AN IMPACT ASSESSMENT PARADIGM FOR THE EFFECTIVE ADOPTION OF COMPUTER BASED TESTING SYSTEM IN TERTIARY INSTITUTIONS USING CROSS-IMPACT METHOD

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ABSTRACT: Computer Based Test (CBT) system has become a widely used tool for assessing examinee capability in examinations which is not limited to students but also to job seekers because of its instant delivery of results. However, most of the existing work studied a number of events that contributed to the adoption of CBT but little work had been done on the study of correlation between events which made it impossible to know the effect of certain event over the others. Hence, this studied the inter-relationship between events and how the relationship impacts positive changes on the CBT system in tertiary institutions using Cross-impact method. Questionnaires were administered on experts in three selected tertiary institutions in Oyo state. The questionnaire was structured to collate the opinions of experts on the probabilities of single occurrence and conditional occurrence of Examination Policy (EP), Availability of Software and Hardware (SH), Lecturers Acceptance (LA), School Management Commitments (MC) and Students Performance (SP) which were the five major relevant events considered for the adoption of Computer based testing system in tertiary institutions. The data obtained through the questionnaires were analyzed to derive the Initial Probability and Conditional Probability which constitute the Cross-Impact Probability matrix for the occurrence of considered events. Sensitivity testing was performed on each event to determine the individual impact on others.The results of sensitivity testing of the effect of EP on others showed the significant changes of 8, 11, 4 and 10% for SH, LA, MC and SP, respectively. Also, the result of sensitivity testing of the effect of SH on others experienced the significant changes of 9, 14, 6 and 13% for EP, LA, MC and SP, respectively. The result of sensitivity testing of the effect of LA on others experienced the significant changes of 14, 16, 12 and 19% for EP, SH, MC and SP, respectively. The study showed that all five events were important and had impact on one another but lecturers' acceptance has the highest impact while school management commitment has the least impact for the effective adoption of CBT in tertiary institutions. Thus, this will serve as baseline information for intending institutions in adopting CBT system in assessing their students' capabilities.

KEYWORDS: Computer Based Test, Cross-Impact Method, Initial Probability, Conditional Probability, Sensitivity Testing

1. INTRODUCTION

T The history of computer-based testing began in the early 1970s with the introduction of the early computers in the 1970s that revealed the potentials of using technology not only for new learning environments but also for completely new settings in the design and administration of tests. E-assessment originated with the PLATO system from the University of Illinois and commercialized by Control Data Corporation in the 1970s, starting with a computer testing system for National Association of Securities Dealers (now the Financial Industry Regulatory Authority). The testing business grew slowly and is today's known as Thomson Prometric. Further expansion of the testing system was occasioned by Pearson VUE in 1994 which was one of the first to use the internet for CBTS [1].

Today many universities and institutions employ the use of computer based testing [2]. The rapid advancement in Information and Communication Technology (ICT) has resulted in a transformation in the way many manually processed activities are being performed today. One of such activities is the assessment of students which has evolved from the use of paper-and-pencil to a computer-based format in recent years [3]. Assessment is any method used to understand the current knowledge that a student possesses[4]. The concepts of assessment, examination and testing stimulate students to conscientiously study, attend lectures and actively partake in assignments in order to avoid failure as well as ensuring that teachers make a proper planning of their lessons and teach carefully in class [5]. With the growth in the number of students aspiring for western education in Africa, and a

limited number of qualified educators, the use of a Computer-Based Testing System (CBTS) provides a solution to meet the challenge [6]. Nigeria National Information Technology (IT) policy, which was formulated in the year 2000, is responsible for the monumental developments across the various sectors of the economy. The vision is to make Nigeria an IT capable country in Africa and a key player in the information society. Its primary mission is to use IT for education, creation of wealth, poverty alleviation, job creation, governance, health, agriculture; etcetera [7].

2. LITERATURE REVIEW

2.1 Applications of computer based testing system in Nigeria

Online examinations which are a variant of a Computer Based Testing System can be used as an assessment-evaluation tool in distance education systems that have quite a number of students. For such systems, good execution of examination aimed at assessment and evaluation is very critical because problems arising from human-centered errors or technical difficulties may lead to questioning of the examination, and thus reliability and efficiency of the distance education systems [8].

Resuscitated in 2002 by President Olusegun Obasanjo, National Open University of Nigeria (NOUN) (a distance learning institution) which currently has not less than seven schools and academic centers that employs the use of electronic examination in the evaluation phase of students study circle. Research studied on 105 academic staff revealed that 84 respondents recommended CBTS for conducting examination in NOUN based on the fact that it was easy to administer and used by the students. Most especially is the fact that, the result of the examination can be viewed almost immediately after the examination [9].

Tertiary institutions in Nigeria now use Computer Based Testing System in the Post Unified Tertiary and Matriculation Examination (Post-UTME) for screening their students. Also, some Nigerian universities are almost fully or partially implementing the Computer Based Testing System (CBTS) for assessing their students. These include:

  (i) National Open University of Nigeria (NOUN)
  (ii) University of Ilorin, Ilorin
  (iii) Federal University of Technology, Minna
  (iv) Covenant University, Ota (Private)
  (v) University of Nigeria, Nsukka
  (vi) University of Lagos, Lagos
  (vii) Ladoke Akintola University of Technology, Ogbomoso
  (viii) Kogi State University, Anyigba

However, NOUN is the only Nigerian University that is fully implementing Computer Based Testing System for assessing her students and this is employed through the internet. Other universities employ the use of the Intranet [2]. Furthermore, the Joint Admissions and Matriculation Board (JAMB) which is the national matriculation examination body for admissions into Nigerian higher institutions of learning has adopted the use of a CBTS for the conduct of its examination. The revolutionary dimensions of this ICT-enhanced service can only be appreciated when compared with the former system where the examination results were anxiously awaited by the candidates for close to eight weeks as against seven working days with the use of a CBTS [10].

2.2 The Delphi Technique

The Delphi technique is a widely used and accepted method for gathering data from respondents within their domain of expertise. The technique is designed as a group communication process which aims to achieve a convergence of opinion on a specific real-world issue. The Delphi process has been used in various fields of study such as program planning, needs assessment, policy determination, and resource utilization to develop a full range of alternatives, explore or expose underlying assumptions, as well as correlate judgments on a topic spanning a wide range of disciplines. The Delphi technique is well suited as a method for consensus-building by using a series of questionnaires delivered using multiple iterations to collect data from a panel of selected subjects. Subject selection, time frames for conducting and completing a study, the possibility of low response rates, and unintentionally guiding feedback from the respondent group are areas which should be considered when designing and implementing a Delphi study [11].

3. RESEARCH METHODOLOGY

3.1 Research approach

Data was collected through Delphi questionnaire submitted by the experts, and data cleansing was carried out by removing uncompleted data from the record. Initial and conditional probabilities were obtained from the data analyzed using descriptive statistics, cross-impact probability matrix was derived from initial and conditional probabilities of the events, and test for the occurrence of events were carried by adopting developed impact assessment paradigm. Sensitivity testing was carried out on each event that produces results. Figure1 shows the flow diagram of the process.

3.2 Gathering and Formulation of Relevant Events

Delphi questionnaire was used in this research to survey and collect the opinions of experts in the selected tertiary institutions to get opinions as regards to the adoption of CBT in tertiary institutions.

Literatures, online search and experts were consulted to know the factors (events) that immensely contributed to the adoption of Computer based testing system. Therefore, from the review, five major and important relevant events were filtered out from the numerous events gathered based on their inherent contribution in the adoption of Computer based test in tertiary institutions. The five (5) relevant events are:

i. Examination Policy
ii. Availability of Software and Hardware
iii. Lecturers' Acceptance
iv. School Management Commitments
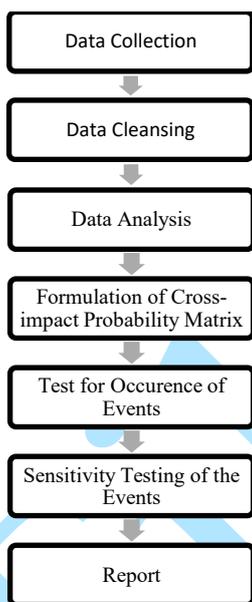v. Students Performance

Figure 1: Flow Diagram of the Process

3.2.1 The events definition

There are many factors that need to be put in place for the successful adoption of CBT in tertiary institutions. These factors are referred to as events in the study. The ones used are briefly explained as follows:

(a) Event 1:Examination Policy

This policy outlines the basic principles, rules and regulations supporting examinations at the institution and the expectations of both students and staff. Examination policy sets the rules and regulations in conducting an examination which includes notification of examination timetable, date and time of the examination, question types and penalties attached to all forms of examination malpractices.

(b) Event 2: Availability of Software and Hardware

Availability of hardware and software are not limited to computer and program only but also include infrastructures like standby power source, good network devices, server, building and so on. In Nigeria, most of the infrastructures for automated examinations are either obsolete or overstretched in terms of capacity, accessibility, reliability and security. The software and hardware needed for the implementation of CBT must be put in place before adoption of CBT system.

(c) Event 3:Lecturers Acceptance

Lecturers' acceptance is highly needed in adoption of Computer Based Test in tertiary institutions because they are the determinant factor of the examinations. Some lecturers are kicking against the adoption of CBT mainly because they believe it cannot perfectly measure the students' abilities while some lecturers supported its adoption only because it eradicates the stress of marking.

(d) Event 4:School Management Commitment

School management members are the major stakeholders in adopting CBT as a mode of accessing student abilities in tertiary institutions. Their commitment must be strong in order to provide all necessary needs for the implementation of CBT.

(e) Event 5: Student Performance

Any form of students' assessment that will affect the student performance negatively would not be accepted as mode of assessment. CBT adds values to students' performance, it encourage the students to read extensively to understand their course well. The immediate release of CBT results and prevention of examination malpractices encouraged students to buckle up for their examinations.

3.2.2 Design of questionnaire and hypotheses

Questionnaire was used to carry out a survey that would capture critical data on the adoption of Computer Based Test in Tertiary Institutions. The hypotheses postulated for the study is as follows; the individual hypotheses testing for each of the factors contributing to student performance;

H_0: Examination Policy is not significant
H_1: Examination Policy is significant
H_0: Lecturers acceptance is not significant
H_1: Lecturers acceptance is significant
H_0: Management commitment is not significant
H_1: Management commitment is significant
H_0: Student performance is not significant
H_1: Student performance is significant

The hypotheses testing for the overall significant of all factors is given as.

H_1: There is significant difference between availability of software and hardware and all factors considered.

The questionnaire was divided into two parts. In the first part, experts were asked to provide the initial probability of occurrence of each single event. The judgment referred to the school management members, lecturers and IT staff of LadokeAkintola University of Technology, Ogbomoso, The Polytechnic of Ibadan, Ibadan and Emmanuel Alayande College of Education, Oyo. In the second part of the questionnaire, experts were asked to indicate the conditional probability of the events, whereby referring to the probability each of the other events listed were implemented given that the selected event turned out to be true (or occurred).

A likert rating scale is psychometric scale commonly used in questionnaires and is the most widely used scale in survey research. The experts responded to the questionnaire using a likert probability rating scale ranges from 1 to 5. The meaning of the Likert probability scale follows this trend:

1= event almost impossible(0-10%)
2= event unlikely(11-30%)
3= event equally likely or unlikely(31-50%)
4= event likely(51-70%)
5= event almost certain(71-90%)

3.2.3 Selection of experts

The participants were selected based on their impact in the adoption of Computer Based Test (CBT) system in tertiary institutions. They are:

i. Vice Chancellor
ii. Rector
iiiProvost
ivBursars
vRegistrars
viLibrarians
viiLecturers
viiiProgrammers
ixNetwork Administrators
xWeb Developers

3.3 Formulation of Cross Impact Probability Matrix

A total number of 120 copies of questionnaire were distributed among Ladoke Akintola University of Technology, Ogbomoso, (LAUTECH), The Polytechnic of Ibadan, Ibadan (Ibadan Poly) and Emmanuel Alayande College of Education, Oyo (EACOED). The questionnaire successfully filled were 43, 32 and 22 by Ladoke Akintola University of Technology, Ogbomoso, The Polytechnic of Ibadan, Ibadan (Ibadan Poly) and Emmanuel Alayande College of Education, Oyo (EACOED) respectively. A total number of 97 questionnaires were returned and used for this research.

The first step of the data analysis was coding. The data was coded into a format with alphanumerical code using the SPSS 17 Statistics. The major events under consideration were coded as follows:

Event 1: Examination Policy (EP)
Event 2: Availability of Software and hardware (SH)
Event 3: Lecturers Acceptance (LA)
Event 4: School Management Commitment (MC)
Event 5: Effects of CBT on Student Performance (SP)

The coded events were analyzed using descriptive statistic in SPSS and Table 1showsCross-impact probabilities of the five events considered when they occurred from the data analysis.

Table 1: Cross-Impact Probability Matrix when Events Occurred

Events	Initial ProbabilityI	EP	SH	LA	MC	SP
EP	0.59		0.80	0.58	0.79	0.31
SH	0.50	0.66		0.63	0.81	0.57
LA	0.33	0.75	0.85		0.86	0.51
MC	0.73	0.75	0.83	0.75		0.43
SP	0.40	0.17	0.24	0.24	0.13	

3.4 Implementation and Occurrence of Considered Events

Impact assessment paradigm was adopted and implemented on the Microsoft.NET framework using Visual Studio.NET (C#). During the implementation, initial probabilities of an event and the conditional probabilities when the events occur were the inputs to the software. The occurrence of each event was calculated using impact assessment paradigm as shown in Figure 2.

The Cross-impact probability matrix was derived from the analysis of experts' opinions gathered. The five (5) events were considered relevant to the adoption of Computer Based test in tertiary institutions, the events and their interpretations were as follows:

Event 1 denotes Examination Policy (EP)
Event 2 denotes Availability of Software and Hardware needed for setting up CBT (SH)
Event 3 denotes Lecturers' Acceptability (LA)
Event 4 denotes School Managements' Commitment (MC)
Event 5 denotes Effects of CBT on Students' Performance (SP)

Step 1: Start {Identify the events [n] relevant to the adoption of CBT in tertiary institutions}
Step 2: Provide the events
Step 3: Provide each event's initial probability (initial Probability)
Step 4: Provide Matrix M1 = Matrix[n,n]; {the matrix of the conditional probabilities of each event.}
Step 5: Initialize i to 0 and j to 0 {i.e. i = 0 & j = 0}
Step 6: Compute Odd Ratio
Repeat
  i. oddRatio[i,j] = M1[i,j]/(1 - M1[i,j]);
  ii. increment j;
  iii. until j = n;
  iv. repeat
  v. increment i;
  vi. Goto (i.)
  vii. Until i=n;
Step 7: Initialize i to 0 and j to 0 {i.e. i = 0 & j = 0}
Step 8: Compute Occurrence Odd Ratio
Repeat
  i.SET isCross = false; {test for occurrence of i and j}
  ii.If i=j then SET isCross = true;
  iii.If isCross = true then ocurenceOddRatio[i,j] = null;
  iv.Else ocurenceOddRatio[i,j] = oddRatio[i,j] / intialProbability[j];
  v.Increment j;
  vi.Until j = n;
  vii.Repeat
  viii.Increment i;
  ix.Go to (i.)
  x.Until i = n;
Step 9: Select random number (99 <overalRandom< 151)
Step 10: Initialize z to 0 {i.e. z = 0}
Step 11: Initialize i to 0 {i.e. i = 0}

Step 12: Perform Test for Occurrence
  i.Select random number (0 < rand < 1);
  ii.Select event[i]
  iii.If rand <initial Probability[i] then SET is Occur = true;
  iv.Else is Occur = false;
  v.Initialize j to 0 {i.e. j = 0}
    a. If is Occur = true then occurence Frequency[i,j] += 1;
    b. If k != i then Matrix J1[i,j] = (initial Probability[j] * occurrence Odd Ratio[i,j]);
    c. If rand <initial Probability[k] then occurrence Frequency[i,j] +=1;
    d. Increment j;
    e. Until j = n;
    f. Repeat
    g. Increment i;
    h. Go to (ii.)
    i. Until i = n; {All events are tested}
    j. Repeat
Step 13: Repeat
  i. Increment z;
  ii. Repeat step 11;
  iii. Repeat step 12;
  iv. Until z = overalRandom;
Step 14: Compute final Probabilities
  i.Initialize i to 0 and j to 0 {i.e. i = 0 & j = 0}
  ii.Select event[i];
  iii.If i != j then(finalProbability[j] = occurenceFrequency[j,i] / overalRandom) {Final Probability of event [j] for the occurrence of event[i]}
  iv.If i = j then(finalProbability[i] = null) {Final Probability of event [i] for the occurrence of the same occurrence is null}
  v.Increment j;
  vi.Repeat
  vii.Until j = n;
  viii.Incrementi;
     ix. Go to (ii.)
  x. Repeat
  xi. Until i = n;
Step 15: Display Final Probabilities for all Events n;
Step 16: Stop

Figure 2: The Developed Impact Assessment Paradigm [12]

The initial probability p(i) of each event was determined without considering how any other events might affect it, these were derived from the analyzed experts' opinions and the conditional probabilities of the events taken in pairs were also derived from the analyzed experts' opinions which were defined as follow:

p(1) = probability that event 1 will occur (initial probability of event 1)

$p(\frac{1}{2})$ = probability of event 1 given the occurrence of event 2.

However, the opinions given by the experts through the administered questionnaires were checked in order to be sure that the estimated values fall between the acceptable limits of three elementary postulates of the calculus of probabilities which read as;

(P1) Normalization $0 \leq p \leq 1$ for any probability   (1)

(P2) Rule of product $p(i.j) = p(i) . p(\frac{j}{i}) = p(j).p(\frac{i}{j})$ (2)

(P3) Rule of addition $p(i \text{ or } j) = p(i) + p(j) - p(i.j)$ (3)

The conditional probabilities were calculated from the cumulative probability distribution equation:

$$p(\tfrac{1}{2}) = \frac{p(1) - p(not2) \times P(\frac{1}{not2})}{p(2)} \qquad (4)$$

where;

p(1) = probability that event 1 will occur;

p(2) = probability that event 2 will occur;

$p(\frac{1}{2})$ = probability of event 1 given the occurrence of event 2;

p(not2) = probability that event 2 will not occur; and

$p(\frac{1}{not2})$ = probability of event 1 given the non-occurrence of event 2.

This expression can be rearranged to solve for $p(\frac{1}{2})$: since p(l) and p(2) are already known (the initial probability estimates) and p(not2) is simply 1 - p(2), only $p(\frac{1}{2})$ and $p(\frac{1}{not2})$, the conditional probabilities, are unknown. By substituting 0 for $p(\frac{1}{not2})$ in (4) (the smallest value it could possibly have), the maximum value for $p(\frac{1}{2})$ can be calculated. Thus:

$$p(\tfrac{1}{2}) \leq \frac{p(1)}{p(2)} \qquad (5)$$

Similarly, by substituting 1 for $p(\frac{1}{not2})$ in (4) (the largest possible value for $p(\frac{1}{not2})$), the minimum value for $p(\frac{1}{2})$ can be calculated:

$$p(\tfrac{1}{2})) <= \left\{ \frac{p(1) - p(not2)}{p(2)} \right\} \qquad (6)$$

4. CONCLUSION AND RECOMMENDATION

The impact assessment paradigm implemented on Microsoft.NET framework using Visual.NET (C#) shows that the occurrence of Examination Policy (EP), Availability of Software and Hardware (SH), Lecturers' Acceptance (LA), Management Commitments (MC) and Students Performance (SP) had impact on all other alternative events. This implies that all five events are important influential events on adoption of CBT in tertiary institutions, which means without them CBT system in tertiary institutions cannot be completely actualized and sensitivity testing carried out gives the results that change in each events EP, SH, LA, MC and SP produced positive effect on all other events. It is recommended that the resultof this work should put into practice in order to have effective adoption of CBT.

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