Efficiency Analysis of UTME Registration Process in Nigeria: Case Study of a Typical CBT Centre in Ibadan, Oyo State

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Abstract—JAMB UTME, the only entry route for admission into any Nigerian tertiary institution has few accredited centres having adequate facilities where registration can be carried out. This has resulted in pressure on the few accredited centres within the short timeframe allowed for registration. Thus, there is need for efficiency in the registration process to ensure that as many students as possible are registered within the short timeframe, while maximising financial turnover of registration centre operators.
A JAMB UTME registration centre in Ibadan, Nigeria was studied. The requirements and procedures of the registration process were studied through personal observation and interviews during site visits, as well as questionnaires. PERT approach was used to determine the expected time for performing the registration process based on the reported values by the operators. With the aid of a stopwatch, time study was carried out on the registration process. The difference between standard and expected times was used to determine the efficiency of the centre. A cause and effect analysis was carried out to investigate the immediate and root causes of inefficiency.
Information gathered include required tools and procedures involved in the registration process. The expected time was found to be 13 minutes while the standard time was discovered to be 6 minutes and 54 seconds, indicating that the efficiency level of the system was at 53%. From the cause and effect analysis, 7 immediate and 15 root causes were found to be responsible for the inefficiency observed.
Finally, it was found that inefficiency exists in the process, and as such, it becomes necessary to take some remedial actions so as to improve the efficiency of the whole process.

Keywords: Analysis, Cause and effect, Efficiency, Inefficiency, Registration process, Standard time, Time study.

1.0 INTRODUCTION

Arrival of the digital media has greatly impacted the ways organisations operate, and even the educational sector is not left behind as more and more innovations are being made towards digital transformation of this sector. This transformation is making computer based tests replace the conventional pencil and paper tests, and it is not so surprising that many organisations are paying unprecedented attention to digital media which has witnessed tremendous growth in recent years.

Before the inception of JAMB, there were only 6 universities in Nigeria, and each of them conducted their own entrance examinations independently. This makes it possible for candidates to apply to, and be offered admission by multiple universities. This resulted in deprivation of qualified candidates of the offer for admission in institutions whose offers were declined by some candidates. In order to ensure uniform standards in the conduct of matriculation examinations, as well as admission of suitably qualified candidates into Nigerian tertiary institutions, JAMB was established in 1978, and has contributed greatly to the improvement of educational standards in Nigeria [Ojerinde, 2009].

The JAMB UTME registration exercise is now a major annual exercise for computer based test centers all over the country, as well as major cyber cafes.

Computer based testing is now the order of the day in many societies [Davey, 2011]. This is due to:

i. Ability to measure skills and aptitudes which cannot be adequately captured by conventional paper based tests [Bennet, 2002; and Parshal *et. al.*, 2010].
ii. Increase in efficiency and precision of the grading process [Van der Linden & Glas, 2000; and Parshal *et. al.* 2001].
iii. Convenience in test administration for examiners, examinees and sponsors [Davey, 2011].

In the year 2011, JAMB announced the introduction of the option of computer based test (CBT) to augment the conventional pencil and paper test (PPT) and later in 2015,

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PPT was completely eradicated in favour of CBT. The registration process is also fully computer based.
According to economic scholars, the standard of living of a country largely depends on her local productivity [Mankiw, 2012]. Thus, every form of waste, in terms of delays, man/machine idleness, excessive inventory, human worker motion, material handling, processing steps and production volume, as well as production of defective parts would invariably decrease the efficiency and contribute negatively to the financial performance of any organisation and by extension, the economy of a society. [Easterlin, 2000; Schaeeffer, 2012; El-Namrouty & Abu-Shaaban, 2013]. With the recent economic recession, it is important that every business organisation in Nigeria optimise their operations not just for profit making, but actually to remain in existence.

The restriction of registration rights of the annual Joint Admissions and Matriculation Board (JAMB)'s Unified Tertiary matriculation Examination (UTME) to certain accredited centres has brought about an increase in the number of candidates calling at the few designated centres within the stipulated time frame. The need thus arose for the optimisation of the registration process in order to reduce the time and resources used in registering each candidate, thereby giving room for registering more candidates in shortest possible time. This will also result in customer satisfaction, promotion of goodwill and attraction of even more candidates, thereby increasing financial turnover, while reducing the operating cost of the centre.

The aim of this study was to evaluate the efficiency of JAMB UTME registration process at the CBT centre under study, and to identify the immediate and root causes of inefficiency, so as to know where improvements can be made.
Therefore, the objectives of this study are:

1. Gathering of information concerning requirements, procedures and time estimates for carrying out JAMB UTME registration.
2. Using time study to quantify the efficiency and wastes in the registration process.
3. Investigating for the cause(s) of inefficiency(ies) in the registration process.

2.0 METHODOLOGY

The computer based test (CBT) centre used is located in Ibadan, Nigeria. The JAMB UTME registration exercise is now a major annual exercise for computer based test centers all over the country, as well as major cyber cafes.

2.1 Gathering of Information Concerning Requirements, Procedures and Time Estimates for carrying out JAMB UTME Registration

The system was carefully studied by observing some registration exercises carried out during the period of study in order to identify the steps involved in the process. During this period, all the information to be supplied by each candidate, tasks necessary to initiate, execute and complete a registration process by an operator, the tools and materials to be used, as well as the conditions for successful capturing of candidates' biometric data were identified. The tools, materials and procedures used are as discussed below.

1. **Site visits:** Visits were made to a registration centre in Ibadan to familiarise with the system under study. Essence was to understudy the nature of job and problems likely to be encountered in the course of the registration process.
2. **Personal interviews:** In order to understand the operators' point-of-view, challenges and pain points, some of them were randomly selected and interviewed.
3. **Questionnaires:** This was used to collect data in relation to the time taken per registration as well as immediate causes of delays, and the frequency of delays experienced due to each factor. The questionnaire was divided into 4 Sections. Section A captured the demographic data of respondents; Section B was used to validate the necessity of the study; Section C was used to gather data concerning the frequency and concentration of delay factors over the different tasks associated with the registration process; and Section D was used to gather the data needed to evaluate the system performance.
4. **Data vetting:** In order to validate acquired data, identify outliers etc., the data collected from each operator were carefully studied by comparing with data given by other operators. In cases where significant differences exist, the causes were investigated in order to decide whether such particular observation should be included or excluded.

2.2 Determination of expected time

After the standard time has been established, some of the information provided in the questionnaires were used to derive the average time expected (T_e) to complete the registration of one candidate using PERT three-point estimate approach. The minimum (optimistic), most likely

and maximum (pessimistic) times reported by the workers were analysed using Equations (1) and (2).

$$T_e = \frac{a+4m+b}{6} \quad \ldots\ldots (1)$$

The standard deviation is given as

$$\sigma = \frac{b-a}{6} \quad \ldots\ldots (2)$$

Where,

T_e = expected time to completely carry out a single candidate registration

a = optimistic (minimum) time for carrying out the task

b = pessimistic (maximum) time for carrying out the task

m = most likely time for carrying out the task

2.3 Using Time Study to Quantify the Efficiency Wastes in the Registration Process

In order to evaluate the efficiency of the system, the duration was taken as the basis for comparison. Time study was carried out using a stopwatch to observe time taken to carry out the registration process.

2.3.1 Determination of required number of observations

In order to determine the minimum sample size required to carry out the time study at a confidence level of 95%, Equation (3) was used. A preliminary sample of 5 observations was drawn and analysed.

$$n = \left(\frac{40\sqrt{n'\sum T^2 - (\sum T)^2}}{\sum T}\right)^2 \quad \ldots\ldots (3)$$

Where,

n = the actual number of observations required for time study

n' = number of observations made in the preliminary study

Σ = arithmetic sum of the values

T = individual value of observations

2.3.2 Observation of the sample registration times and determination of performance rating

The number of required observations determined and the total time used in carrying out the registration each time was recorded. The average value was determined using Equation (4). The performance rating for the work was determined based on the pace at which the worker was working and thereafter used to determine the normal time for the task using Westinghouse performance rating. A base rating of 1.0 was initially set, after which adjustments for skill, conditions of work, effort applied and consistency were factored in.

$$\overline{T}_o = \frac{(\sum_{i=1}^{n} T_{oi})}{n} \quad \ldots (4)$$

Where,

T_o = Raw observed time

i = Individual observations

n = Total number of observations

2.3.3 Determination of allowance and standard time

A 15% allowance, as suggested by United States Department of Labour [2008]; Akanbi [2015] and Rios *et. al.* [2016] was given to account for personal needs, fatigue (rest pauses) and delays. The normal time and allowance were summed together to arrive at the standard time.

Mathematically,

Raw observed time, T_o = Time recorded by stopwatch to complete one registration

Normal time, $(T_n) = (T_o)$ X (PRF) ....(5)

Allowance, $(A_{pfd}) = 0.15$ X (T_n) ....(6)

Standard time, $(T_s) = (T_n) + (A_{pfd})$ ....(7)

2.3.4 Quantification of deviation from ideal situation

In order to quantify the time wasted, the expected time was compared to the standard time previously determined. The observed difference represents the waste and wasted time was expressed as a percentage of the total time spent working as shown in Equations (8) and (9).

Wasted time =

Estimated time, T_e – Standard time, T_s .... (8)

Proportion of time wasted = $\frac{\text{(time wasted)}}{\text{(Estimated time)}}$ ....(9)

2.4 Investigating the Inefficiency(ies), as well as their Causes in the Registration Process

With the use of direct observation, personal interviews and questionnaires, investigation was carried out to identify the tasks in the process that do take longer time than reasonably necessary. The identified causes of delay were sorted based on their frequency of occurence so as to begin improvements from the ones causing most frequent delays or disruptions. A scale of 1-5 was used depending on whether the factors never contributed to total delay/disruption at each work centre, or the contribution occurred quite often.

A more in-depth investigation and brainstorming was carried out with the cooperation of the workers involved in the registration process, particularly those with the technical personnel, so as to gain insight into the causes of disruptions/delay.

2.4.1 Suggestions for improvement

After the investigative activities have been done to ascertain the root cause(s) of the problems encountered in the system, remedial actions are suggested, such that will eliminate or minimise the problems.

3.0 RESULTS AND DISCUSSION

In this section is given the results obtained on: investigating the system's performance, identifying the problem areas, immediate and underlying causes of the problems, as well as discussion of resulting outcomes.

3.1 Gathering of Information concerning Requirements, Procedures and Time Estimates for carrying out JAMB UTME Registration

On carefully studying the registration process, it was discovered that the operator would attempt to log into earlier created individual candidate's profile using the email address and password provided by each of them, on the first interface.

After a successful login, the second interface on which candidate's information, O' level results, UTME subjects, as well as courses and institutions of choice would be provided and checked for correctness is obtained. The subsequent page obtained has to do with biometrics capturing: the candidate's passport photograph and the ten finger prints. It was observed that after successful capturing of the biometric data, the last page would require the choice of examination centre, that is, the state and geographical area of choice, after which the final submission of updated and saved profile would be made and examination slip could be printed.

3.1.1 Site visits

Having visited and understudied the JAMB registration centre, it was found out that there were at most 10 registration points where candidates could be registered within the centre. Candidates calling at the centre were so numerous that the single 250-seater capacity wing normally used for registration could not accommodate all the candidates, as a result of which some of them had to stay outside for hours before being called to join the queue inside the facility (Figure 1 and Figure 2). Each registration point is manned by one operator and consisted of a personal computer, enhanced with a fingerprint scanner and external camera.

Figure 1: Candidates waiting for their turn to be registered

Figure 2: Candidates in the CBT centre's facility during the registration exercise

3.1.2 Personal interviews

On interviewing the workers, it was gathered that their working environment was somewhat conducive, especially in the mornings, but expressed concern about candidates who do not have all the required documents needed for registration; those who find it difficult to remember some of their details such as examination numbers; and those who chose unmatched institutions and courses of study. Other possible delay-causing factors included photography problems, distractions, power outage, network failure, low audibility, noise, fingerprint problems, the personal computer not responding, improper logistics, improper layout and visual discomfort.

3.1.3 Questionnaires

Results gathered from questionnaires-administration with respect to the time taken per registration by each of the ten operators/respondents (Res 1 to Res 10), in the course of the registration process are as collated and presented in Table 1.

Table 1: Three-point estimate of time taken per registration as reported by the operators

S/N	Optimistic time (a)	Most likely time (m)	Pessimistic time (b)
1	6	10	20
2	8	10	20
3	8	12	18
4	10	15	20
5	5	8	17
6	6	10	20
7	8	12	17
8	10	15	25
9	5	12	23
10	5	12	60

From Table 1, it was discovered that, under no given condition could any candidate be registered in less than 5 minutes, while the maximum time was not to be expected to exceed 60 minutes. The wide gap between these two extreme points can be attributed to the occurrence delay-causing issues/factors in an unpredictable manner.

3.1.4 Data vetting

On carefully vetting the gathered data, it was discovered that some unrealistic and widely varied figures were reported, particularly for the daily average number of registrations executed by each operator. These were left out of the analysis, because the population of respondents (10 operators) was not large enough to accommodate such variation.

3.2 Determination of expected time

Results obtained from expected time determination are as presented in Table 2.

Table 2: Expected time for registration by each operator

S/N	Optimistic time (a)	Most likely time (m)	Pessimistic time (b)	Expected time $= \frac{a+4m+b}{6}$
1	6	10	20	11
2	8	10	20	11
3	8	12	18	12
4	10	15	20	15
5	5	8	17	9
6	6	10	20	11
7	8	12	17	12
8	10	15	25	16
9	5	12	23	13
10	5	12	60	19

From Table 2,

Average expected time $= \frac{11+11+12+15+9+\cdots+19}{10}$

= 13 minutes

Thus, the average time expected to execute one registration process was estimated to be 13 minutes.

3.3 Using Time Study to Quantify the Efficiency and Wastes in the Registration Process

The results of activities relating to the time study are presented in section 3.3.1 to section 3.3.4.

3.3.1 Determination of required number of observations

The results of the duration of the 5 cases, representing preliminary study is presented in Table 3 to the nearest minutes.

Table 3: Observed times during preliminary study

S/N	Observed Time (T)
1	9
2	12
3	11
4	9
5	11

From the result of preliminary study shown in Table 3, a fairly constant duration between 9 and 12 minutes for registration of one candidate was observed.

On substituting the necessary parameters into Equation 3, it was discovered that at least 21.3 observations were needed in order to confidently estimate the time used, at 95% confidence level.

3.3.2 Observation of sample registration times and determination of performance rating

The time taken to carry out 22 registrations were observed and recorded as presented in Table 4.

Table 4: Observed times for carrying out 22 registrations

S/N	Raw Observed Time (T in minutes)
1	11
2	8
3	10
4	8
5	11
6	8
7	6
8	13
9	5
10	6
11	7
12	9
13	7
14	8
15	11
16	7
17	6
18	10
19	6
20	8
21	6
22	7

From Table 4,

Average raw observed time $= \frac{11+8+10+8+11+6+\cdots+7}{22}$

= 8.1 minutes

= (8.1 X 60)

= 486 seconds

The performance rating factor was determined thereafter:

Base factor for normal work	= 1.00
Adjustment for skill (fair)	= -0.05
Adjustment for conditions (poor)	= -0.07
Adjustment for effort (fair)	= -0.12
Adjustment for consistency (fair)	= -0.02
Total performance rating factor	= 0.74

Thus, the performance rating factor was determined to be at 0.74, meaning that the worker studied is $\frac{37}{50}$ times as efficient as an average qualified worker working at a normal pace under ideal conditions.

3.3.3 Determination of allowance and standard time

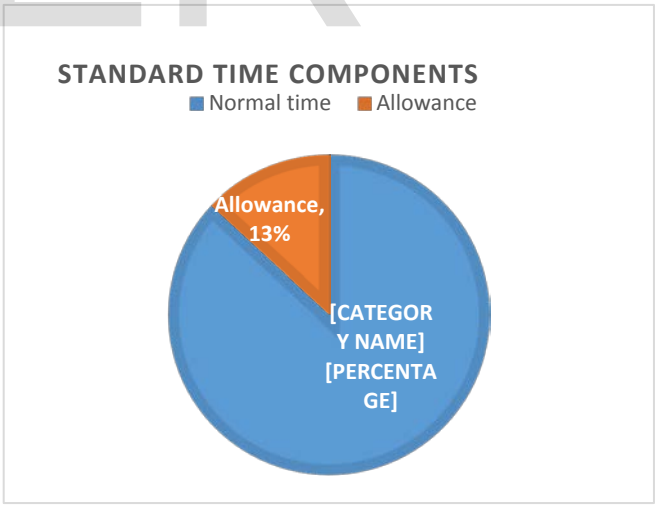
On substituting necessary parameters into Equation (5) under section 2.2.3, the normal time (T_e) was found to be 6 minutes. This implies that an average qualified worker would require approximately 6 minutes to completely carry out a single registration, assuming there are no delays and/or distractions.

Using Equation (6) under Section 2.2.3 and substituting for the necessary parameters, the allowance (A_{pfd}) required was found to be 54 seconds. This implies that an average worker requires additional 54 seconds per candidate registration to account for personal needs, fatigue, and delays.

Also, using Equation (7) under section 2.2.3 and substituting already determined values for the normal time and allowance, the standard time was found to be 6 minutes and 54 seconds.

Thus, 6 minutes and 54 seconds was found to be the actual time required to completely carry out a candidate registration with allowance given for personal time, fatigue and delays. This implies that 87% of the standard time is required for the work, while the remaining 13% is given as allowance as shown in Figure 3.

Figure 3: Components of standard time



3.3.4 Quantification of deviation from ideal situation

Results obtained are as indicated in Figure 4.

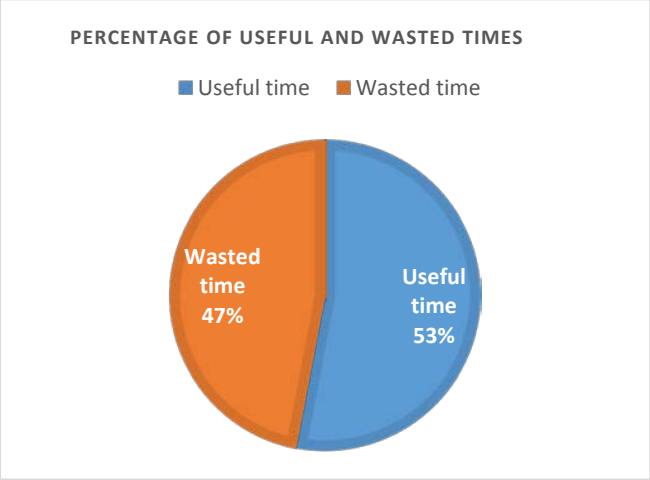


Figure 4: Percentage of useful time and wasted time

The results presented in Figure 4 imply that almost half (28 seconds) of every minute of the registration process was being wasted. This corresponds to 47% of the total time spent being wasted. This makes it imperative to investigate the factors contributing to this huge waste.

The deviation of average time taken for one complete registration, compared to an ideal situation is summarised in Table 5.

Table 5: Comparison of actual and ideal system efficiency

	Raw observed time	Performance rating factor	Efficiency (%)	% of time wasted
Actual	486	0.74	53	47
Ideal	360	1.00	100	0

As shown in Table 5, economically significant deviations were observed between the current and ideal situations of the registration system.

3.4 Investigating the Inefficiency(ies), as well as their Causes in the Registration Process

Having established that the current system performance being at 53% is far below optimal (Figure 4 and Table 5), The frequency of occurrence of each delay-causing factor at each registration point is presented on a scale of 1-5 in Figure 5.

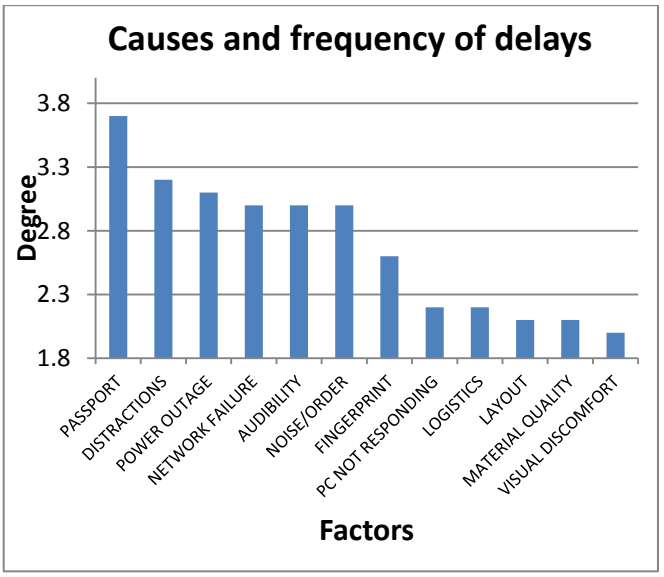


Figure 5: Delays factors and frequency of occurrence

From Figure 5, it was deduced that delays arising from passport photograph capturing, distractions, power outage, network failure, inaudible candidates and noisy environments were the important factors that negatively impacted the smooth running of the registration process. Highest variability was reported in the levels of delays brought about by distraction, fingerprint scanning, and network failure. Apart from the factors in the questionnaire, no other factors were identified by the workers. From further investigations of the immediate factors, the root causes behind them were as reported in Table 6.

Table 6: Immediate and root causes of delay

Immediate delay-causing factors	Root cause 1	Root cause 2	Root cause 3	Root cause 4
Passport	Candidate's face not centralised	Background not plain	Low level of illumination	Movements at the background
Distractions	Movements of candidates	Noise	Too many candidates in the hall	
Power outage	Outage from source	Faulty generator	Power supply cable is dis-connected from generator	
Network failure	Data cable disconnected	Random uncontrollable factors		
Noise/order	Too many candidates in the hall			
Fingerprint	Fingers are wet/oily	Fingers not appropriately positioned		
Inaudible candidate				

From Table 6, it was inferred that some immediate factors had more than one root causes, with passport photograph having four identified root causes. A total of 15 root causes were identified from the 7 immediate causes, which were used to plot the fishbone diagram (Figure 6) where the immediate factors are written in bold block letters and the underlying factors in small letters.

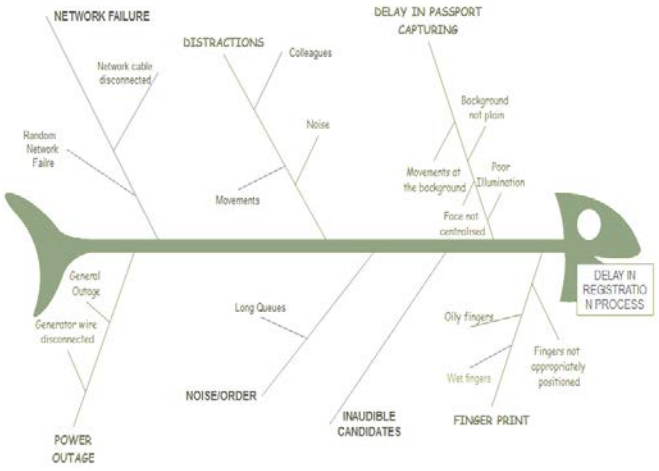


Figure 6: Causes and effects diagram for JAMB registration problems

3.4.1 Suggestions for improvement

i. Only the plain portion of the wall should be used as background for taking photographs.
ii. Movements should be restricted around the registration points, especially while capturing passport photographs.
iii. Only a few candidates that would occupy the seats available should be allowed entry into the facility.
iv. Information concerning the required data and documents should be clearly displayed at strategic locations where every candidates can easily see them.
v. Efforts should be made to minimise the noise made by the candidates. This can be achieved when not too many of them are allowed into the facility at any given time.
vi. Seats should be turned away from the computer units, this will prevent the candidates from toying with the computers, as well as allow easy movement of candidates on queue without noise.
vii. Candidates should be instructed to ensure their fingers are clean and dry at the time of registration.
viii. Operators should desist from career counselling at the point of registration. This will reduce the average flow time of the candidates.

4.0 CONCLUSION

Based on this study, the following conclusions were drawn:

1. Gathered information showed that the time expected for carrying out a candidate's registration in the centre under study was 13 minutes.
2. Time study analysis gave the standard time for carrying out a candidate's registration in the centre was determined to be 6 minutes and 54 seconds, and the current level of efficiency in the system was at 53%.
3. 7 immediate and 15 root causes were found to be responsible for inefficiency in the registration process.

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