



## Science Research Annals

### A Scholarly Peer-reviewed Research Journal

Volume 13, No 1, Pages 55- 63, 2022

Available online at: <http://journals.aaua.edu.ng/sra>

ISSN: 2805 - 3508

Faculty of  
SCIENCE  
AAUA

## NUO: Nigerian University Ontology

A. A. ADÉGBÌTÉ<sup>1</sup> \*

<sup>1</sup> Department of Computer Science, Adekunle Ajasin University, Akungba–Akoko, Ondo State, Nigeria

\*Corresponding author E-mail address: [adewuyi.adegbite@aaau.edu.ng](mailto:adewuyi.adegbite@aaau.edu.ng)

### Abstract

#### Keywords:

Ontology, Protégé,  
Hierarchy, University  
System, Information,  
Nigeria.

*The huge amount of information available online and its unstructured nature is reaching a point that some actions has to be taken in order to ease the use of queries within a web search engine. The introduction of order/organization and structure is necessary for the process of this information. One-step toward this goal is the use of ontologies for specific areas and domains. Due to the unavailability of digital structured information pertaining to a university hierarchy especially the operations peculiar to Nigeria, hence this study. The study developed an ontology with over 500 axioms for a university hierarchical system with related work associated to ontology reviewed, all the information associated to a university collected, a university ontology model designed and the implementation of the ontology done using Protégé.*

Accepted: 27 Sept, 2022

© Science Research Annals. All rights reserved.

### INTRODUCTION

The word “ontology” is used with different meanings in different communities, context or domain. In the first case, we refer to it in the philosophical discipline, namely the branch of philosophy which deals with the nature and structure of “reality.” Aristotle dealt with this subject in metaphysics and defined Ontology as the science of “being qua being,” that is, the study of attributes that belong to things because of their very nature (Gruber, 1995). Ontology focuses on the nature and structure of things, and also as a special kind of information object or computational artefact. Computational ontologies are a means to formally model the structure of a system, that is, the relevant entities and relations that emerge from its observation, and which are useful to our purposes.

Ontologies are becoming the corner stone of the semantic web. Ontologies aim as capturing domain knowledge in a generic way and provide a commonly agreed understanding of a domain. They shared conceptualizations of a domain, and they possibly include the representations of these conceptualizations. Ontologies are independent from the applications that use them. This leads to easier software and knowledge maintenance, and contributes to the semantic interoperability between applications.

It is widely accepted to consider an ontology as a conceptualization of a domain of interest that can be used in several ways to model, analyze and reason upon the domain. Obviously, any conceptualization of a certain domain has to be represented in terms of a well-defined language, and, once such a representation is available, there ought to be well-founded methods for reasoning

upon it, that is, for analyzing the representation, and drawing interesting conclusions about it (Maurizio et al, 2004).

A university is an institution of higher education and research which awards academic degrees in several academic disciplines. Universities typically offers both undergraduate and postgraduate programs. Nigeria as a country has its first university in 1932, which is fast growing rapidly in number as seen from forty-five in 2000 to 132 in 2014. The majority of these new universities were privately funded and managed.

University encompasses university employees who are responsible for decisions making in Nigerian universities, and are sometimes called management, principal officers or stakeholders. However, Monanu et al. (2019) pointed out that university management can viewed from two dimensions, internal and external. The external dimension is controlled by regulatory bodies, such as the Federal Ministry of Education (FME) and the National Universities Commission (NUC), a body charged with the coordination of university management and compliance with government policy in the country.

The organizational structure of universities is an important guide to institutional activity, but not the only one. Scholars of higher education have developed a variety of multi-dimensional models of organizational behavior that also shed considerable light on university structure and process. Multi-dimensional models seek to explain organizational behavior across institutional types, and in various institutional activities.

### **Nigeria Higher Education**

Ibadin et al. (2005) related their definition of education to Nigeria, and argued that Nigeria is a multi-religious and multi-ethnic African country located in West Africa, and is the most populous and largest Black African Country in the world, with a population of approximately 167 million people. They stressed that Higher Education is strategic in the policy and national development of Nigeria, as it produces graduates in quality and quantity, to drive the various sectors of the economy. Fashina (2005) also explained that education is seen as the bedrock of human development in the Nigerian economy, with a focus

on sectors such as agriculture, infrastructure, energy, oil and gas.

However, Mgbekem (2004), and Ekundayo and Ajayi (2009) argued that the Nigerian system of higher education is binary in nature, as it constitutes universities and non-universities. Universities are mainly directed by their faculties' academic and non-academic staff, while the non-universities sector is made up of monotechs, polytechnics and colleges of education, which provide higher technical education. Babalola et al. (2007) stated that Nigeria operates a federalist system of government consisting of three levels, namely federal, state, and local government. Currently, among these three levels, only the state and federal governments own universities. These two types of university are classified as public universities. Babalola et al. (2007) noted that academic sessions run from October to June, and that a session is normally two semesters. A semester consists of thirteen weeks of learning. Akinyemi and Abiddin (2013) stated that the Federal Ministry of Education (FME) is responsible for all federal universities. The State Government is responsible for the state-owned universities, and the remaining universities are primarily controlled and funded by private investors (such as missionaries, groups of individuals or foreign organisations).

### **University Management**

University management, as defined in this study, encompasses university employees who are responsible for decisions making in Nigerian universities, and are sometimes called management, principal officers or stakeholders. However, Ojelabi (2004) pointed out that university management can viewed from two dimensions, internal and external. The external dimension is controlled by regulatory bodies, such as the Federal Ministry of Education (FME) and the National Universities Commission (NUC), a body charged with the coordination of university management and compliance with government policy in the country.

According to Ibukun (1997), the main objectives of the NUC are to ensure the order and development of education in Nigerian universities, to maintain standards and to ensure adequate funding. Okojie (2007) stated that NUC activities that aim to

improve the quality of university education in the country include: accreditation of courses, approval of courses and programmes, maintenance of minimum academic standards, monitoring of universities and providing guidelines for the setting up of universities.

Whereas, Mgbekem (2004) explained that internal management of universities in Nigeria are run through committee systems, which are either responsible to the Council or the Senate. There is a hierarchy of authority for all official positions. In the organogram of the entire university, the authority flows directly down the line in a maze of subordinate authorities from the vice-chancellor (the executive director) through his deputies and heads of departments, such as the head of the library or university librarian, the university bursar and the registrar and other head of committees like the faculty head or dean, directors and many more. Under them are several other categories of officers, working as committee members, who clearly exercise authority at their respective levels. These committees include finance and general-purpose committees, development committees, appointments and promotion committees, admissions committees, academic planning committees, committees of deans, research grants committees and ceremonies committees among others. All members of committees are known as employees or principal officers, depending on the university.

In a Nigerian university system, for example, the Vice Chancellor is the chief executive officer of the university, but, even though they are the number one academic officer of the institution, they cannot make instant decisions on very important matters which affect all students and staff (Ibukun, 1997). In purely academic matters, for example, all universities have a body called the Senate. The Senate is comprised of the professors of the institution and the provosts, deans, institute directors, and heads of academic departments. They organize and control admission, teaching, graduation and discipline of students, and determine priority areas for research (Ojelabi, 2004).

Ofoegbe (2002) explained that the management are a body of employees that ensures daily administration of the university. The vice-chancellor presides over the senate, but even as

comprehensive and representative as the senate appears to be, many of its decisions are based on the recommendations from the various faculties and committees. In other words, committees are an integral part of Nigerian university. In Nigerian universities, there are all kinds of committees, some of which are called by different names, like boards or even panels (whether panels, boards, or committees, they all perform very similar functions in Nigerian universities). One of the most important committees of any university in Nigeria is the admission committee; this committee is one of several committees of the senate. It is made up of representatives of all the faculties, colleges, schools and institutes. It is headed by a senior academic, generally of the rank of professor, who is appointed by the vice-chancellor in consultation with the committee of deans and university management. He functions solely on criteria which have been stipulated by the senate. The admission committee collates all the applications and recommendations for admission into the university program.

### **Semantic Web**

The Semantic Web is an extension of the World Wide Web through standards set by the World Wide Web Consortium (W3C). The goal of the Semantic Web is to make Internet data machine-readable. The Semantic Web is a collaborative group led by the World Wide Web Consortium (W3C) that support common formats for data on the World Wide Web by encouraging the addition of semantic content in web pages, the Semantic Web intend for converting the current web of unstructured documents into a "web of data". It builds on the W3C's Resource Description Framework (RDF). According to the W3C, "The Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries". The term was coined by Tim Berners-Lee (2001), the originator of the World Wide Web and chief of the World Wide Web Consortium ("W3C"), which oversees the development of projected Semantic Web standards. He defines the Semantic Web as "a web of data that can be processed directly and indirectly by machines." As Tim burners lee say the semantic web is an extension of the current web in which information is given well defined meaning.

## **Ontology**

Ontologies are becoming the corner stone of the semantic web. Ontologies aspire for capturing domain knowledge in a generic way and supply a commonly agreed understanding of a domain. It shared conceptualizations of a field. Owl language has lots of advanced features rather than other languages of ontology like rdfs (Stefano, 2007; Farghaly et al., 2022). Ontologies play an essential role in providing a vocabulary comprising unambiguous definitions for terms that can fundamentally serve as a formal support for communication among software agents and also important for reuse (Sowinski, 2022). A few of ontology editors are available for developing an ontology, e.g, Protégé, OntoEdit, Altova.

## **Protégé Tool**

Protégé is an ontology and knowledge base editor produced by Stanford University. Protégé is a tool that enables the construction of domain ontologies, tailored data entry forms to enter data. Protégé permits the definition of classes, class hierarchies, variables, variable-value restrictions, and the relationships among classes and the properties of these relationships. Protégé comes with visualization packages all of these assist the user visualize ontologies with the aid of diagrams. The key strong point of Protégé is that it supports at the same time tool builders, knowledge engineers and domain specialists. In this paper, Protégé was used, which is an open source freely available ontology editor and knowledge base framework.

## **LITERATURE REVIEW**

To compare conceptual information across two knowledge bases on web, a program must have a way to discover common meanings and the solution to this is to collect information at a common place called Ontologies. Ontology formally describes a list of terms which represent important concepts, such as classes of objects and the relationships between them in order to represent an area of knowledge. Ontologies provide a formal semantics that can be employed to process and integrate information on the web. Gruber (1995) describes ontology as an explicit specification of conceptualization. Ontologies play a pivotal role in providing a vocabulary comprising unambiguous definitions for terms that can essentially serve as a

formal support for communication between software agents. They provide a communication mechanism for users and software agents, clearly define the semantics for different domains for the purpose of interactions on the web, and help in creating a knowledge base that will enable people to work on a particular domain (Dillion, 2011).

The organizational structure of universities is an important guide to institutional activity, but not the only one. Scholars of higher education have developed a variety of multi-dimensional models of organizational behaviour that also shed considerable light on university structure and process. Multi-dimensional models seek to explain organizational behavior across institutional types, and in various institutional activities. Semantic web came into place providing interoperability between machines making them process web information using ontologies as the knowledge based repository, making intelligent decisions like human and classification of information.

Naser et al. (2015), and Mustapha and Adnan (2019) developed university ontology but it was limited to the operation of things for Ahlia University in Bahrain, University of Palestine in Gaza, Palestine and Mosul University in Iraq respectively, which cannot be applicable to the system of operation in Nigeria. An information system was also developed using ontology by Nilsson et al., and from the evaluation of the ontology, there were several errors in the relationship and class that existed there. Activities existing in higher institution was automated by Alrehaili et al. (2021) with focus on assessment tools, and learning outcomes (as evaluated by Alomari (2016) was done and it result in improvements of learning patterns of students. Ontology was used to decide who can best handle a course in university by Ashour et al. (2020), which deals with decision making in the universities. Another area of note in the universities, is the accreditation of programmes, ontology solution was given by Alomari (2016) to map course learning outcomes to student outcome and related assessment so as to avoid over mapping or under mapping.

Hungarian university data relating to course, institution, teacher was formalized using ontology as researched by Fleiner et al. (2017), it focused more on curriculum, course, subject, location and

who to take the course. This work can only fully be used for University operating in the full capacity of the system used by Hungary as a country. Rajiv Gandhi Technical University Bhopal, India was focused by Malviya et al. (2011), and the departments, courses done there annotated.

Semantic web can also be established using ontology, and this was done for the website used in University of Gezira at Sudan and framework established by Babikir et al. (2020).

From the various existing work done studying from long time research to work to recent work done in that area in 2020, none was able to give a true representation of the organogram of university system in Nigeria.

## METHODOLOGY

The design and development of ontology usually encompasses several tasks. There is no one standard methodology for developing ontologies. The main rule is that the ontology concepts and relations should be close to the objects and the relations in the given domain.

To ensure the consistency of ontology structure and increasing its efficiency, during development, this following step would be considered as stated by Andrew et al. (2019) which is vividly seen in Figure 1.

According to Kallet (2004) methods section describes actions to be taken to investigate a research problem and the rationale for the application of specific procedures or techniques used to identify, select, process, and analyze information applied to understanding the problem, thereby, allowing the reader to critically evaluate a study's overall validity and reliability. The methodology section of a research paper answers two main questions: How was the data collected or generated? And, how was it analyzed?

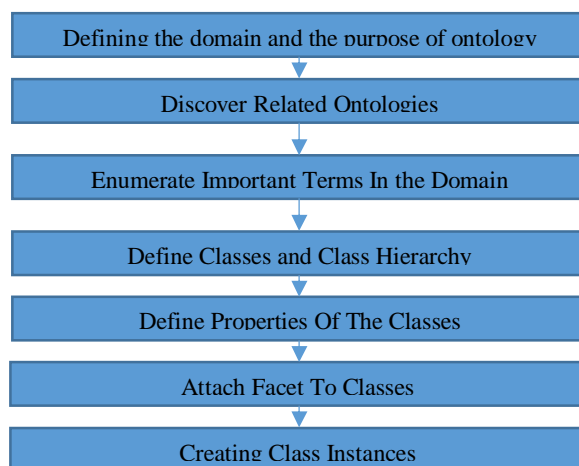


Figure 1: Steps in Ontology Development

## Methodology Work Flow

In this study ontology, will be used to design university hierarchical system. Ontology makes machines understands semantic of languages that humans use by producing the abstract modeled representation of already defined finite sets of terms and concepts involved in intelligent information integration and knowledge management. The following procedures shall be followed in the execution of this work:

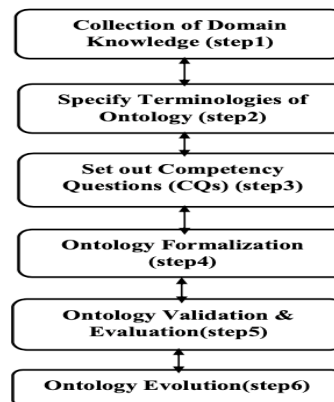


Figure 2: Methodology Work Flow

## Information/ Data gathering

There is need to capture necessary information pertaining to a university and its structure, in other to do this related works was accessed and that gave detailed explanation about a university and also how ontology can be use in modelling the hierarchy system (Fatimah et al., 2020). Although information was also gathered from other sources like personal observation as an academia.

## Construction of Domain Ontology

In constructing the ontology, the following will be considered:

1. Determining the domain and scope of the ontology: For the purpose of this study, the scope of consideration is university system of Nigeria and it is concentrating on the hierarchical structure of the Nigeria University.
2. Considering reusing existing ontologies: The various existing domains cannot be used as the terminologies used for the Nigeria system is different and the hierarchy different too.
3. Enumerating important terms in the ontology
4. Defining the classes and the class hierarchy
5. Defining the properties of classes (slots)
6. Defining the facets of the slots
7. Creating instances
8. Ontology Evaluation

**Mathematical model**

Generally, the structure of an ontology is described as a 5-tuple  $O = (C, H^C, R, H^R, I)$ , where:

- $C$  represents a set of concepts (instances of “*rdf:Class*”). These concepts are arranged with a corresponding subsumption hierarchy  $H^C$ .
- $R$  represents a set of relations that relate concepts to one another (instances of “*rdf:Property*”).  $R_i \in R$  and  $R_i \rightarrow C \times C$ .
- $H^C$  represents a concept hierarchy in the form of a relation (a binary relation corresponding to “*rdfs:subClassOf*”).  $H^C \subseteq C \times C$ , where  $H^C(C_1, C_2)$  denotes that  $C_1$  is a subconcept of  $C_2$ .
- $H^R$  represents a relation hierarchy in the form of a relation  $H^R \subseteq R \times R$ , where  $H^R(R_1, R_2)$  denotes that  $R_1$  is a subrelation of  $R_2$  (“*rdfs:subPropertyOf*”).
- $I$  is the instantiation of the concepts in a particular domain (“*rdf:type*”).

**IMPLEMENTATION**

There are many data shared between organizations and organization divisions, which can be used in building up the university structure. Yet there seems not to be a suitable shared terminology for presenting such information in linked data. Based on the need of a clear structure for any organization, this paper will present an ontology that is reusable for universities structure in Nigeria but specifically for Adekunle Ajasin University

showing some few specific situations that are agreeable for any working university in Nigeria as a country. Various objects and entities are listed as seen in Figure 3, Figure 4 and Figure 5. In other to achieve this development, we have chosen Protégé to implement the ontology, due to its extensibility, quick prototyping and application development. According to Kaur and Aggarwal (2017), Protégé software is a more powerful and useful tool for creating the best ontologies ever due to its functionality (hierarchical visualization, annotation, and searching), expressiveness and efficiency.

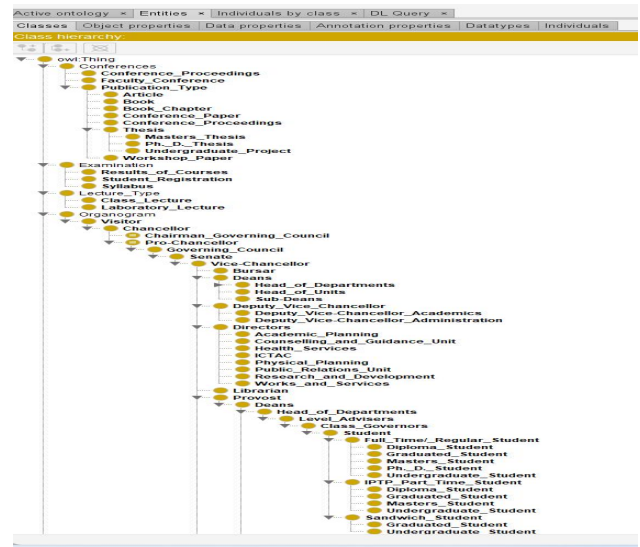


Figure 3: Sample Snapshot of NUO Entity 1

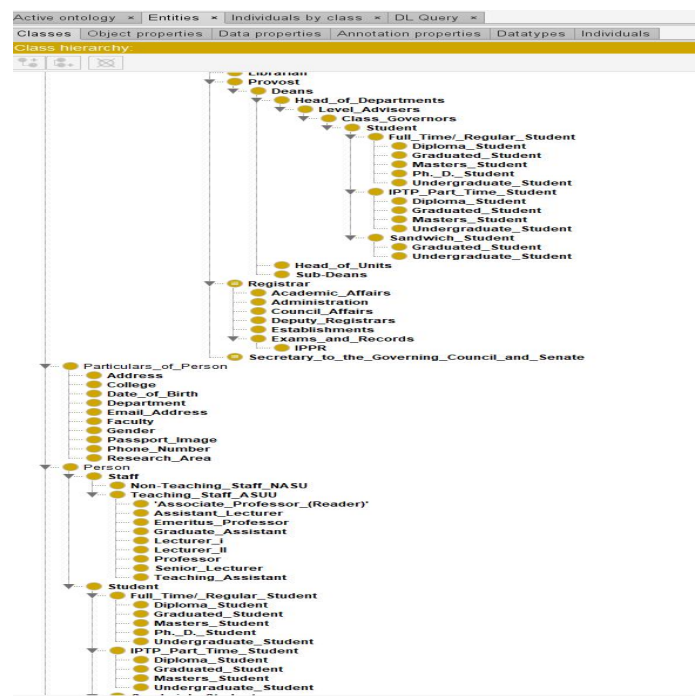


Figure 4: Sample Snapshot of NUO Entity 2

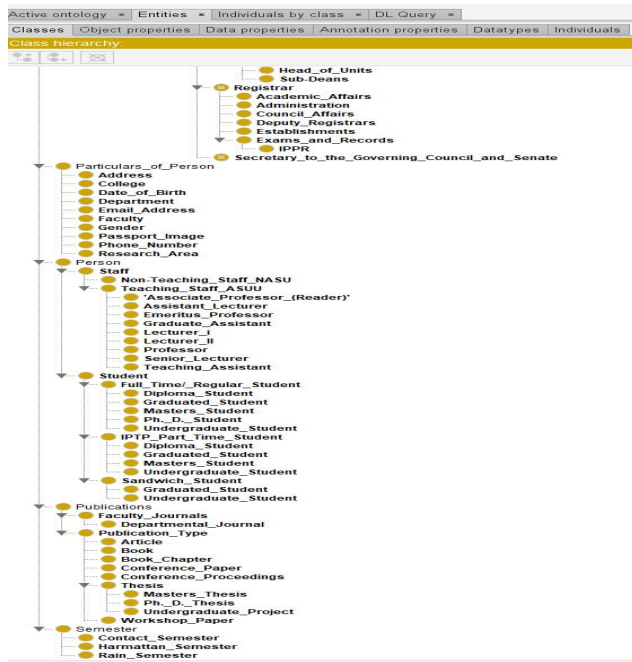


Figure 5: Sample Snapshot of NUO Entity 3

The metrics in an ontology is the quantity of the element in the domain. The metric of the implemented ontology shows states Axiom is 595. The axioms are for the classes, properties, assertions and annotations. Logical axiom relates

the axioms which affect the logical meaning of an ontology, there are 102 of logical axiom count in the implemented ontology. Declaration axioms count is 101, Class count is 98 and Annotation Property count is 4. Class axioms has set of individual elements which are subset of others and which is an expression of the hierarchy of the axiom and they are tagged SubClassOf, for this implementation we have 100 of such categories, EquivalentClasses is 2, and Hidden GCI Count is 4. Annotation axioms has AnnotationAssertion which is 392.

One particular plugin of protégé is the OntoGraf which enables the user to view a graphical representation of the ontology model created, which is always in a hierarchical tree format. The OntoGraf representation of the Nigeria University organogram ontology is given above in Figure 6. The representation gives a visual support and interpretation for relationships existing in the ontology domain. The CoModODE Schema was generated from the ontology and shown in Figure 7 while the XML code snippets of the ontology rendering is shown in Figure 8. One of the features that give protégé an upper edge in information system development is the possibility to generate Java code for each classes and a snapshot of the file is shown in Figure 9.

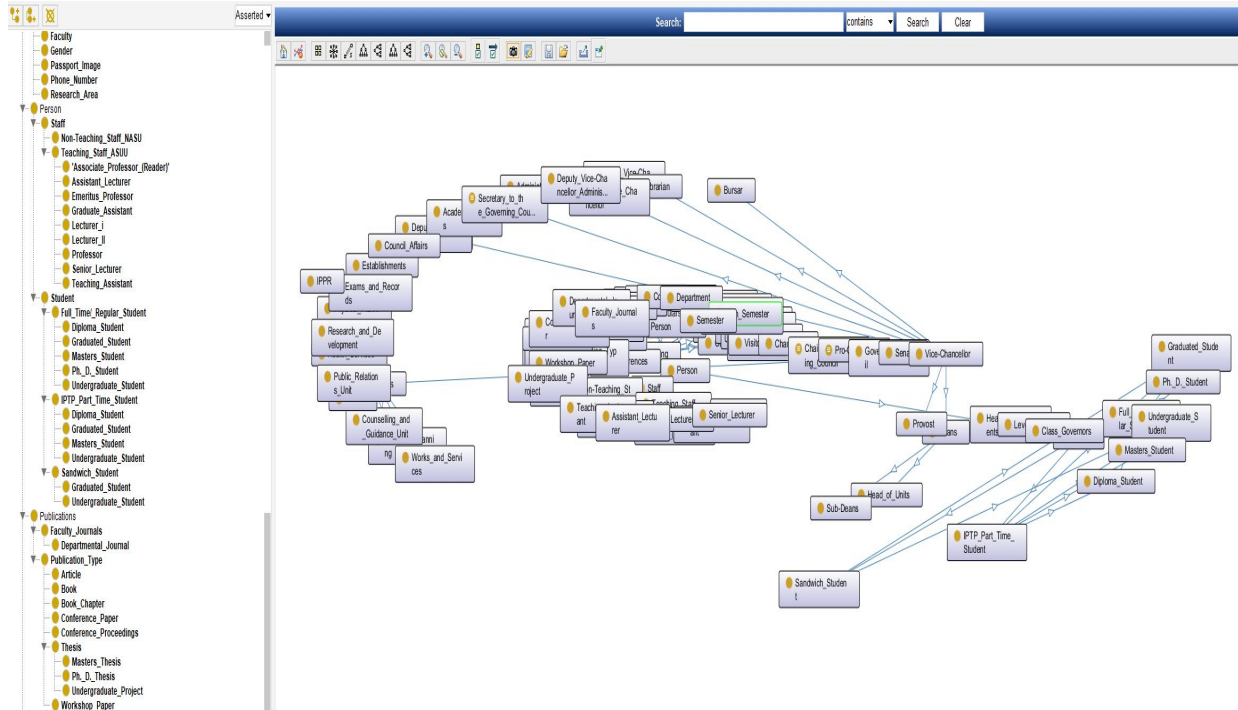


Figure 6: OntoGraf Visualizations of NUO

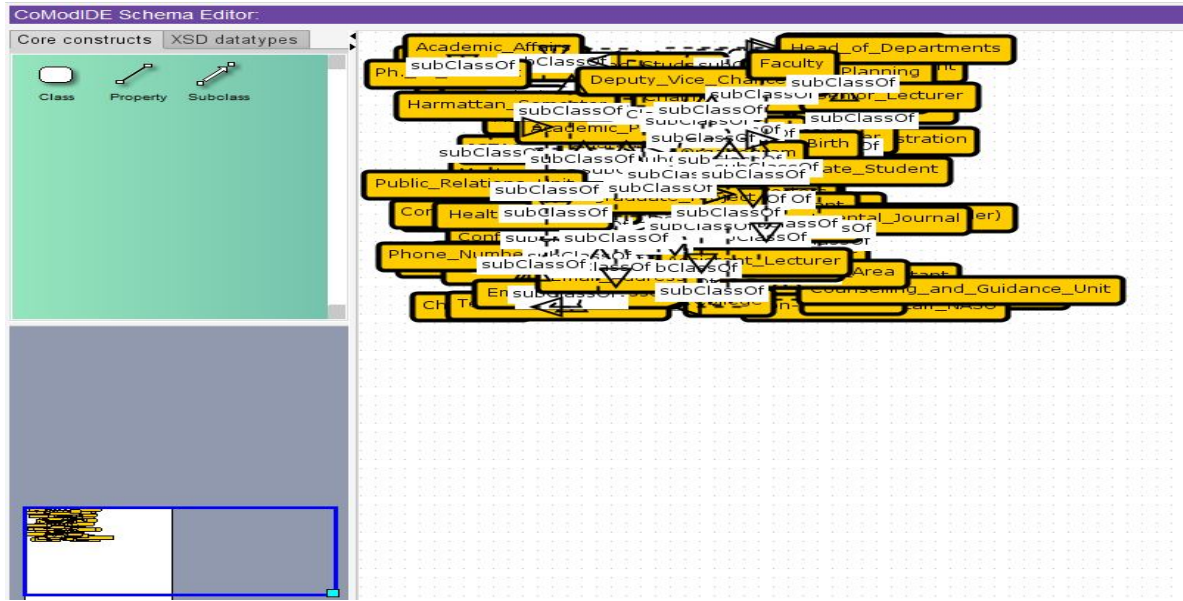


Figure 7: CoModODE Schema Editor for NUO

```

<?xml version="1.0"?>
<Ontology xmlns="http://www.w3.org/2002/07/owl#"
  xmlns:rdfs="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:xml="http://www.w3.org/XML/1998/namespace"
  xmlns:rdfs="http://www.w3.org/2001/XMLSchema#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  ontologyIRI="http://www.semanticweb.org/hp/ontologies/2022/6/untitled-ontology-5">
  <Prefix name="" IRI="http://www.semanticweb.org/hp/ontologies/2022/6/untitled-ontology-5#"/>
  <Prefix name="owl" IRI="http://www.w3.org/2002/07/owl#"/>
  <Prefix name="rdfs" IRI="http://www.w3.org/1999/02/22-rdf-syntax-ns#"/>
  <Prefix name="xml" IRI="http://www.w3.org/XML/1998/namespace"/>
  <Prefix name="xsd" IRI="http://www.w3.org/2001/XMLSchema#"/>
  <Prefix name="rdfs" IRI="http://www.w3.org/2000/01/rdf-schema#"/>
  <Declaration>
    <Class IRI="#Academic_Affairs"/>
  </Declaration>
  <Declaration>
    <Class IRI="#Academic_Planning"/>
  </Declaration>
  <Declaration>
    <Class IRI="#Address"/>
  </Declaration>
  <Declaration>
    <Class IRI="#Administration"/>
  </Declaration>
  <Declaration>
    <Class IRI="#Article"/>
  </Declaration>
  <Declaration>
    <Class IRI="#Assistant_Lecturer"/>
  </Declaration>
  <Declaration>
    <Class IRI="#Associate_Professor_(Reader)"/>
  </Declaration>
  <Declaration>
    <Class IRI="#Book"/>
  </Declaration>
  <Declaration>
    <Class IRI="#Book_Chapter"/>
  </Declaration>
  <Declaration>
    <Class IRI="#Bursar"/>
  </Declaration>
  <Declaration>
    <Class IRI="#Chairman_Governing_Council"/>
  </Declaration>
  <Declaration>
    <Class IRI="#Chancellor"/>
  </Declaration>
  <Declaration>
    <Class IRI="#Class_Governors"/>
  </Declaration>
  <Declaration>
    <Class IRI="#Class_Lecture"/>
  </Declaration>
  </Ontology>
  
```

Figure 8: OWL/XML Rendering of NUO

Name	Date modified	Type
impl	9/27/2022 5:27 PM	File folder
Academic_Affairs	9/27/2022 5:27 PM	Java Sourc
Academic_Planning	9/27/2022 5:27 PM	Java Sourc
Address	9/27/2022 5:27 PM	Java Sourc
Administration	9/27/2022 5:27 PM	Java Sourc
Article	9/27/2022 5:27 PM	Java Sourc
Assistant_Lecturer	9/27/2022 5:27 PM	Java Sourc
Associate_Professor_(Reader)	9/27/2022 5:27 PM	Java Sourc
Book	9/27/2022 5:27 PM	Java Sourc
Book_Chapter	9/27/2022 5:27 PM	Java Sourc
Bursar	9/27/2022 5:27 PM	Java Sourc
Chairman_Governing_Council	9/27/2022 5:27 PM	Java Sourc
Chancellor	9/27/2022 5:27 PM	Java Sourc
Class_Governors	9/27/2022 5:27 PM	Java Sourc
Class_Lecture	9/27/2022 5:27 PM	Java Sourc

Figure 9: Java Code Generated for each classes

## CONCLUSION

This paper has been able to discuss and highlights development of an ontology and illustrates its usage of protégé super class and sub class hierarchy. OntoGraf representation, CoModODE Schema Editor, and XML generated were presented with the snapshot of the code snippets. The ontology developed focused on the interaction between the various units of the Nigeria University concept considering also the organogram and hierarchy of the Nigeria University system with over 500 axioms implemented. It is useful for researchers in designing and developing an Ontology and also useful to know the operations of the Tertiary Education system in Nigeria. This study is useful in semantic web, ontology engineering, knowledge engineering, etc. It also gives a template for building correctly organized hierarchical structure for new institutions whether private or public for their websites.

## REFERENCES

Akinyemi, Gbenga M., and Norhasni Zainal Abiddin (2013). "Quality Administration and Management in Higher Education in Nigeria: Implications for Human Resource Development." *International Education Studies* 6, no. 4 (2013): 225-235.

Andrew G. T., Ajayi O. O., Kekere A. I. and. Bamigboye P. (2019). Semantic Judge Assistant (SJA): An Ontology-Based Case Classifier for Nigeria Judicial System. *Science Research Annals Vol 10 (Special Edition) June, 2019 - Pages 166-173*

Babalola, Joel B., G. O. Akpa, A. O. Ayeni, and S. O. Adedeji (2007). "Access, equity and quality in higher education." *NAEAP publication* (2007).



- Ban Sharief Mustafa, and Ibrahiem Adnan (2019). OMU: An Ontology for Mosul University. Raf. Journal of Comp. & Math's, Vol. 13, No.2, 2019 pp 56-66
- Berners-Lee, T., Hendler, J. and Lassila, O., (2001). The semantic web. *Scientific american*, 284(5), pp.34-43.
- Björkenstam, K.N., Hjelm, H. and Oxhammar, H., (2006). SUIs-cross-language ontology-driven information retrieval in a restricted domain. In *Proceedings of the 15th Nordic Conference of Computational Linguistics (NODALIDA 2005)* (pp. 139-145).
- Ekundayo, H. T., and I. A. Ajayi (2009). "Towards effective management of university education in Nigeria." *International NGO journal* 4, no. 8 (2009): 342-347.
- Farghaly, K., Soman, R. K., Collinge, W., Mosleh, M. H., Manu, P. & Cheung, C. M. (2022). Construction safety ontology development and alignment with industry foundation classes (IFC). *Journal of Information Technology in Construction*, 27, 94-108.
- Fashina, D. (2005). "Reforms in Nigeria university system: What direction." *National Freedom* 1, no. 6 (2005): 9-12.
- Fatihah R., Shahrul A. M. N. and Tri B. K. (2020). Using Ontology-Based approach to improved Information Retrieval semantically for historical domain. *International Journal on Advanced Science, Engineering and Information Technology*, vol. 10, no. 3, pp. 1130-1136.
- Gais Alhadi Babikir, Murtada Khalfallah Elbashir, and Mohammed A. Saleh (2020). A Framework for Establishing a Semantic Web in a University Website: A Case Study University of Gezira. *International Journal of Intelligent Computing Research (IJICR)*, Volume 11, Issue 1, 2020 pp. 1059-1065.
- Ghadeer Ashour, Ahmad Al-Dubai, and Imed Romdhani (2020). Ontology-based Course Teacher Assignment within Universities. (IJACSA) *International Journal of Advanced Computer Science and Applications*, Vol. 11, No. 7, 2020 pp. 720-728. [www.ijacsa.thesai.org](http://www.ijacsa.thesai.org).
- Gruber, Thomas R (1995). "Toward principles for the design of ontologies used for knowledge sharing?." *International journal of human-computer studies* 43, no. 5-6 (1995): 907-928.
- Hadjar K. and Chanane N. (2016). University Ontology: case study Ahlia University, Department of Multimedia, Ahlia University, Al Manama, Bahrain.
- Ibadin, V. O., A. D. Shofoyeke, and G. Ilusanya. (2005). "The history of private sector participation in the provision and management of education in Nigeria." *Deregulating the Provision and Management of Education in Nigeria. NAEAP Publications. Jos, Nigeria: MP Ginac Concept Ltd* (2005).
- Ibukun W. O. (1997). Educational management: theory and practice. AdoEkiti: Green Line Publishers.
- Jehad Sabri Alomari(2016). Ontology for Academic Program Accreditation: Ontology of Accreditation Board of Engineering and Technology(ABET) Process (2016). (IJACSA) *International Journal of Advanced Computer Science and Applications*, Vol. 7, No. 7, 2016, pp. 123-127.
- Kallet, R. H. (2004). How to write the methods section of a research paper. *Respiratory Care*, 49, 1229-1232.
- Kaur N. and Aggarwal H. (2017), Evaluation of Information Retrieval Based Ontology Development Editors for Semantic Web (2017). I.J. Modern Education and Computer Science, 2017, 7, 63-73. Published Online July 2017 in MECS (<http://www.mecs-press.org/>). DOI: 10.5815/ijmecs.2017.07.07
- Lenzerini, Maurizio, Diego Milano, and Antonella Poggi (2004). "Ontology representation & reasoning." *Universit di Roma La Sapienza, Roma, Italy, Tech. Rep. NoE InterOp (IST-508011)* (2004).
- Mgbekem S. J. A. (2004). *Management of University Education in Nigeria*. Calabar: University of Calabar Press.
- Monanu, Oge G., and Adonai Okechukwu Prince Okonkwo (2019). "Impact of Management Guideline in Appointment of Chief Executives on State Own Tertiary Institution in Enugu state, Nigeria." *Journal of Academic Research in Economics & Management Sciences* 8, no. 2 (2019): 53-64.
- Nada Abdullah Alrehaili, Muhammad Ahtisham Aslam, Dimah Hussein Alahmadi, Dina Abdullah Alrehaili, Muhammad Asif, and Muhammad Sheraz Arshad Malik (2021). Ontology-Based Smart System to Automate Higher Education Activities. *Hindawi Complexity* Volume 2021, Article ID 5588381, pp. 1-20. <https://doi.org/10.1155/2021/5588381>.
- Naveen Malviya, Nishchol Mishra, and Santosh Sahu (2011). Developing University Ontology using protégé OWL Tool: Process and Reasoning. *International Journal of Scientific & Engineering Research* Volume 2, Issue 9, September-2011 pp. 1-8. ISSN 2229-5518. <http://www.ijser.org>
- Ofoegbu, F. I. (2002). Agencies, Boards and Commissions in Nigerian Education System. In Nwagwu, N. A. Organization and Administration of Education: Perspectives and Practices Benin City. Festa Press Ltd.
- Ojelabi, A. (2004). A Guide to School Management. Valuta Educational Publishers, Ibadan.
- Okojie J. A. (2007). Higher education in Nigeria. Being a paper presented at Education in Africa Day, held at house of commons palace of Westminster, London. Retrieved from <http://www.nucnigeriainfo/es%20houseofcommons.ppt>
- Rita Fleiner, Barnabás Szász, and András Micsik (2017). OLOUD - An Ontology for Linked Open University Data. *Acta Polytechnica Hungarica* Vol. 14, No. 4, 2017 pp. 63-82.
- Samy S. Abu Naser, Rasha R. Atallah, and Sahar Hamo (2015). Building an Ontology in Educational Domain Case Study for the University of Palestine. *International Journal of Research in Engineering and Science (IJRES)*. Volume 3 Issue 1 Jan. 2015 pp 15-21. ISSN (Online): 2320-9364, ISSN (Print): 2320-9356. [www.ijres.org](http://www.ijres.org).
- Stefano Paolozzi, Paolo Atzeni (2007). Interoperability for Semantic Annotation IEEEConference 2007.
- Sowinski, P., Wasielewska-Michniewska, K., Ganzha, M., Paprzycki, M., & Badica, C. (2022). Ontology Reuse: the Real Test of Ontological Design. ArXiv preprint arXiv:2205.02892.