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EVALUATION OF COMPUTER MODELING AND SIMULATION TOOLS IN MANAGING ENGINEERING PROJECTS AT NIGERIAN TERTIARY INSTITUTIONS

Abubakar, A[*1]., Adamu, A[2]., Hassan, M. A[1]. and Umar, Z[3].
[*1]Department of Mechanical Engineering, Waziri Umaru Federal Polytechnic Birnin Kebbi
[2] Department of Applied Geophysics, Federal University Birnin Kebbi
[3]Department of Computer Science, Waziri Umaru Federal Polytechnic Birnin Kebbi
[*1]Correspondence's e-mail: lamido787@gmail.com

ABSTRACT
Engineers and Technologist in Nigeria encounter their first challenge/task as Project designers and Managers in the final year of their studies, i.e. ND II, HND II and Level 500 for National Diploma, Higher National Diploma and University students, respectively. Where they are mandated to come up with a reliable and functional project, however, their need for Computer Modelling and Simulation tools becomes paramount in order to develop and test a model due to uncertainties, complexity and cost of engineering projects. This paper is aimed to evaluate the level at which Computer Modelling and Simulation Tools are being used to carry out engineering projects in Nigerian Tertiary institutions, with the ultimate goal of highlighting its significance and address the challenges that hinder their use of it at Waziri Umaru Federal Polytechnic Birnin Kebbi as a case study. Descriptive research design was used for data collection, 50 academic staff and 100 final year students (ND and HND) from the departments of Agricultural, Civil, Electrical, Mechanical and Metallurgical engineering, were randomly selected for the study. Data was collected using a distributed questionnaire. Results obtained indicated that the percentage of staff with training, accessibility and capacity respectively was 14%, 18% and 14%. And that of the students was 3%, 14% and 3% respectively. Therefore, the study reveals poor level of training, accessibility and capacity amongst both the staff and the students.
Keywords: Modelling; Simulation; Tools; Tertiary Institutions and Waziri Umaru Federal Polytechnic.

INTRODUCTION

Engineers and Technologist in Nigeria encounter their first challenge/task as Project designers and Managers in the final year of their studies, i.e. ND I, HND II and Level 500 for National Diploma, Higher National Diploma and University students, respectively, where they are mandated to come up with a reliable and functional project. After which, they will venture into the engineering field to provide solutions to real-life problems. However, their need for Computer Modelling and Simulation tools becomes paramount to handling a project due to uncertainties, complexity and cost of engineering projects. A model can be the replica or prototype of the project (what is to be produced). A model is similar (in properties and behaviors) but usually simpler and smaller (in size) than the actual project so that it can be subjected to experiment or test against different design conditions in order to avoid project failure. A model is used to predict and ascertain the behaviors of the project before its actual production. A model represents the construction and working of some system of interest. This is the process of building a representation of a system that will mimic the actual system or plant by unfolding the model through time (Nyemba, 2002). According to Singh (2009), formal models can be classified as physical, mathematical and computer models. Models are used to capture aspects of existing or envisioned systems and are simulated to predict the behavior of these systems. However, developing such models from scratch requires significant time and effort. (Hussain et al., 2022). A model is a simplified representation of a system at some particular point in time or space intended to promote understanding of the real system. (Gupta and Grover, 2013). The model of a system is a replica (physical or mathematical) which has all the properties (attributes) and function of the system. (Ekeocha and Ogbonnaya, 2018).

Modelling is the process of producing a model. Modeling is an essential and inseparable part of all scientific activity, and many scientific disciplines have their own ideas about specific types of modeling. There is an increasing attention for scientific modeling in fields such as of philosophy of science, systems theory, and knowledge visualization. (Gupta and Grover, 2013).

A system simulation is the operation of a system model (Maria, 1997). A simulation brings a model to life and shows how a particular object or phenomenon will behave. Such a simulation can be useful for testing, analysis, or training in those cases where real-world systems or concepts can be represented by models. Simulation is a decision analysis and support tool. Simulation software allows you to evaluate, compare and optimize alternative designs, plans and policies. (Gupta and Grover, 2013). Modeling and simulation constitute a powerful method for designing and evaluating complex systems and processes, and knowledge of modeling and simulation principles is essential to APL's many analysts and project managers as they engage in state-of-the-art research and development. (Menner, 1995). Modeling and simulation refer to a combination of processes in which a system's behavior is demonstrated or predicted by a reductive computational representation. (Magana, 2017). Modeling and simulation (M&S) is getting information about how something will behave without actually testing it in real life. (Sharma and Sharma 2014). Thus, simulation is a process which allows an engineer to subject a prototype or model under different design conditions or factors in order to ascertain its reliability.

The simulation software includes Autocad, Archicad, Catia, Solid Works, ProE, Python, e.t.c. This simulation software is as good as the simulation model and can be built up to address some challenges in project development, especially in tertiary institutions. Basically, all engineering disciplines have developed special computer-aided engineering tools that are specific to their domain. (Volker et al., 2011).

Computer Modelling and Simulation Tools are sets of computer hardware and software used by different professionals (engineers, architects, doctors, military, academia etc.) to develop a model and test it virtually before the development of the actual project. When making decisions, engineers often use computer based simulations models to predict the behavior of the system and infer new information. For example, an engineer may simulate a model of a ground vehicle with various engine displacement values to make predictions about its 0-60 mph acceleration time. The prediction can then be used to inform the engineer about the tradeoffs in the vehicle design for decision making. (Hussain et al., 2022). A computer simulation (or "sim") is an attempt to model a real-life or hypothetical situation on a computer so that it can be studied to see how the system works. By changing variables in the simulation, predictions may be made about the behaviour of the system. It is a tool to virtually investigate the behaviour of the system under study. (Gupta and Grover, 2013).

Engineering design remains a highly uncertain activity and the costs of failure can be high. It was found that the use of modelling and simulation helps engineers to better understand physical properties and behaviour—quickly, cheaply and accurately—before they construct artefacts and systems. Such tools can help engineers 'learn-before-doing' and experiment with integrating different technologies and components. In addition, modelling and simulation help build the 'design conversation' between contributors to an engineering project, including customers and regulators. It provides opportunities for feedback and learning and can promote open, interdisciplinary and collaborative working styles. (Dodgson *et al.*, 2007). Modeling and simulation techniques are being widely applied in organizational and operational systems, in addition to their success in physical system design, manufacture, analysis and improvement. (Yin and McKay 2018). Other advantages include the following:

- It can be used by academia (for research, teaching and learning purposes) and different professionals.
- It saves time, energy and other resources in developing and testing a physical model.
- Validation opportunity, i.e. allows designers to judge and choose the best among options at hand.
- Provide chance of combinations of technologies and components
- It allows professionals of diverse backgrounds (architects, engineers, quantity surveyors etc.) and project stakeholders (regulators, sponsors, policy makers etc.) to communicate, share and exchange information.
- It provides chances for diagnosis and solution (problem-solving) for existing engineering problems.
- It increases/improves the confidence level of engineers and other professionals.
- It is reusable
- It provides the chance to cut/lowering budget

- It provides the chance for risk assessment and management

Therefore, this study was aimed to investigate the level of training, accessibility and capacity amongst the staff and students in order to utilize computer modelling and simulation tools in managing engineering project at Waziri Umaru Federal Polytechnic Birnin Kebbi, as well as highlight its significance and address the challenges that hinder the use of it.

MATERIAL AND METHODS

Study Area

The study was conducted at School of Industrial Engineering and School of Natural Resources of Waziri Umaru Federal Polytechnic Birnin Kebbi, Kebbi state. The schools at the time of this research has about 1250 students and 100 Academic staffs.

Sample Size

The sample size was determined using Yamane formular (Yamane, 1967).

$$n = \frac{N}{(1 + Ne^2)}$$

Where
n= number of sample size
N= the population size
e= the error of 10% point, e = 0.1

The population size of the staff was found to be 50 and that of the students 93. And 8% of the 93 was added in order to account the non-respondent. Therefore, a total number of 150 made the population under study.

Questionnaire

A questionnaire was designed and distributed to respondents (staff and students) which was later used to evaluate their responses.

Statistical analysis

One-way Analysis of variance (Anova) using Microsoft Excel.

RESULTS

A total 150 responses were considered for the study which include 50 academic staffs and 100 final year students from the departments of Agricultural, Civil, Electrical, Mechanical and Metallurgical Engineering. The students' responses were used to analyze their level of training, accessibility and capacity (TAC) to the modelling & simulation facility. The questionnaire consists of total of six and eight questions for staff and students respectively. It includes;

i. What is your status? Staff or Student
ii. Are you aware of Modelling and Simulation Software? Yes or No
   a. Comment _
iii. Do you have access to Modelling and Simulation facility? Yes or No
   a. Comment _
iv. Do you have a practical knowledge of Modelling and Simulation? Yes or No
   a. Comment _
v. Can you use Modelling and Simulation Software to manage/handle project? Yes or No
   a. Comment _
vi. Have you ever attended Modelling and Simulation training? Yes or No
   a. Comment _
vii. How long have you been lecturing? _ _ _ _ _ _ _ _ _ _ _ _ _ _ __(For Staff only)
viii. Has any of your students used Modelling and Simulation Software to manage project?
   Comment _

Final score was calculated based on frequency and percentage; Training, Accessibility and Capacity are found to be 7 (14%), 9 (18%) and 6 (14%) respectively for staff and that of students were 3 (3%), 14 (14%) and 4 (4%) respectively. A score above 75% was considered to be good, between 50% to 74% were reported as fair and <50% to be Poor. Figures 1. and 2. represents the histogram of percentages of the results obtained respectively.

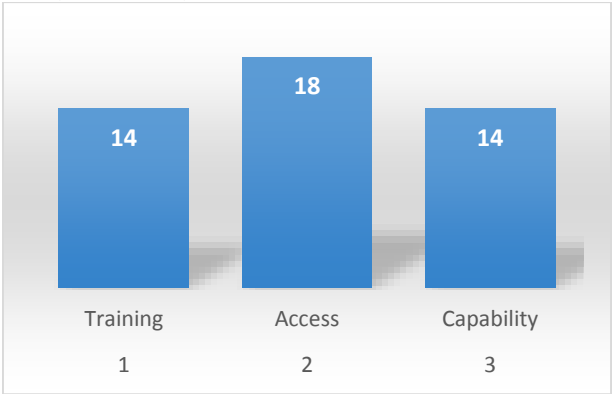

Figure 1. Percentile Score of Staff

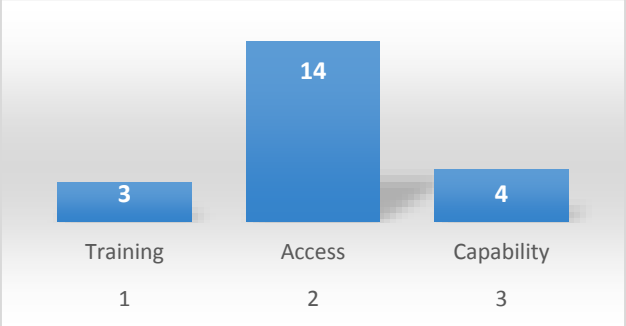

Figure 2. Percentile Score of Students.

DISCUSSION

Computer Modelling and Simulation have experienced amazing development since their beginning in 1920. At that time, technology was only available to a handful of university groups. Today, it is available on the desk of an engineer who needs it (Johan et al., 1998). Unfortunately, this study indicates that only negligible number of staff and students are trained (to use), have accessibility and capable (of utilizing) computer modeling and simulation tools. Result of this study indicates the need for serious concern to train the staff and provide infrastructure for both teaching and learning purposes.

From this study, the level of training amongst the staff with frequency 7 and percentage 14% was obviously poor for teaching their students with frequency and percentage of 3 and 3% respectively. The accessibility to computer modeling simulation tools of staff is low for them to learn even amongst themselves with frequency of 9 and percentage of 18% respectively, likewise the students with 14 (14%) to be improved. The capacity to use computer modeling and simulation tools to manage projects by staff and students were observed to be of with frequencies 6 (14%) and 4 (4%) respectively, that are also low for the benefit of computer modeling and simulation tools.

CONCLUSION

The study reveals poor level of training, accessibility and capacity amongst both the staff and the students. And these can be addressed by providing the following:

i. Knowledge: The user needs robust knowledge and experience which can be acquired through training and re-training.
ii. Fund: Funds to provide Computer Modelling and Simulation infrastructure (computer hardware, software, computer room, server, license, etc).

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