTRODUCTION

Over the years, popular opinion has been that Information and Communication Technologies (ICT) are useful solutions for improving learning and service delivery by educational institutions. Particularly, ICT can be used to make transactions, processing and operations became faster, accurate and more effective. Consequently, ICT-based solution is increasing being demanded to handle the various aspects of Post Unified Tertiary Matriculation Examination popularly called PUTME aptitude test. Presently, in Nigeria, PUTME aptitude test in most Nigerian tertiary institutions is administered through partly manual and partly Optical Character Recognition (OMR) approaches. Such approaches are time consuming, prone to many errors and require many materials such as papers that are eventually turned into waste at the end of the screening exercise. As such, an end-to-end computerized solution for administering PUTME aptitude test is highly recommended. Presently, few universities across Nigeria have started using computerized aptitude test solutions. In any case, there is the need to understand these ICT solution approaches for managing the PUTME in Nigerian tertiary institutions with a view to improve the processes and also to enable the institutions to develop in-house solutions rather than outsourcing which undermines the integrity of the results.

On the other hand, from project management perspective, processes are the most effective way to manage an organization at any level and eventually support its overall goals. Documenting processes involving people and other resources can lead to insights and changes that can help improve any area of operation in the organization. By improving processes, an organization can improve internal efficiencies, effectiveness, adaptability and customer service levels. One way to understand a process is to think about its major elements - inputs, outputs, activity steps, decision points, and functions. Importantly, process mapping is an exercise to identify all the steps and decisions in a process in diagrammatic form, with a view to continually improving that process. The resulting process maps depict the inputs, the performers, the sequence of actions the performers take, and the outputs of a work process in a matrix or flowchart format, usually combining both words and simple graphics.

Importantly, a well-designed process map serves as an operational definition of the way work gets done and time gets used. In this paper, the process maps for two different ICT solutions for managing the Post Unified Tertiary Matriculation Examination (PUTME) in the various tertiary institutions in Nigeria are presented. The purpose of the process maps is to provide better understanding of the processes as they are presently with a view to improving them. Equally, it provides a working tool that will enable each institution to start developing in-house solution rather than outsourcing and hence losing control of some aspects of the process that may undermine its integrity. The paper is relevant since there is no known documentation of the ICT solutions used to manage the PUTME in Nigerian tertiary institutions.

REVIEW OF RELEVANT LITERATURE

Process Map

A process is a series of steps or actions performed along with the decisions taken to achieve a specific purpose. Process mapping is the step-by-step description of the actions taken by workers as they use a specific set of inputs to produce a defined set of outputs. The resulting process maps depict the inputs, the performers, the sequence of actions the performers take, and the outputs of a work process in a matrix or flowchart format, usually combining both words and simple graphics [1]. Process mapping helps represent work processes visually and identify problem areas and opportunities for process improvement. It provides a common understanding of the entire process and specific roles and contributions of process participants [2].

In addition, a process map is also a communication tool, a business planning tool and a tool to help manage the organization. Key elements include: inputs, outputs, activity steps, decision points, functions [3]. The purpose of process mapping is for better understanding. It involves the gathering and organizing of facts about the work and displaying them so that they can be questioned and improved by knowledgeable people. Process maps aid in understanding by abstracting, using visual charting symbols consistently and masking unnecessary details [3]. Importantly, process maps help an organisation to understand the important characteristics of a process, allowing the organisation to generate useful analytical data in order to derive findings, draw conclusions and formulate recommendations. Furthermore, process maps allow an organisation to systematically ask many important probing questions that lead to developing a view on business process improvement [3]. There are two basic types of charts used in processing map [2]:

- a) **Process Flowchart:** This chart simply sets out the sequence of activities and decision points. These are useful for capturing the initial detail of the process.

- b) **Deployment Flowchart:** This shows who does what along with the interactions between people and departments.

Process Flowcharts

A flowchart is a type of diagram that represents an algorithm or process, showing the steps as boxes of various kinds, and their order by connecting them with arrows. This diagrammatic representation illustrates a solution to a given problem or the steps and decisions for a process. Process operations are represented in these boxes, and the arrows indicate the sequencing of operations. Flowcharts are used in designing, analyzing, documenting or managing a process or program in various fields [4]. Like other types of diagrams, they help visualize what is going on and thereby help the viewer to understand a process, and perhaps also find flaws, bottlenecks, and other less-obvious features within it. There is a repertoire of boxes and notational conventions used in drawing flowcharts [4]. The most common flowchart symbols are:

- Terminator:** An oval flow chart shape indicating the start or end of the process.
- Process:** A rectangular flow chart shape indicating a normal process flow step.
- Decision:** A diamond flow chart shape indicating a branch in the process flow.
- Connector:** A small, labeled, circular flow chart shape used to indicate a jump in the process flow. (Shown as the circle with the letter “A”, below.)
- Data:** A parallelogram that indicates data input or output (I/O) for a process.
- Document:** Used to indicate a document or report (see image in sample flow chart below).

A simple flowchart showing the symbols described above can be seen in Fig 1.

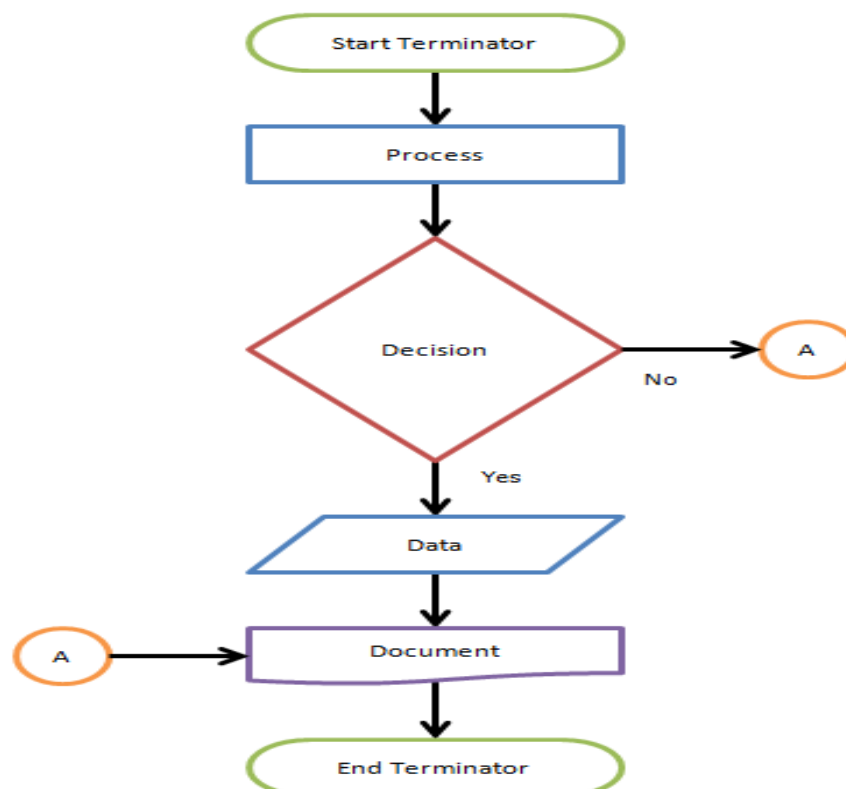


Figure 1 : A Flowchart Showing The Common Flowchart Symbols

The first structured method for documenting process flow, the "flow process chart", was introduced by [5] to members of the American Society of Mechanical Engineers (ASME) in 1921 in the presentation titled, "Process Charts—First Steps in Finding the One Best Way" [5]. Gilbreth's tools quickly found their way into industrial engineering curricula. Also, [6] adapted the flow process chart to information processing with his development of the multi-flow process chart to display multiple documents and their relationships [7]. In 1947, ASME adopted a symbol set derived from Gilbreth's original work as the ASME Standard for Process Chart. Since then, flowchart has been a popular means for describing computer algorithms [8]. Modern techniques such as UML activity diagrams can be considered to be extensions of the flowchart. In the 1970s the popularity of flowcharts when interactive computer terminals and third-generation programming languages became the common tools of the trade, since algorithms can be expressed much more concisely as source code in such a language, and also because designing algorithms using flowcharts was more likely to result in spaghetti code because of the need for 'goto' to describe arbitrary jumps in control flow.

METHODOLOGY

This paper is focused on developing the process maps for the development of an ICT-based PUTME administration system. Ethnography and a Rapid Assessment Process (RAP) are used for the data collection and the design of the process maps. The justification for using RAP is that it is a rapid research method used to investigate complicated situations in which issues are not yet well defined [9]. According to [9], RAP uses intensive team interaction in both the collection and analysis of data to quickly develop a preliminary understanding of a situation from the insider's perspective. Specifically, during the requirement engineering phase of the process maps, literature survey and interview are used within the RAP framework to collect and analyze data. The focus in the RAP includes;

- To carefully analyze the steps and the activities involved in the existing partly manual and partly OMR-based PUTME administration systems.
- To identify the associated problems and challenges with the existing manual and OMR based systems.
- To carefully analyze the possible approaches to which the above challenges and problems can be solved using an ICT-based examination system.
- To provide process map that graphical and clearly stipulates the step by step approach to design an error-free, paperless, faster, more efficient, and fully computerized PUTME administration system.
- To briefly discussing some strategies to be deployed for effective implementation.

Furthermore, Ethnography is a type of participatory action research and shares many of the characteristics of Rapid Assessment Process research, but RAP differs from ethnography in two important ways:

- i. In RAP, more than one researcher is always involved in data collection, with data triangulation based on teamwork, and
- ii. In RAP, more than one researcher is involved in an iterative approach to data analysis and additional data collection.
- iii. In RAP, intensive teamwork is necessary because of the shortened fieldwork [10].

The Process Maps For The PUTME In The Tertiary Institutions In Nigeria
The Process Map For The OMR-Based PUTME Administration In The Tertiary Institutions In Nigeria

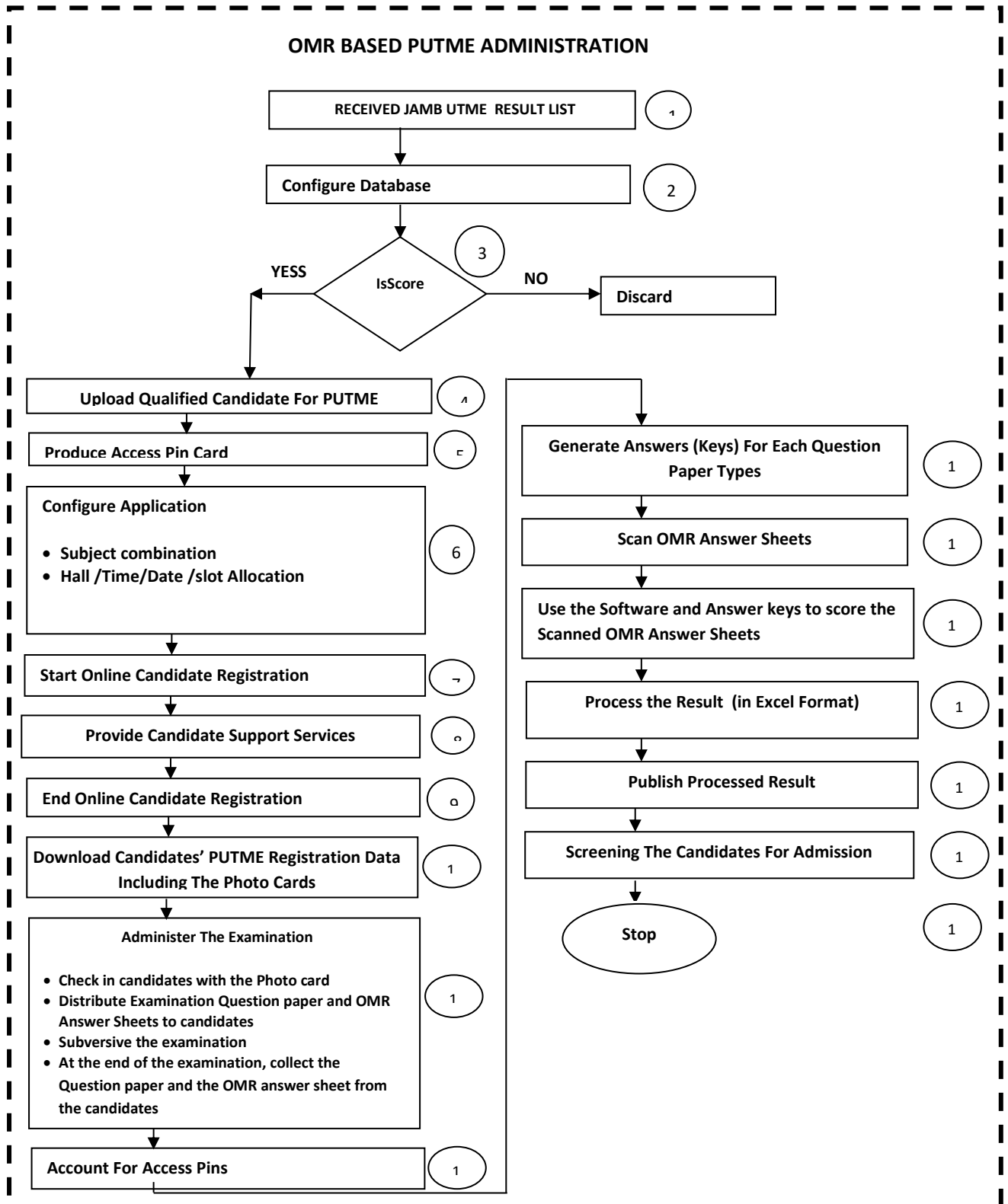


Figure 2 : Process Map For OMR based PUTME Administration System

In Figure 2, each elements of Process Map For OMR based PUTME Administration System is annotated with a number. The annotated process map elements in Figure 2 are explained as follows:

1. Received JAMB UTME Result lists :The Joint Admission and Matriculation Examination Board (JAMB) after conducting the Unified Tertiary Matriculation Examination (UTME), they send the JAMB UTME result list in Excel format to respective tertiary institutions. The JAMB UTME result lists are in two parts ;
 - (i) The First Choice list and
 - (ii) The Second Choice List.

Each of the result list contains the JAMB UTME result and particulars of the candidates. In all, each of the candidate's JAMB UTME result has the following fields:

1	JAMB REG.NO.	GENDER	STATE OF ORIGIN	LGA	1ST CHOICE	UTME SUBJECTS				TOTAL SCORE
2						SUBJ 1	SUBJ 2	SUBJ 3	SUBJ 4	
3	264848531B	F	TARABA	LAU	PET. ENGINEERING	MAT-67	ENG-78	PHY-45	CHE-60	250
4	2358954H	M	AKS	IKER	HISTORY/INT'L RELATIONS	ENG-45	LIT-75	CRK-34	GOV-68	222
5	25867756DA	F	RIVERS	PH SOUTH	COMPUTER ENGINEERING	MAT-56	ENG-43	PHY-49	CHE-29	177

Figure 3: First Choice list in Excel format

1	JAMB REG.NO.	GENDER	STATE OF ORIGIN	LGA	2ND CHOICE	UTME SUBJECTS				TOTAL SCORE
2						SUBJ 1	SUBJ 2	SUBJ 3	SUBJ 4	
3	26480555HK	M	CROSS-RIVER	OGOJA SOUTH	LINGUISTIC	LIT-56	ENG-64	CRK-79	GOV-42	241
4	23647754BL	F	ANAMBRA	AGUATA	LAW	ENG-60	LIT-71	CRK-54	GOV-58	243
5	28748383EY	F	SOKOTO	BODINGA	ECONOMICS	MAT-45	ENG-48	ECO-65	COM-34	192

2. Configure Database: This has to do with creating a database to upload the JAMB UTME result list into the PUTME local server in the institution. This activity is performed by the PUTME ICT solution provider for the institution. Furthermore, each of the raw Result data (The First and Second Choice Results) from JAMB will be processed as follows;
 - i. Sort the candidates according to their academic programs, departments and faculties.
 - ii. Align the sorted list in descending order based on their JAMB UTME result scores (JAMB UTME -SCORE)
 - iii. Assign serial number (S-NUMBER) to the candidates based on the sorted list in step ii

The first two steps are taken in order to provide the list for arranging the candidates in the various examination halls based on their JAMB UTME scores. Some universities arrange the candidates according to their JAMB UTME registration numbers. In that case, the JAMB UTME result list will be sorted according to the JAMB UTME registration numbers. The problem with this approach is that the registration numbers is alphanumeric, as such it poses a problem to the candidates to find it difficult to locate their examination hall with respect to the JAMB UTME registration number. In essence, the JAMB UTME score is preferred. However, The JAMB UTME score has little issue because many candidates do have the same score and hence, all the candidates with the same JAMB UTME score may not fit into the same hall due to limited sitting arrangement. In this case, the candidates are assigned serial number (S-NUMBER) based on the sorted list. As such, the halls are allocated to candidates with respect to a combination of their JAMB UTME-SCORE and their S-NUMBER.

3. Generate the List Of Eligible candidates for the PUTME:
According to JAM, only candidates with JAMB UTME score from 180 and above are qualified to take part in the POST-UMTE screening exercise. Furthermore some

Universities conduct the PUTME for only the First choice candidates. Also, some other universities do conduct the PUTME for both first and second choice candidates but the examinations are conducted separately on separate days. Still, other universities conduct the examination for both list at the same time. In all, the 180 JAMB UTME score is the minimum score allowed for candidates to be qualified to take the PUTME examination. So, each of the list is further process to generate the list of candidate with JAMB UTME -SCORE from 180 and above. Also, depending on the University policy, the list of candidates with JAMB UTME -SCORE from 180 and above will further be processed to generate the list of qualified candidate. This further processing depends on whether the University conducts the examination for the First choice only, or second choice only or both.

4. Upload The Particulars of The Eligible Candidate for PUTME to the Online Database: The list of qualified candidate is then uploaded on the online website of the institution to facilitate the PUTME examination registration process.
5. Generate the Access PIN And Then Produce The Access Pin Card Otherwise Known As Scratch card: The institutions use the sales of 'Scratch Cards' to generate revenue they use to offset the cost of conducting the POST-UMTE examination. The Scratch cards can be in two parts (i) PUTME examination registration card and (ii) PUTME Result Checking card. Each card has a Personal Identification Number (PIN), a Card Serial Number (C-SN) and a Card Batch Number (C-BN). The PIN on the Examination Registration Scratch Cards (ERSC) is use by the candidates to register for the PUTME on the institution's PUTME website. Also, another Scratch card may be required for the candidates to check their result. The C-SN and C-BN are used by the administration to keep track of card production, distribution, accounting, and forensic investigation of frauds. So, after loading the list of qualified candidates for the PUTME examination, the ERSC are produced and distributed to the banks for sales to the candidates. As stated above, each ERSC has on it PIN, C-SN and C-BN. The candidates purchase the ERSC from the banks and then use the PIN on the scratch cards to access the online PUTME registration form and hence register for the PUMTE.
6. Configure The Online PUTME Application Enable PUTME Registration Process: The online system to be used for the examination registration is configured such that the applicants can select their subject combination, hall allocation, examination date, time and slot.
7. Start Online PUTME Registration: Here, the applicant can do online registration with the help of the ERSC cards they purchased.
8. Provision of Candidate Support Services: A support phone line and online helpdesk are provided to help or support candidates with registration problems. For instance, candidates that have problems with scratch cards and other registration problems can access the support service.
9. End Online Candidate Registration: This is where all online PUTME registration process are completed.
10. Download Candidates' Examination Registration Data: Download candidates examination registration data, sort the data according to academic programmes, departments and faculties. Also, sort the candidates' examination registration data according to the examination date, time, and halls. These sorted examination data are printed to assist the examination supervisors to manage the examination administration and supervision. Among the printed examination materials are the candidates' registration photo-cards which contain the list of registered candidates, their particulars and their passport photograph they used to register for the examination.

11. **Administer The Examination:** Examination administration involves using the photo-card to admit the candidates into their respective examination halls, distribution of examination question papers and the OMR answer sheets, supervision of the candidates and collection of the OMR answer sheets at the end of the examination. The OMR answer sheets are the answer sheets or form that are given to candidates in order for them to shade or mark their chosen option from the multiple choice options following each of the questions on the question paper.
12. **Account For Access PIN:** the scratch cards that were sold out to candidates has to be accounted for and compared to the number of candidates that registered for the PUTME.
13. **Generate Answer Keys for Each of The Question Paper Type:** (Answer) keys are the answers to the questions that were set for the candidates. These answer keys are generated such that they can be used in the optical Mark Reader OMR for scoring the scanned OMR answer sheets.
14. **Scan The OMR Sheet:** The Optical Mark Reader machine is used to scan the OMR answer sheets. In each OMR sheet being scanned, if the shading by the candidate on any question is not thick (dark) enough, the OMR machine will normally omit that particular answer or the OMR machine will indicate BLANK SHADING. If the OMR answer sheet is squeezed or rumped, the OMR machine may not scan it at all. Also, if for any question, the options are double-shaded by the candidate, the OMR machine will omit scanning that particular answer or it will indicate MULTIPLE SHADING.
15. **Use the Software and The Answer Keys To Score the Scanned OMR Sheet:** After scanning the candidates' OMR answer sheets, the raw results are uploaded into the OMR result processing software platform. In the OMR result processing software platform the answer keys are used to score each of the candidates in each of the subjects he/she answered.
16. **Process The Results:** Normally, each candidate takes about four subjects. The scores from the four subjects are aggregated to obtain the total score for each candidate. The results scanned with OMR and uploaded are then presented and sorted in Excel format before publishing. At this point, the JAMB UTME score of the candidate is added to the POST-UMTE score and the average is obtained. These three results are then the final results that are made available to the candidate, namely; the JAMB UTME result, the PUTME result and the Average of the JAMB UTME and PUTME results.
17. **Publish Result:** The processed result are afterwards published online for the candidates to check their result on the PUTME website.
18. **Screening for Admission:** It has been observed that a candidate can send another person to register and sit for the PUTME for him/her and them come in to take up the admission once the result is published. Due to this fact, it is necessary to screen all successful candidates of the PUTME before admission in order to stop people from using impersonators to take the PUTME examination.
19. **Admission:** This is the last stage in the administration of OMR-based PUTME system where the successful candidates are finally admitted as students into the universities.
In summary, it is observed that, the OMR-based PUTME administration system is time consuming, error prone, vulnerable to missing OMR forms/sheet and examination malpractice. Hence, an End-To-End (from start to finish) Computerized PUTME will provide a completely computerized approach of administering the PUTME such that all the challenges and setbacks in the present OMR-based administration will be corrected.

4.2 The Process Map For The End-To-End Computerized PUTME Administration System

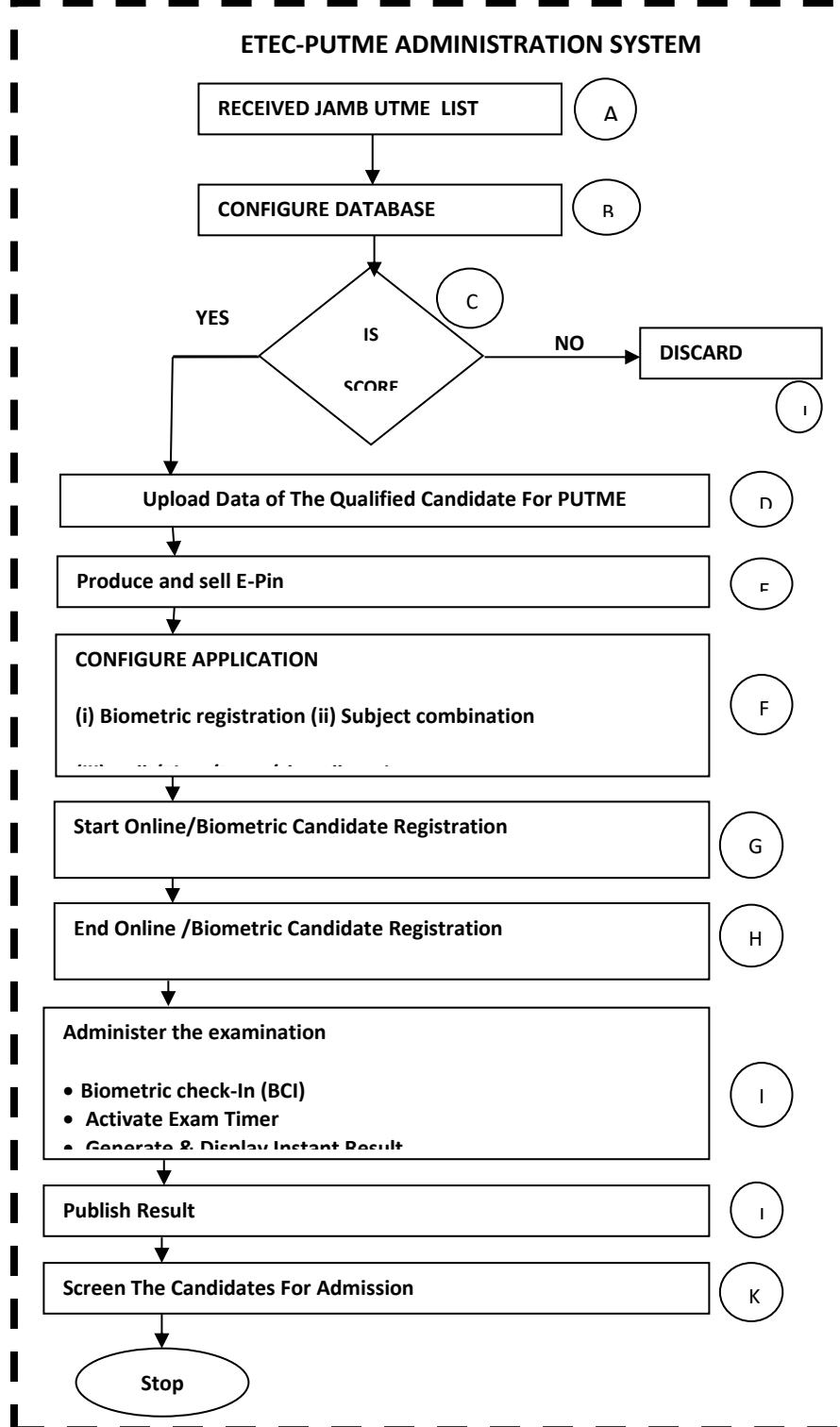


Figure 5: The Process Map For The End-To-End Computerized PUTME Administration System

END-TO-END COMPUTERIZED POST UNIFIED MATRICULATION EXAMINATION (ETEC-PUTME) ADMINISTRATION SYSTEM (from Figure. 5)

Stages A,B,C and D: These stages happen to be same as step 1,2,3 and 4 respectively in details of Figure A as stipulated above.

- E. Sales of Electronic Personal Identification Number (E-PIN): Sales of E-PIN involves the sales of Access PIN online through designated banks nationwide. It is done such that candidates can purchase the PIN and register for PUTME at their convenient locations without transporting themselves to the institution or to the state where the institution is located in order to buy access scratch cards. Hence, the problem of unavailability and loss of scratch cards is solved. In this case, scratch cards are not needed rather E-PIN are generated along with electronic payment gateways and bank payment option. Once a candidate makes payments he/she keys in the payment detail on the online payment verification form. Once the payment is verified, the E-PIN is generated and sent to the candidate's email and phone.
- F. Configure Application: In this system, there is no need for OMR answer sheets. The candidates take computer-based examination based on questions that are randomly drawn from question bank. In addition, there is no need for Photo-card. Rather, biometric verification system may have to be included to improve on the reliability of the system to check impersonation. So, in order to configure the application for the PUTME the question bank with randomization technology, platform for registration of candidates biometrically and enabling/providing them with the date, time, hall and slot of their examination have to be provided and setup for administering the examination.
- G. Start Online/Biometric Candidate Registration: Candidates start online and biometric registration at this state. Biometric registration helps upload candidate biometric information such as finger print that can be used to check impersonation and other forms of examination malpractices at different stages of the examination and admission process.
- H. End Online/biometric Candidate Registration: This is where all online biometric application registrations are completed.
- I. Admission Into The Examination Center/Hall: Examination administration in the ETEC-PUTME involve Biometric check-In of candidates into examination hall to prevent impersonation, activation of examination start and automated maximum examination completion time and (optional) brief time for the candidate to familiarize with the computer system . The ETEC-PUTME system has Instant Result Capture and Display (IRCD) which provides candidate's results immediately at the end of the test and will also store the same result into the ETEC-PUTME database. This eliminates the time consumption and errors involved in scanning, scoring and grading of candidate results which are the case in OMR-based POST-UMTE system. The problem of loss of result and omission of result prevalent in the OMR-based system is also eliminated.
- At this point, the JAMB UTME score of the candidate is added to the POST-UMTE score and the average is obtained. These three results are then the final results that are made available to the candidate.
- J. Publish Result: In the case of ETEC-PUTME system, publishing of result is a mere formality as the candidates already know their score immediately after the examination or aptitude test.
- K. Screen Successful Candidates For Admission: At this final stage, successful candidates can be screened with the same biometric devices before being offered admission to check impersonation as it is possible to admit different candidate from the ones that actually registered and sat for the examination s.

CONCLUSION

In this paper, the challenges faced by the manual and OMR based examination system has been exhaustively reviewed. The paper seeks to present an ICT-based examination system tailored to address the problems identified in the traditional examination systems. A well-outlined Activity Flow Chart for the ICT Based Examination System (AFCIBES) designed to provide guidelines for achieving an ETEC-PUTME administration system is equally presented in this paper. The adoption of this methodology and the ETEC-PUTME administration system will not only help tertiary institutions in Nigeria in achieving the set goals for conducting PUTME but will also contribute to the institutions economy since the examination is conducted in a paperless manner.

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