COLLEGE OF EDUCATION

DEPARTMENT OF INFORMATION STUDIES

A BIBLIOMETRIC ANALYSIS OF THESES AT THE SCHOOL OF NUCLEAR AND ALLIED SCIENCES, UNIVERSITY OF GHANA, LEGON

BY

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(10109515)

THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MPHIL INFORMATION STUDIES DEGREE

JULY, 2018
DECLARATION

I do hereby declare that apart from the references to other published works which I have duly acknowledged, this thesis is the output of my own original research. This thesis has never been presented in whole nor in part elsewhere for another degree.

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DATE………………………
DATE………………………
DEDICATION

This thesis is dedicated to God Almighty for his faithfulness and guidance in the writing of this thesis. I also dedicate it to my children, Samuel Paa Kwesi Asinah Bilson and Daniel Nana Kweku Bilson, my parents Dr. Kweku Asinah Bilson and Mrs. Nana Nyarko Agyeman Bilson and my siblings Stephen Bilson and Dinah Bilson.
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<tr>
<td>AFRA</td>
<td>African Regional Cooperative Agreement for Research Development and Training related to Nuclear Science and Technology</td>
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<tr>
<td>CARLIGH</td>
<td>Consortium of Academic and Research Libraries in Ghana</td>
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<td>ETDE</td>
<td>Energy Technology Data Exchange</td>
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<td>GAEC</td>
<td>Ghana Atomic Energy Commission</td>
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<td>GC</td>
<td>General Conference</td>
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<tr>
<td>IAEA</td>
<td>International Atomic Energy Agency</td>
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<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
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<tr>
<td>INIS</td>
<td>International Nuclear Information System</td>
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<td>LIS</td>
<td>Library and Information scientists</td>
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<tr>
<td>M.Phil.</td>
<td>Master of Philosophy</td>
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<td>NCL</td>
<td>Non-conventional literature</td>
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<tr>
<td>NRA</td>
<td>Nuclear Regulatory Authority</td>
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<tr>
<td>Ph.D.</td>
<td>Doctor of Philosophy</td>
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<td>SNAS</td>
<td>School of Nuclear of Allied Sciences</td>
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<td>UG</td>
<td>University of Ghana</td>
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ABSTRACT

The purpose of the study was to analyse the Master of Philosophy and the Doctor of Philosophy theses publications by postgraduate students at SNAS, University of Ghana from (2008 - 2016) using the INIS database as the source of data. The studies main objectives were to identify the number of theses by academic year, the academic qualifications awarded, the gender distribution of graduate students, the distribution of graduate student theses by academic department, the subject coverage of graduate student theses, the page ranges, figures and tables and citations found in theses by graduate students and the most frequently used keywords assigned by the indexer (subject specialist).

The study employed the bibliometric method. The purposive sampling technique was used to retrieve four hundred and fourteen (414) theses records from a population of five hundred and thirty eight (538) theses records published in Ghana. The International Nuclear Information System (INIS) database and the search query language (country:Ghana AND recordtype:Thesis/Dissertation) were the main instruments used for retrieving the data before extracting them onto Microsoft excel spreadsheet for analysis.

The major findings of the study revealed that the yearly publication trend of graduate student theses at SNAS showed a constant rise and fall in the number of theses published over the period. There was also a big gender gap with male students dominating their female counterparts with (300 or 79.71%) counts. The most frequently used keyword assigned by the indexer (subject specialist) was radiation protection with (189) counts.

It is recommended that the School of Nuclear and Allied Science (SNAS) should gain autonomy from the University of Ghana, the parent University as autonomy will make it run its academic programs by itself, take decisions that will benefit its smooth running and
management in the long run and also help SNAS to accelerate the plans already in place for a nuclear power plant to be added to the energy mix for Ghana.
CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The application of Bibliometrics has been in existence since the days of Gross and Gross (1927), where the means of scholarly communication was mainly through non-electronic resources such as books, theses and journals. This has changed with the arrival of Information and Communication Technology (ICT) to include digital or electronic resources. The use of Bibliometrics as an evaluation tool enables Library and Information scientists (LIS) to conduct studies on theses and dissertations, databases, online journals and institutional repositories.

Academics play an important role in the research process. For instance, they play a pivotal role in guiding students to undertake an independent academic study and finally come out with the findings of their thesis which helps to fill the research gap. These theses do not just end up on the shelves of these academic institutions but sometimes can be found on online databases, institutional repositories and even published in online journals.

In the words of Alemna (2016), “Academics all over the world place emphasis on research and publications, not only because it is presumed that research enriches both teaching and the learning process as well as contributing to the body of knowledge, but also because it is a major determinant of institutional prestige” (p. 4).

Due to information overload, academic institutions and their staff, students, library and Information scientists (LIS), researchers, Governments and Policymakers are therefore not always aware of the means by which scholarly materials are published and shared.
Assessing research output and impact using bibliometrics has now become a common phenomenon worldwide.

Based on supporting literature and practical experiences, “Bibliometrics is ideal for librarians to develop and provide innovative services for both academic and administrative university staff. In doing so they made sure to actively participate in the development of new strategies and in fostering innovation”. (Gumpenberger, Wieland and Gorraiz, 2012).

In Sri Lanka, Dilani (2015) argues that librarians can respond to the research demands of students by analysing bibliographic citations in theses through the use of citation analysis. This is a commonly used bibliometric method worldwide which is a useful tool for collection management.

In Austria, the International Nuclear Information System (INIS) secretariat offered bibliometric services to the Physics Section of the International Atomic Energy Agency (IAEA) by analysing the topic ‘muon tomography’ (IAEA, 2017).

The application of bibliometrics is now a common phenomenon worldwide.

1.1.1 Vision and Mission of the School of Nuclear and Allied Sciences (SNAS)

The strategic direction of SNAS is geared towards the training and development of nuclear scientists for national development. Its vision is to be a leading Graduate school producing high calibre nuclear scientists and engineers to support the health care, industrial, environmental and the socio-economic development of Ghana and Africa (SNAS, 2016).

On the other hand its mission states that SNAS exists for the preservation, maintenance and enhancement of nuclear knowledge in Ghana and Africa through the provision of high quality
teaching, research, entrepreneurship training, service and development of postgraduate programmes in the nuclear sciences and technology (SNAS, 2016).

1.1.2 The Ghana Atomic Energy Commission (GAEC) library

The GAEC Library was created after the establishment of GAEC in 1963 by an Act of Parliament (Act 204 of 1963). The library is an academic/special library and an active member of the Consortium of Academic and Research Libraries in Ghana (CARLIGH). The library exists to support the teaching, learning and research activities of the commission and SNAS. It also serves as a resource base for information in nuclear science and technology in Ghana.

According to the GAEC library website (2017), the mission of the GAEC library is as follows:

I. “Serve as a resource base for information in nuclear science and technology in Ghana.

II. Acquire scientific literature relevant to the interest of the user population,

III. Organizing and displaying these materials, and making them available to the research scientists, engineers and technicians of the commission and also

IV. Extending its services to other institutions in the country.

The library has an online digital library where most of the resources in the library such as Journals, newsletters, brochures, Technical Reports, Books, Conference Proceedings and Theses can be electronically accessed online either in the library or remotely.

The library also provides the following services:

I. Selective Dissemination of information (SDI)

II. Literature Searching

III. Current Awareness
IV. Abstracting & Indexing

V. Compilation of Bibliographies

VI. Interlibrary lending & Document Delivery and

VII. In-service Training To Library Personnel

The GAEC library is also the designated International Nuclear Information System (INIS) centre for the country and therefore responsible for fulfilling article 2.3.1 of the INIS members’ rights, privileges and responsibilities namely the collection, selection, description, categorization, indexing, abstracting and related preparation, of items of literature published within its national boundaries (or organizational confines if an international body) and submission to the INIS Secretariat in Vienna in accordance with the definitions, rules, procedures, formats, and guidelines set forth in the ‘IAEA/INIS Reference Series’ and associated INIS Circular Letters (IAEA, 2000).

1.1.3 International Nuclear Information System (INIS)

INIS was established in 1970 and it is one of the biggest repositories containing over 4 million published literature on the peaceful uses of nuclear science and technology. INIS constitutes a very remarkable example of global cooperation under IAEA auspices (Savic, 2017).

INIS is currently operated by the IAEA in collaboration with 154 members who are made up of 130 countries and 24 international organisations who all come together to contribute and share nuclear literature in their member states and organisations.
According to Savic (2017), INIS as a tool in managing nuclear information fulfils the following roles:

I. Repository. A single centralised location containing millions of published materials on the peaceful uses of nuclear science and technology which is safely stored and well managed.

II. Technical. Using modern information technology, INIS is able to collect and share nuclear information and promoting automation, use of standards and best practice for document processing and information management.

III. Pragmatic. Scientists, engineers, technicians and managers in the nuclear field use INIS as a tool in staying informed with developments in the subject scope covered by the INIS repository.

IV. Knowledge Management. Serves as a repository on publications containing increasing scientific knowledge in the field of peaceful applications in nuclear science and technology as recorded in scientific journals and the full-texts of non-conventional literature (NCL) i.e. grey literature which cannot be easily acquired through regular commercial channels.

V. Preservation. It preserves several valuable documents collected for long-term storage for the present and future generations.

VI. Economic. Both money and effort is saved by several nuclear information stakeholders in locating and accessing information resources.

VII. Political. Despite the sophisticated nature of the subject area, INIS is proof that countries with varied political, social, economic and cultural backgrounds from all the world and technical levels of development can productively work together and exchange information.
1.2 Statement of the Problem

To fulfil the nuclear sector manpower requirements of the country SNAS was established in 2006 to train nuclear scientists in Ghana and the rest of Africa. Several academic research works have been undertaken by over five hundred (500) postgraduate students who have graduated from the programmes offered at SNAS over the period.

Also, the GAEC library which is the mandated national INIS centre has also been collecting, processing and forwarding relevant inputs on nuclear sciences and applications within Ghana to the INIS secretariat in Vienna, Austria for onward transmission to the INIS database. Some of the inputs processed by the GAEC Library include the theses from SNAS which rank among the top best globally in terms of input contribution and quality.

A review of the literature shows that several bibliometric investigations have been conducted by various researchers to evaluate research outputs in several research and academic institutions. Some of these include (Agyeman and Bilson, 2015; Kankam, 2014; Tsafe and Aliefo, 2008; Fosu and Alemna, 2006).

Bibliometric studies aid in policy evaluation and the review of research output. This may explain the reason why the Research Excellence Framework (REF) was established in 2014 to secure the continuation of a world-class, dynamic and responsive research base across the full academic spectrum within the United Kingdom higher education (REF, 2014).

SNAS by virtue of being a centre of excellence has continuously trained high calibre Nuclear Scientist both in Ghana and Africa for the past decade. However no study available has attempted to investigate the research output of postgraduate students at SNAS since its
inception a decade ago. It is against this background that this study attempts to analyse the bibliographic data of M.Phil. and Ph.D theses published at SNAS to identify the research output, measure enrolment and identify areas of research.

1.3 Purpose of the Study

The purpose of this study is to analyse the M.Phil. and Ph.D. theses publications by postgraduate students at SNAS, University of Ghana from (2008 - 2016) using the INIS database as the source of data.

1.4 Objectives of the Study

The main objectives of the study are:

1. To identify the number of graduate student theses by year.
2. To identify the academic qualifications awarded.
3. To identify the gender distribution of graduate students.
4. To identify the distribution of graduate student theses by academic department.
5. To identify the subject coverage of graduate student theses.
6. To identify the page range, figures and tables and citations found in theses by graduate students.
7. To identify the most frequently used keywords assigned by the indexer (subject specialist).

1.5 Theoretical Perspective

A theoretical framework is a collection of interrelated concepts, like a theory but not necessarily so well worked-out (Borgatti, 1999).

Borgatti (1999) further reiterates that a theoretical perspective guides your research, determining what things you will measure, and what statistical relationships you will look for.
Various theories have been propounded to explain bibliometrics and its use. This study will use Pritchard’s (1969) Bibliometrics theory.

According to Carrizo-Sainero (2000), “the conceptual and theoretical foundations of the science of Bibliometrics rely on the following hypotheses:

(a) Bibliometrics finds its epistemological roots in Bibliography;

(b) Bibliometrics, as applying Bibliography, constitutes a factor of measurement and evaluation of information sources and

(c) Bibliometrics consists in a method, or set of methods, that can be employed to evaluate research” (p. 1).

1.5.1 Pritchard’s Bibliometrics Theory

The theoretical foundations of bibliometrics was laid by notable pioneers such as Gross and Gross (1927), Lotka (1926), Bradford (1934), Zipf (1949) and Garfield (1955). However its usage and practice of what is now known as bibliometrics can be traced back to the earlier model of Hulme (1923) called “Statistical Bibliography”. Bibliometrics was however first used by Pritchard (1969) in a publication titled “Statistical Bibliography or Bibliometrics” in the “Journal of Documentation”. He reiterated that the term “Statistical Bibliography” was clumsy, not very descriptive, and could be confused with statistics itself or bibliographies on statistics. He proposed a new term called Bibliometrics which he referred to as “the application of mathematics and statistical methods to books and other media of communication” (p. 2).

The bibliometric model has been tested and used extensively in diverse disciplines and has become a basic instrument used in evaluating research performance. Tague (1988) is of the view that bibliometrics has been heralded as the theoretical basics of information science. It is
not surprising that Pritchard (1969) in the conclusion of his publication entitled “Statistical Bibliography or Bibliometrics” by indicating that the term BIBLIOMETRICS was going to be be used fully in every study that aims at quantifying the processes of written forms of communication and it will be quickly in the information science field. It is not surprising that today bibliometrics has become a widely used research approach to quantify various forms of publications.

Regarding this study, the variables of the bibliometric theory are as follows:

(a) Bibliography - The bibliographic details of M.Phil. and Ph.D. theses publications from SNAS, University of Ghana from (2008 - 2016) indexed in the INIS online bibliographic database.

(b) Measurement and evaluation - Review of theses publications by postgraduate students of SNAS, University of Ghana from (2008 - 2016) using data from the INIS online bibliographic database to get the results or outcomes from the study.

(c) Method or a set of methods - The bibliometric method. The bibliometric model was therefore appropriate for investigating the study.

1.6 Scope of the Study

The study focuses on M.Phil. and the Ph.D. theses of postgraduate students from SNAS, University of Ghana from (2008 - 2016), indexed in the INIS database. The choice of the database was largely based on its free availability to the researcher in retrieving the relevant data from any location with internet access.
1.7 **Significance of the Study**

The study is significant in many ways. No bibliometric study has been done on the M.Phil. and the Ph.D. theses of postgraduate students from SNAS. The research findings will enrich the body of knowledge on bibliometrics and nuclear science and technology in general and Ghana in particular and also serve as reference for future studies in the subject areas.

The study is also important because the findings of the study will inform management, academia, current and prospective graduate students of the dimensions of research undertaken at the graduate school as well as help in the review and enhancement of its academic research programs. Furthermore the findings of the study will also inform financial donors such as the IAEA of the value of their investment and increase accountability. Besides, the research findings of the study will be relevant to the GAEC Library by showing the trend of the most used indexing terms by its subject specialists in processing the theses inputs from SNAS to the INIS secretariat for input onto the INIS database during the period.

Lastly the study is also significant because the research findings will provide the GAEC library with useful information for its collection management and also inform the acquisition of future information material for users.

1.8 **Setting/ Research Environment**

The research setting which constitutes the environment in which a research is conducted has an important effect on the experimental design, the kind of data that can be gathered and the analysis of results (Psychology Wiki, 2017). The research setting is SNAS which is located on the Haatso-Atomic road and about 31 kilometres from the East of Accra, Ghana. The research
setting also includes the INIS database which contains the indexed theses of postgraduate students from SNAS

1.8.1 School of Nuclear and Allied Sciences (SNAS), University of Ghana

The IAEA’s General Conferences of 2002, 2003 and 2004 all adopted a resolution on nuclear knowledge which was meant to address the usefulness of nuclear knowledge management, calling for greater concern as well as making the International Atomic Energy Agency and its Member States to step up their activities and efforts in this important area (IAEA, 2007).

These knowledge management initiatives became paramount during that period since according to the IAEA (2007), “A large number of veteran nuclear professionals including engineers, researchers, and professors are reaching their retirement ages. At the same time, the younger generation appears to be losing interest in nuclear technology, which they do not consider as attractive or challenging as it was in the past. These factors are causing a situation that threatens to jeopardize smooth and effective technology transfer giving rise to the looming risk of a shortage of knowledgeable workforce in the future” (p. 1).

In response to this threat Ghana in 2005 declared its intention to train and develop nuclear scientists and engineers to meet the manpower requirements for the peaceful development and use of nuclear energy and technology in Ghana and the rest of Africa during the 117th IAEA Board of Governors meeting in Vienna, Austria (IAEA, 2007).

The training of nuclear scientists started in 2006 with the establishment of the School of Nuclear and Allied Science (SNAS) jointly by the Ghana Atomic Energy Commission (GAEC) and the University of Ghana (UG) with support from the International Atomic Energy Agency (IAEA), Vienna, Austria.
In 2009, SNAS was officially upgraded to a Regional Centre of Excellence for professional and higher education in Nuclear Science and Technology and now called the African Regional Cooperative Agreement for Research Development and Training related to Nuclear Science and Technology (AFRA)/IAEA.

In October 2011, SNAS was again designated as the IAEA Regional centre for training in radiation protection.

Starting from the 2014/2015 academic year, SNAS has been under the College of Basic and Applied Sciences when the collegiate system was adopted (University of Ghana, 2014).

SNAS can currently boast of five (5) established departments which offer 14 programmes as follows:

I. Department of Nuclear Engineering (With specialization in Nuclear Engineering, Computational Nuclear Sciences and Engineering and Nuclear Technology Applications in Petroleum and Mining).

II. Department of Nuclear Sciences and Applications (With specialization in Applied Nuclear Physics, Nuclear Earth Science, Nuclear and Radiochemistry and Nuclear and Environmental Protection).

III. Department of Nuclear Safety and Security (With specialization in Radiation Protection, IAEA Post-Graduate Education Course In Radiation Protection and Nuclear Security).

IV. Department of Medical Physics (With specialization in Medical Physics and Nuclear Science and Technology).

V. Department of Nuclear Agriculture and Radiation Processing (With specialization in Nuclear Agriculture and Radiation processing) (Serfor-Armah, 2015).
The above academic programmes lead to the award of Master of Philosophy (M.Phil.) and Doctor of Philosophy (Ph.D.) degrees of the University of Ghana and a five (5) months IAEA post graduate education course (PGEC) in Radiation Protection popularly known as the postgraduate diploma. Over five hundred (500) students have successfully graduated from several programmes at the Graduate school since its inception a decade ago. Some of its alumni have come from Ghana, all over Africa and the Carribean. The departments and the programmes at SNAS are illustrated in figure 1 below.

Figure 1.1: Departments and Programmes Offered at SNAS

1.9 Ethical Considerations

In the view of Neuman (2007), “Social researchers confront many ethical dilemmas and must decide how to act. They have a moral and professional obligation to be ethical, even if research participants are unaware of or unconcerned about ethics.” (p. 48).

Therefore, the researcher ensured the strict confidentiality of the research data on the authors of the SNAS theses on the INIS database. Furthermore the researcher also adhered to the University of Ghana Code of Ethical Research for post graduate research. More significantly,
the researcher also ensured that data collected was not manipulated to satisfy the research objectives.

1.10 Organization of Chapters

The study is made up of six chapters:

**Chapter One** serves as the introduction to the study. It includes the background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, theoretical perspective, scope of the study, significance of the study, setting/research environment and ethical considerations.

**Chapter Two** focuses on the review of relevant literature. This comprises related works on the topic under study and discussed under the following headings: Bibliometrics, bibliometric laws, types of bibliometrics, applications of bibliometrics, bibliometric indicators, importance of using bibliometrics and its limitation, subfields in library and information science related to bibliometrics, citation analysis and associated measures, the purpose of citations, citation analysis as a tool for collection management and previous bibliometric studies.

**Chapter Three** consists of the research methodology used for the study. It discusses the research design, selection of subjects (population and sample size and sampling procedures, data collection instrument and presentation of data analysis.

**Chapter Four** presents the analysis and interpretation of the data.

**Chapter Five** focuses on the discussion of the findings.

**Chapter Six** provides the summary of findings, conclusion and recommendations.
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CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature pertaining to the study. According to Fraenkel, Wallen and Hyun (2012), a literature review is “an assessment of a body (or bodies) of literature that pertains to a specific question” (p.38). Fraenkel, Wallen and Hyun (2012) further reiterate that the “It not only helps researchers glean the ideas of others interested in a particular research question through important research findings and theories, but it also lets them read about the results of similar or related studies” (p.38). Fraenkel, Wallen and Hyun (2012) finally state that “literature reviews also give researchers ideas about areas where more research needs to be done; they refer to these as gaps in the literature” (p.38).

2.2 Bibliometrics

In the view of Agyeman and Bilson (2015), “bibliometrics, also known as scientometrics is a research technique in library and information science that applies quantitative analysis and statistics to describe publication patterns in any field of knowledge” (p.2).

Thomson Reuters (2008) also defines bibliometrics as “the application of quantitative analysis and statistics to publications. It is used in research performance evaluation especially in university and government laboratories and also by policymakers, research directors and administrators, information specialists and librarians, and researchers themselves” (p.2).

Tague-Sutcliffe (1992) is of the view the “bibliometrics is the study of the quantitative aspects of the production, dissemination, and use of recorded information. It develops mathematical
models and measures for these processes and then uses the models and measures for prediction and decision making” (p.1).

Kanagasundari et.al. (n.d.) postulate that bibliometrics “is a quantitative study of several aspects of literature on a topic and it is used in identifying the patterns of publication, authorship and secondary journal coverage with the view to gain insight into the dynamics of the growth of knowledge in the areas under consideration” (p.1).

According to UNESCO (2015), bibliometrics “is a set of methods that are used to quantitatively analyse academic literature and scholarly communications”. (p.10).

2.3 Bibliometric Laws

Bibliometrics is associated with three basic laws namely Lotka’s law, Bradford’s law and Zipf’s law. These laws are very instrumental since they contributed in laying the foundation for the existence and development of the bibliometric method.

2.3.1 Lotka’s Law

It was proposed by Alfred James Lotka in 1926. It is concerned with the efficiency of (researchers) in a field of study and also known as Lotka’s inverse square law of scientific productivity (Lotka, 1926). His work was concerned with the statistical distribution (probability) of authors on chemical abstracts and physics. It looked at how many authors (researchers) had written a specified number of articles i.e. one (1), two (2), three (3), four (4) and so on.

Lotka’s study focused on the fields of chemistry and physics in which comprehensive bibliographies were used and the percentage of authors who made 1, 2, 3,...n contributions were
plotted against the number of contributions with variables from both ends on a logarithmic scale (Porter, 1988). The slope of the line which could fit the plotted data best was calculated using the least squares method and it was found out that the slope was approximately -2 (Porter, 1988).

This law states that “the number (of authors) making n contributions is about \( l/n^2 \) of those making one; and the proportion of all contributors, that make a single contribution, is about 60 percent” (Lotka 1926, cited in Potter 1981, p.21). What this implies is that 60% of all authors within the field will have one publication, 15% will have two publications, 7% will have three publications whiles only 6% of authors in the field will have more than 10 publications. As a result if Lotkas law covers a period of ten years or more and the community of authors is defined broadly, author productivity will approximate the frequency distribution that Lotka observed (Potter, 1981).

### 2.3.2 Bradford’s Law

It was proposed by Samuel Clement Bradford in 1934. It is concerned with the scattering of literature in a field within journals i.e. Law of scattering of scientific papers. It is also concerned with the reduction or diminishing returns in the output of extended search for literature in journals. Bradford (1934) indicated that "if scientific journals are arranged in order of decreasing productivity on a given subject, they may be divided into a nucleus of journals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus when the numbers of periodicals in the nucleus and the succeeding zones will be as 1: b : b^2 …" (p. 85-86).

Bradford (1934) examined all journal titles which were contributing to a bibliography in geophysics and then discovered that he could divide the titles into three groups such that they
all contributed similar number of articles (Bradford 1934, cited in Drott 1981). Bradford later divided these articles into three groups beginning with those journal titles that had contributed the most articles with these grouping as follows:

- The first 9 titles contributed 429 articles;
- The next 59 titles contributed 499 articles;
- The last 258 titles contributed 404 articles (Bradford 1934, cited in Drott 1981).

Bradford later saw that there was a definite pattern in which the number of titles were calculated in each of the three groups:

- 9 titles
- 9 X 5 titles (equals 45 titles)

Drott (1981) argues that although Bradford's Law might not be statistically accurate, it is still commonly used as a general rule of thumb.

2.3.3 Zipf's Law

It was proposed by the American psychologist and philologist called George Kinsley Zipf in 1935. It is concerned with predicting the frequency of word occurrences in a text. Using statistical and linguistic theories to human communication, Zipf developed the study of word frequencies, not just to apply this to questions of style, but as a way of throwing light on the nature of communication (Feather and Sturges, 2003). A theory of word frequencies was developed from the studies which corresponds to that of Lotka for research papers and the use
of ranking also relates to the study of the distribution of papers across a range of journals which was recounted by Bradford (Feather and Sturges, 2003).

Zipf (1935) in his book titled “The Psychobiology of Language” related his linguistic ideas to human communication generally (Feather and Sturges, 2003). He stated that it is reasonably clear that words that are shorter are clearly more favoured than words that are longer (Zipf, 1935).

Zipf (1935) is also of the view that the length of words decreases with the increase in word frequencies such that words tend to stand in an inverse (not necessarily in a proportionate) relationship to the number of word occurrences.

Finally Zipf (1949) in his book titled “Human Behaviour and the Principle of Least Effort” brought together semantic, psychological, sociological and geographical elements into a broader theoretical basis for his statistical observations (Feather and Sturges, 2003). He proposed in his book an empirical law on word frequencies on natural language speech or text and this law stated that although it is only a few words that are used most often, almost all other words tend to be used occasionally (Zipf, 1949). This law can however be seen in a way to be very helpful for indexers.

2.4 Types of Bibliometrics

Bibliometrics can be grouped into two areas namely the descriptive and the evaluative forms. van Leeuwen (2004) labels both as the top down (descriptive) versus the bottom up (evaluative) bibliometric approaches respectively.
2.4.1 Descriptive Bibliometrics

van Leeuwen (2004) reiterates that publications that are from the descriptive bibliometric approach (top down) are descriptive in nature and the following features in a publication such as country names, or fields are collected however research findings from such studies are limited in terms of the real research assessment.

Kawatra (2000) also labels descriptive bibliometrics as productivity count and breaks it down as follows:

(a) Geographic (Countries)
(b) Time periods (Years)
(c) Disciplines (Subjects)

This form of bibliometrics also studies the publications that accrue within a field of study or the productivity of literature in that field with the aim of measuring the productivity level of the literature in that field of study in different periods or the subdivisions of that field of study. (Kawatra, 2000).

2.4.2 Evaluative Bibliometrics

van Leeuwen (2004) postulates that publications that are from the evaluative bibliometric approach (bottom up) are those that are collected from the individual works of scientists with a verification process. This approach significantly contributes to the publications validity and results got from this kind of bibliometric analyses can aid in research assessment procedures (van Leeuwen, 2004).

Kawatra (2000) also labels it as literature usage count and breaks it down as follows:
(a) Reference count and

(b) Citation count

Evaluative bibliometrics also involves the study of the literature used by the researcher in their field of study and this usually includes the counting of cited references by a considerable large number of research workers in their papers (Kawatra, 2000).

Narin (1976) also sees evaluative bibliometrics as the use of bibliometric techniques such as publication and citation analysis in assessing scientific projects.

From these two approaches it can be concluded that the level of validity in the research output tends to be more higher with evaluative bibliometrics than with descriptive bibliometrics.

2.5 Applications of Bibliometrics

Anitharajan (2011) postulates that bibliometrics can be applied in several areas some of which include the following:

(a) To study research trends and growth of knowledge;
(b) To estimate comprehensiveness of secondary periodicals;
(c) To identify users of different subjects;
(d) To identify authorship trends in documents of various subjects;
(e) To measure the usefulness of retrospective and current awareness services;
(f) To identify past, present publishing trends as well as forecast future publishing trends;
(g) To develop experimental models;
(h) To identify core periodicals in different disciplines through the application of Bradford’s law of scattering and citation analysis;
(i) To formulate stacking and weeding policies;
(j) To initiate effective multilevel network system;
(k) To formulate collection development/management policy;
(l) To study obsolescence and dispersion of scientific literature;
(m) To study productivity of institutions/individuals and disciplines;
(n) To develop norms for standardization and
(o) To design automated language processing for auto indexing, auto classification
and auto abstracting.

2.6 Importance of Using Bibliometrics and Its Limitations

University of Leeds library (2014), has identified some areas that make the application of bibliometrics very important. They include the following:

I. Demonstrating the importance and impact of your own research and/or that of your research group. This can be very important where applying for tenure, promotion or grants, including bibliometric data on your CV demonstrating the value of your research to your institution and demonstrating return on investment to funding bodies, industry and the general public.

II. Identifying areas of research strength and weaknesses. This can be very helpful in informing future research priorities for an institution.

III. Identifying top performing journals in a subject area. This can be very helpful in deciding where to publish, learning more about a subject area and identifying the emerging areas of research.
IV. Identifying top researchers in a subject area. This can be very helpful in locating potential collaborators or competitors, learning more about a subject area and informing the recruitment process.

Despite the benefits of using bibliometrics it has some limitations. University of Leeds library (2014) has identified some of these limitations to include the following:

I. Citations patterns can differ greatly between disciplines. For instance in some disciplines research outputs may be cited more frequently than in other disciplines. It is therefore important to compare researchers, or groups of researchers against those from the same or similar discipline.

II. Manipulation of the system by researchers inappropriately self-citing, citing colleagues, splitting outputs into many articles etc. can distort the data. However a number of bibliometric tools now allow you to exclude self-citations.

III. Experienced researchers will have an advantage over early career researchers when using certain metrics as they will have produced more outputs. It will be important to compare researchers who are at the same stage of their career.

2.7 Data Sources for Bibliometric Research

Data sources for conducting bibliometric studies are mainly from bibliographic databases and bibliographies. This could be a compiled set of publications from a book of abstracts. Also data could be manually accessed from a thesis or a group of theses or even a journal article.

2.8 Subfields in Library and Information Science Related to Bibliometrics

There are several subfields in the library and information science field which have emerged over the years. These subfields share certain similarities with bibliometrics in scholarly
communication. The most prominent ones include scientometrics, webometrics, Informetrics and cybermetrics. These subfields all employ the use of quantitative techniques. Figure 2.1 illustrates the relationships that these subfields share in common.

**Fig. 2.1: Relationship Among Some Subfields in Library and Information Science**

![Diagram showing relationships among subfields](image)

Adapted from: Bjørneborn and Ingwersen (2004, p. 1217)

### 2.8.1 Scientometrics

The term was coined by two Russians namely Vassily V. Nalimov & Z. M. Mul'chenko in 1969. They termed it “naukometriya” (Nalimov & Mul'chenko, 1969b) which is the Russian equivalent for scientometrics.

The father of scientometrics is however credited to Derek J. de Solla Price a physicist, historian of science and an information scientist who contributed significantly to the subject area.

Scientometrics also refers to an analysis and investigation of science, technology and innovation from a quantitative approach (Leydesdorff and Milojević, 2012).

According to Feather and Sturges (2003), “Scientometrics forms part of the sociology of science and is often applied to issues of science policy-making. It involves quantitative studies
of scientific activities including, significantly, publication. For this reason, it overlaps with bibliometrics. It aims, through the revelation of objective quantitative regularities, to determine the stage reached by an intellectual domain and suggest possible lines of future development” (p.569).

Due to its widespread scholarly impact, Scientometrics has its own journal, publishing its first volume in 1979 and currently has 112 volumes to its credit as of 2017. Topics discussed in the journal include the storage and retrieval of information and Library Science.

The Journal spreads across the following industry sectors namely automotive, chemical manufacturing, finance, business & banking, electronics, information technology & software, telecommunications, consumer packaged goods, aerospace and engineering topics (Scientometrics, 2017). All these subject areas are very useful for the intellectual and economic development of any nation.

Due to their common similarities, it is not surprising that publications on bibliometrics are often found in the journal scientometrics.

2.8.2 Informetrics

Coined from the French word ‘informatie’ by Nacke (1979), it is the most recent of the metric terms.

In the view of Feather and Sturges (2003), “Informetrics is an emerging subfield in information science, based on the combination of quantitative studies of information flows, advanced information retrieval and text, and data mining. It has a broader scope than bibliometrics, because it also covers non-scholarly communities in which information is produced, communicated and used’’ (p.569).
Feather and Sturges (2003), further reiterate that “Informetric studies signifies the new approach to the scientific study of information flows: the improved bibliometric methods are applied not only to scientometric studies and research evaluations of science and technology (S&T), but also to the analysis of their mutual, societal, industrial and other specific relations” (p.569).

The difference between bibliometrics and informetrics is that the former is traditionally linked with quantitatively measuring documentary materials whiles the latter focuses on studying other types of information materials, such as websites, Internet links, voice, sounds, art works, etc (Feather and Sturges, 2003).

Tague-Sutcliffe (1992) postulates that informetrics is “the study of the quantitative aspects of information in any form, not just records or bibliographies, and in any social group, not just scientists. Thus it looks at the quantitative aspects of informal or spoken communication, as well as recorded, and of information needs and uses of the disadvantaged, not just the intellectual elite. It can incorporate, utilize, and extend the many studies of the measurement of information that lie outside the boundaries of both bibliometrics and scientometrics” (p.1).

Informetrics also has its own journal which published its first volume in 2007.

According to Elsevier (2017) the journal of informetrics adheres to high quality publishing of research which focuses on the quantitative aspects of information science on topical issues in bibliometrics, scientometrics, webometrics, and altmetrics.

2.8.3 Webometrics

This was formulated by Almind and Ingwersen (1997). Björneborn (2004) defines webometrics as “The study of the quantitative aspects of the construction and use of information resources,
structures and technologies on the web, drawing on bibliometric and informetric approaches” (p.12).

In the view of Björneborn (2004) further explain that, “this definition covers quantitative aspects of both the construction side and the usage side of the web embracing four main areas of present webometric research namely: (1) Web page content analysis; (2) Web link structure analysis; (3) Web usage analysis (including log files of users’ searching and browsing behaviour) and (4) Web technology analysis (including search engine performance)” (p.12).

2.9 Citation Analysis and Associated Measures

Citations also referred to as to cite, quote or refer, lead the reader to the information source that already exists. Gross and Gross (1927) were the pioneers of citation analysis studies.

Citations serve as notes which are placed in the main text of any academic research to provide a bibliographic reference to the published work which has been used in the study or quoted by the author (Feather and Sturges, 2003). In the view of Chikate and Patil (2008), “citation analysis refers to references in one text to another text, with information on where that text can be found. Citation analysis is useful for understanding subject relationships, author effectiveness, publication trends, and so on” (p.1).

Feather and Sturges (2003) also define citation analysis as “the study of citations to and from documents, of the authorship of such documents and of the journals in which the documents are published” (p.76). The development of citation analysis can be credited to the works of Garfield (1955) who created the Science Citation Index (SCI).
Another notable scientist Price (1965) also made enormous contributions to the subject. In a paper titled “Networks of Scientific Papers” Price (1965) addressed the linking characteristic of the Scientific Citation Index (SCI). This became dynamic when the SCI went online.

2.9.1 Bibliographic coupling

This was developed by Kessler (1963) in a paper titled “Bibliographic coupling between scientific papers”. It occurs when two publishers share one or more references in their work. Bibliographic coupling is very useful because it enables researchers to find similar research investigations that were undertaken in the past. It can also provide a reference point that there is a chance of two documents focusing on a similar subject area (Martyn, 1964).

The concept of bibliographic coupling is illustrated in figure 2.2 below.

**Figure 2.2: Bibliographic Coupling**

2.9.2 Co-citation

The concept of co-citation is credited to Small (1973) and Marshakova (1973) in two separate papers namely “Co-citation in the scientific literature: A new measurement of the relationship between two documents” and “A system of document connection based on references”. Co-
citation happens when two documents tend to be always cited by other documents. The more these documents are co-cited the higher their co-citation index score which indicates that these two documents are more similar. The concept of co-citation is shown in figure 2.3.

Figure 2.3: Co-citation

2.10 The Purpose of Citations

Citations in publications serve several purposes. According to Feather and Sturges (2003), citations serve the follow functions:

I. “Giving credit (i.e. identifying antecedents and original publications in which a fact, idea concept or principle was first published).

II. Previous work (i.e. identifying general documents related to the topic; presenting previous results or announcing future work; commenting, correcting or criticizing previous work; identifying methodology, equipment, etc.).

III. Authority (i.e. substantiating claims and persuading readers; authenticating data and other results, or identifying the results by others supporting the author’s work).

IV. Social factors (i.e. citing prestigious researchers; citing work by the author’s graduate students, fellows and co-workers to increase their visibility; ‘perfunctory’ citations)” (p.76).
Garfield (1965) also gives 15 reasons why people provide citations to a publication. They include the following:

I. Paying homage to pioneers.

II. Giving credit for related works (homage to peers).

III. Identifying methodology, equipment, etc.

IV. Providing background reading.

V. Correcting one’s own work.

VI. Correcting the work of others.

VII. Criticizing previous work.

VIII. Substantiating claims.

IX. Alerting to forthcoming work.

X. Providing leads to poorly disseminated, poorly indexed or uncited work.

XI. Authenticating data and classes of fact physical constants etc.

XII. Identifying original publications in which an idea or concept was discussed.

XIII. Identifying original publication or other work describing an eponymic concept or term as, e.g., Hodgkin’s Disease, Paeto’s Law, Friedel-Crafts Reaction etc.

XIV. Disclaiming work or ideas of others. (negative claims).

XV. Disputing priority claims of others. (negative homage).

2.11 Citation Analysis As a Tool For Collection Management

Citation analysis plays a very useful role in the collection management of every library or information centre. Through the use of citation analysis a library is able to use collection management to weed out obsolete or unwanted materials in the library thereby saving space for the most wanted materials. Also it helps the library in determining its selection priorities
through the acquisition of the most useful resources for users which also helps the library to satisfy user needs and also save finances. Feather and Sturges (2003), postulate that in the present state of collection management includes planning and funding, collection development, book selection, acquisitions, provision of access, use, maintenance, evaluation, preservation and weeding.

Therefore in the view of Feather and Sturges (2003), “It thus encompasses the activities traditionally associated with collection development - the selection and acquisition of library material - but is also far more comprehensive: it also includes the systematic maintenance of a library’s collection, covering resource allocation, technical processing, preservation and storage, weeding and discarding of stock, and the monitoring and encouragement of collection use” (p.81).

Several studies have confirmed how citation analysis can assist a library in its collection management. Dickinson, Gunningham and Boyd (2009) used a reference analysis approach to study Master of Architecture Theses at Dalhousie University. They discovered that monographs were more frequently used than journals by architecture students, suggesting architecture research is more closely aligned with arts and humanities rather than pure sciences. Similarly, the age of materials used by architecture students was older than materials in other reference analyses. The research also identified the most frequently and infrequently used journals. They indicated that these findings may assist librarians facing limited budgets when making selection and de-selection decisions.

Also, Kohn and Gordon (2014) analyzed bibliographies from three departments of undergraduate senior theses with the goal of improving both collection development and information literacy instruction. The research findings revealed that although undergraduate students were not citing major journals or key authors, the study revealed popular research
topics, which will inform collection development. The research finding indicating that the library owned 70% of the journal articles that undergraduates cited suggests that they are more likely to cite what their own institution owns, and thus a strong collection can have a significant influence on undergraduate work.

In a study by Kimball, Stephens, Hubbard and Pickett (2013) on the citation analysis of atmospheric science publications by faculty at Texas A & M University, the authors are of the view that “Academic libraries could benefit from a citation analysis for a particular department, subject area, or broader discipline to determine how well their library is providing access to the most cited journal and non-journal items and discovering any coverage gaps” (p.365).

Furthermore, another made by Kimball, Stephens, Hubbard and Pickett (2013) showed that although the current study indicated that the Texas A & M University Libraries’ journal collection served the atmospheric sciences faculty’s need well, it however identified other material for possible acquisition and since in very tough economic times, many libraries are forced to cancel journals, the results from the study could also form the beginnings of a broader list of in-frequently used titles (across multiple departments) as candidates for potential cancellation or for storage.

Labonte (2005) used the citation analysis approach in investigating the Sciences Engineering library at the University of California with the aim of determining if the library was meeting the needs of 60 faculty members at the California Nano-Systems Institute. The research findings indicated that the library was adequately meeting their needs and that journal articles made up the majority of literature used for nanoscience research. The study also revealed the journal titles used the most and that information obtained on journals which were not owned could be used in collection management decisions in the future.
2.12 Previous Bibliometric Studies.

This section reviews the literature on bibliometric studies on theses and dissertations by students from academic institutions. Several studies have been conducted to investigate theses and dissertations of students from academic institutions in different parts of the world.

2.12.1 Bibliometric Studies Outside Africa

In India, Kavitha and Sivaraj (2014) reviewed 106 Ph.D. theses in commerce at the Periyar University, India from 1989 - 2012. Their research findings revealed that out of 106 Ph.D. theses submitted during the period. The year 2009 recorded the highest number of theses with 21 (19.81%) counts and the lowest number of theses submitted was 1 (0.94%) counts in 1993, 1999, 2002 and 2004. Theses submitted during the period by male and female students were 80 (75.47%) counts and 26 (24.53%) respectively. The highest authorship pattern of the references was single authors with 1234 (63.25%) citation counts. The total citation count for the 23 year period i.e. 1989 - 2012 was 1951 citations. The most preferred subject area for undertaking the Ph.D theses in commerce was marketing with 26 (24.53%) counts. The study further revealed that books were the most preferred forms of reference by research scholars in commerce at the University with 4616 (42.28%) counts in comparison of any other form of cited documents.

In another study in India, Mishra, Gawde and Solanki (2014) quantitatively analysed 55 Ph.D. theses in English submitted between 1975 - 2007 at Vikram University. The outcomes of their research findings revealed that the highest number of theses was submitted in 1991, 1996 and 2002 with 5 (9.09%) counts each. Male researchers dominated their female counterparts with 30 (55%) counts and 25 (45%) counts respectively which confers with the findings by Kavitha and Sivaraj (2014). Their findings further revealed that all theses used a combined citation total
of 5399 and 51 - 100 references was the highest with 30 (54.55%) counts. Books were the preferred bibliographic form for referencing theses with 4346 citations (80.47%) counts. This finding concurred with the findings by Kavitha and Sivaraj (2014).

Rarely has any bibliometric analysis been done on theses publication in the nuclear science and technology field using the INIS database as source of data. However directly related to this study is the quantitative analysis of theses at the Instituto De Pesquisas Nucleares - São PAULO Brazil by Santos et.al. (n.d.). These theses were analysed using the INIS/ETDE (Energy Technology and Data Exchange) manual as the data source. The results of their study revealed that the theses spread through 33 subject categories with material science having the highest number of theses (243).

Mahapatra and Sahoo (2004) investigated 164 doctoral theses in Library and Information Science (LIS) appearing in the ‘University News’ publication by the Association of Indian Universities (AIU) from 1997 - 2003. The study revealed that the highest number of doctoral theses i.e. thirty seven (37) was awarded in the year 2003 with the lowest i.e. sixteen (16) awarded in the year 2000. User study happened to be the only broad subject area which had attracted the attention of professionals in which the highest number of doctoral works had been done followed by bibliometrics and citation analysis. In the narrow subject areas, researchers were more interested to take up research works on library resources and services. Their study further revealed that Karnataka University produced the highest number of Ph.Ds. awarded in LIS i.e. eighteen (18). Research on academic libraries were also more than other types of libraries.

Gohain and Saikia (2014) collected data from 30 doctoral theses projects completed at the Department of Chemical Sciences of Tezpur University, Assam, India from 2008 - 2012. The
findings of their investigation revealed that the highest number of theses was submitted in 2010 with 8 (26.67%) counts and the lowest number of theses submitted was in 2008 with 3 (10.0%) counts. The total number of bibliographical references used by researchers in completing their doctoral theses was 10,983 with an average of 366.10 per theses. Their study further revealed that journals were the most preferred bibliographic format in citing the doctoral theses with 8658 (78.83%) citation counts. This was followed by books with 1,710 (15.57%) citation counts, patents/standards/technical reports with 241 (2.20%) citation counts, seminar/conference proceedings with 191 (1.74%) citation counts, Web resources with 165 (1.50%) citation counts and Ph.D. theses with 18 (0.16%) citation counts. The Journal of American Chemical Society was the most preferred journal with 617 (7.13%) citation counts.

In Taiwan, Hsieh, Chuang and Wang (2013) used the bibliometric analysis approach in studying the attributes of 767 theses and dissertations on information literacy in the United States and Taiwan from 1988 to 2010. Their study revealed that theses and dissertations on information literacy grew more rapidly in Taiwan than in the United States with 502 (65.45%) counts and 265 (34.55%) counts respectively. There was also significant differences in other literacy research between the two countries in media literacy and digital literacy. Furthermore the methodology employed by both countries on theses and dissertations were different.

Kushkowski, Parsons and Wiese (2003) analysed 629 theses and dissertations at the Iowa State University, United States from 1973 - 1992. Demographic data retrieved from each thesis included the department, major, publication date, number of pages, and total number of citations with each thesis assigned a unique identification number to identify. Their findings revealed that doctoral and master’s theses were 61 (41.5%) counts and 368 (58.5%) counts respectively. The theses and dissertations were also found in broad disciplinary areas of social sciences with 232 (36.9%), biological sciences with 170 (27.0%), engineering with 130
(20.7%), physical sciences with 66 (10.5%) and arts and humanities with 31 (4.9%). Furthermore, a total number of 9100 citations were used across the various theses and dissertations. Journals were the most cited information source followed by monographs with 5790 (63.6%) and 2153 (23.7%) of the total citation counts respectively. The finding concurred with the findings by Gohain and Saikia (2014).

Eckel (2009) investigated the citation analysis of 96 masters and 24 Ph.D. theses and dissertations at Western Michigan University's College of Engineering and Applied Sciences between 2002 and 2006. The results of the study showed that doctoral engineering students cited more journal articles (44.3%) and conference papers (21.9%) than the masters students (29.3%) and (12.5%) respectively. The master's students also relied heavily on literature available on the web.

In France, Salmi, Gana and Mouillet (2001) studied the patterns of French medical theses between 1st January 1993 and 31st December 1997 using a random sample from 36 Universities with data extracted from the CD-ROM Doc-Thèse. The results of their study showed that out of the 300 theses included in the study 238 (79.3%) were from medicine, 43 (14.3%) from surgery, and 19 (6.4%) from biology. Also, a total of 51 theses (17.0%) resulted in publication. They also discovered that almost all the French medical theses were not made available to the scientific community.

In another study in India, Kumar, Sah and Singh (2013) undertook a comparative bibliometric study of Social Science Doctoral Theses of Kumaun University and Delhi University in India. The study revealed that the number of male scholars was higher than female researchers. They therefore were of the view that female scholars should be encouraged and preference given to them to do research work in their interested area since it will help to fulfil the concept of
women’s empowerment in the university. On the other hand at Delhi University the number of female scholars was higher than the male researchers. They were of the view that Delhi University gives preference and encourages female scholars to do research work in their interested area which is a good sign for women empowerment.

Sudhier and Kumar (2010) analysed 168 biochemistry Ph.D. theses awarded at the University of Kerala, India. Their research findings showed that the highest number of Ph.D. theses was awarded during 1993 with 16 theses. The page distribution of the Ph.D. theses showed that theses with the highest number of pages ranged from 151 - 200 pages with 70 (41.66%) counts. With regard to the gender distribution of Ph.D. theses females dominated with 89 theses as against their male counterparts with 79. However the research publication productivity was higher for the males than the female’s scholars after completing the Ph.D. theses with 165 (55%) counts and 135 (45.0%) counts respectively. With the distribution of citations in theses, 201 - 300 citations was the highest with 55 (32.74%) counts. Also with the citations of the various bibliographic forms journals were the most cited documents with 5245 (88.75%) counts, books with 527 (8.92%) counts, conference proceedings with 51 (0.86%) counts and others (Standards, Reports, Patents, etc.) with 87 (1.47%) counts. The finding that journals were the most cited bibliographic forms was also confirmed by Eckel (2009); Kushkowski, Parsons and Wiese (2003) and Gohain and Saikia (2014).

A citation analysis of 12 doctoral theses in Zoology at Kuvempu University, India from 2002 to 2006 was undertaken by Banateppanvar et. al. (2013). The focal point of their study sought to improve the existing collection development of the library. The findings of their study showed that there was a total of 2209 citations with an average of 184.08. Again it was observed that journals contributed the highest number of citations with 74.47% of the total citation counts followed by books (18.02%), seminar/conference proceedings (3.36%), theses and
dissertations (1.99%) and reports with (1.62%) of the total citation counts. The finding that journals were the most cited bibliographic forms is consistent with the results by Sudhier and Kumar (2010) Eckel (2009); Kushkowski, Parsons and Wiese (2003) and Gohain and Saikia (2014).

In another bibliometric study in India, Bohra and Devi (2015) analysed 528 Ph.D. theses submitted at the central library of Kumaun Himalaya, India on the topic ‘Kumaun Himalaya’. The study period was from 1978 to 2014. Their study revealed that male research scholars dominated their female counterparts with 315 (59.65%) and 213 (40.34%) of the Ph.D. theses respectively. Also the yearly distribution of the Ph.D. theses showed that 2012 had the highest number with 59 (11.17%) counts followed by 2013 with 52 (9.84%), 2011 with 51 (9.65%) counts, 2008 with 45 (8.52%) and 2002 with 42 (7.95%) counts. The subject distribution of the Ph.D. theses saw botany as the most preferred subject with 87 (16.47%) counts. This was followed by history with 76 (14.39%), geography with 58 (10.98%), political science with 51 (9.65%) and economics with 44 (8.33%) counts. Another finding from the study revealed that 319 and 144 Ph.D. theses were between 200 - 300 pages and 300 - 400 pages respectively.

In the United States, Gooden (2001) undertook a citation analysis studies of Ph.D. dissertations at the Ohio State University to determine the kinds of materials cited, currency of the literature and dissertation topics. The results of the study showed that out of the 30 doctoral dissertations there was a total of 3704 citations with an average of 123 citations. Journal articles were the most cited material with (85.8%) followed by monographs (8.4%) and dissertations, theses and proceedings, newspapers and annual reports with (2.2%). The finding that journal articles were the most cited document also corroborates with other previous findings by Sudhier and Kumar (2010) Eckel (2009); Kushkowski, Parsons and Wiese (2003); Gohain and Saikia (2014) and Banateppanvar et. al. (2013). On the hand the most cited journal articles was the Journal of the
American Chemical Society with 364 citations. The study also revealed that some of the doctoral dissertations cited materials as far back as 1817. With the subject distribution of the doctoral dissertations, organic chemistry had (10), analytical chemistry (6), physical chemistry (6), inorganic chemistry (4) and biochemistry (4). Gooden (2001) is of the view that the findings from this study may be used to assist the University as well as other Universities in the collection development of chemistry information sources.

In another study in Peru, San Martin and Pacheco (2008) undertook a bibliometric analysis of undergraduate theses at the Faculty of veterinary medicine at San Marcos National University from 2001 - 2006. The findings of their study revealed that a total of 247 theses were successfully defended with an average of 41. Also the most studied animal species were canine (15.5%), bovine (15.5%), poultry (13.4%), swine (12.6%) and alpaca (11.3%) were the most studied species. Animal health also accounted for seventy-five percent of the total theses and among them parasitology (64) and epidemiology (46) were the most studied subject disciplines. Three and five lecturers supervised 33% and 57% of the total number of theses within the period 2001 - 2006.

Maranna (2016) analysed mathematical science Ph.D. theses literature at Rani Channamma University library, India between 1962 and 1972 using the bibliometric method. The study revealed that 11 Ph.D. theses were submitted within the period with an average of 1 Ph.D. thesis per year. There were 744 references in the Ph.D. theses with the forms of literature used showing that journal articles were the most cited document with 351 (47.18%) counts followed by books with 221 (29.70 %) counts and theses with 172 (23.12%) counts. With the obsolence of literature it was observed that 52.34% of the literature was above 15 to 25 years old, 9.37% was 5 years old, 7.81% was 4 years old and 7.03% percent was 2 years and 7 years old respectively.
In another study, Ramachandran (2012) analysed 249 theses in physical education awarded in the states of Kerala and Tamil Nadu in India. The finding of the study showed that 35.7% of the theses were descriptive studies, 8.4% were correlational studies and 55.8% were experimental studies. Again the subject distribution of the theses showed that health & fitness was the most commonly subject area addressed with 90 (36.1%) followed by exercise physiology with 57 (22.9%), sport psychology and others (mixed) with 38 (15.3%) respectively, sports management/history with 16 (6.4%), sports biomechanics and sports medicine with 4 (1.6%) and sports sociology the least subject area with 2 (0.80%). Furthermore the gender distribution of the theses revealed that males dominated females with 206 (82.7%) and 43 (17.3%). The finding that male students who successfully completed the academic theses were more than their female counterparts corroborates with other previous findings by Kavitha and Sivaraj (2014) and Bohra and Devi (2015). Again male academic supervisors also dominated their female counterparts with 223 (89.6%) and 26 (10.4%) counts respectively.

Kumar (1998) analysed 293 doctoral degrees awarded in library and information science in India from 1950 to 1997. One major finding from the study stipulated that University libraries was the most preferred subject area of research with 20 doctoral degrees. However in the last decade information related subjects had also gained importance. These included information services (15), information technology (14) and bibliometric studies with (11) doctoral degrees. Other subject areas were classification (11), library profession (14), library education and library personnel with (10) doctoral degrees each and library automation, special libraries and user education with (9) doctoral degrees each.

In a bibliometric study in Sri Lanka, Angammana and Jayatissa (2015) studied postgraduate theses in Library and information science at two educational institutions namely University of Kelaniya and University of Colombo, Sri Lanka using the bibliometric research technique. For
this study 70 theses were analysed comprising 50 theses submitted for the Master of LIS degree (MLS) of the University of Colombo and 20 theses submitted for the Master of Social Science in LIS (MSSc) of the University of Kelaniya. It was revealed that there was a total of 4,901 citations. The top 5 cited information sources were books with 1921 (39.20%) counts, journals with 1664 (33.95%) counts, web sites with 310 (6.33%) counts, reports with 213 (4.35%) counts and conference papers with 192 (3.92%) counts. The least cited information sources were pamphlets with 5 (0.10%) counts. The finding that books were the most cited information source concurred with the findings by Kavitha and Sivaraj (2014) and Mishra, Gawde and Solanki (2014).

In another bibliometric study in India, Garg, Tamrakar and Tamrakar (2009) investigated Doctoral research on academic libraries and allied fields in Indian Universities. The study analysed 287 Ph.D. awards. The findings of their study revealed that the highest number of Ph.Ds. were awarded during the period of 1998 to 2008 with 168 Ph.D. awards followed by the period 1988 to 1997 with 87 Ph.D. awards. The lowest number of Ph.Ds. were awarded during the period 1963 to 1987 with 24 Ph.D. awards. With the subject distribution of the Ph.D. awards it was revealed that the top 5 researched subject areas were library organisation with 64 Ph.D. awards. This was followed by library services with (42), human resource development with (39), impact of information technology with (26) and resource sharing and networking with (21). Marketing management was the least subject area with (3) Ph.D. awards.

Suma and Sudhier (2013) investigated 137 doctoral dissertations of CSIR-National Institute of Interdisciplinary Science and Technology (NIIST) from 2001 to 2010. The findings of their study revealed that the highest number of theses was submitted in 2007 with 21 (15.33%) counts whiles the lowest number of theses was submitted in 2003 with 4 (2.92%) counts. There
was a total of 33,263 references with an average of 242.79 per thesis. The subject distribution of the theses revealed that Chemistry was the most researched area with 107 (78.10%) counts.

2.12.2 Bibliometric Studies In Africa

In Nigeria, Tsafe and Aliefo (2009) investigated 198 research projects of final year students of the Faculty of Veterinary Medicine, Usmanu Danfodiyo University, Sokoto from 1994 to 2004. The research results showed that the largest number of research projects were produced during the 2001 - 2002 and 2002 - 2003 academic years with 25 research projects whiles the lowest number of research projects were produced during the 1998 to 1999 academic year. Also the most researched area was veterinary parasitology with 44 (22.7%) counts. This was followed by veterinary public health with 31 (16.0%) counts, veterinary pharmacology 23 (11.86%) counts, animal production and veterinary medicine with 20 (10.30%) counts each, veterinary microbiology and theriogenology with 13 (6.70%) counts each, veterinary physiology with 10 (5.15%) counts, veterinary surgery with 6 (3.09%) counts each, veterinary pathology with 5 (2.57%) counts. The most researched animal species was poultry with 29 (22.7%) counts. Sokoto was the most researched geographical area of study with 80 (80%) counts. The study also advocated that heavily concentrated areas as identified in the study should be de-emphasized and future researches should be geared towards the less researched areas.

In a different study in Nigeria, Aliyu and Abba (2009) analysed Masters dissertations in library sciences from the University of Maiduguri. Their research objectives focused on the total number of dissertations by academic year, subject coverage, type of library focused, geographical areas covered and the gender of researchers. The findings of their study revealed that 2006 had the highest number of dissertations with 9 (23.0%) counts whiles 1996, 2007 and 2008 had the least number of dissertations with 1 (2.6%) counts each. With the subject
distribution of the masters dissertations showed that information science was the dominant subject area with 7 (17.9) counts. This was followed by library personnel management and library resources with 5 (12.8%) counts. In their view the interest in this subject area could be as a result that a large number of the students are experienced personnel who manage various libraries and they might have recognized difficulties in the management of their libraries. The least subject areas were history of libraries, library association, library profession, library services to children/adolescents, library standards and publishing and the book trade with 1 (2.6%) counts each. Another finding from their study showed that the type of library that was most researched was academic libraries with 24 (57.1%) counts and the least researched library was private libraries with 1 (2.4%) counts.

Saka and Alhassan (2008) investigated (355) Bachelor of Library Sciences research projects submitted to the University of Maiduguri, Nigeria from 2000 - 2006. Data was taken using documentary sources and the accession register in the departmental library. Some of the areas where data was taken included the year of submission, geographical distribution, key titles of the projects and the type of research adopted. The findings of their study revealed that the highest number of research projects were submitted in the year 2005 with 81 (22.82%) counts. This was followed by the year 2004 with 69 (19.44%) counts, 2006 with 67 (18.87%) counts, 2003 with 50 (14.08%) counts and 2000 and 2002 with 44 (12.39 %) counts each. On the distribution of the research methods adopted by the research projects, it was revealed that the case study was the most frequently research method used with 176 (49.58%) counts followed by the survey method with 92 (25.92%) counts, documentary with 38 (10.70%) counts, evaluative with 34 (9.58%) counts and historical with 15 (4.23%) counts. It was suggested that students should be encouraged to be made to diversify the scope of their research projects. In this way it will enable them to employ other research methods. On the subjects areas of the
research projects it was revealed that the top 5 researched areas by the undergraduate students from the University of Maiduguri was problems, development and prospects of libraries with 46 (12.96%) counts, bibliography with 39 (10.99%) counts, collection development with 32 (9.01%) counts, library services with 29 (8.17%) counts, management/administration of library information centres with 24 (6.76%) counts. The least researched subject areas were academic achievement and library services, current awareness services (CAS), library cooperation and library standards with 1 (0.28%) counts each.

Olatokun (2009) used the citation analyses approach in studying doctoral theses in the Department of animal science, University of Ibadan, Nigeria. The outcomes of the research indicated that 10,578 items were cited. The highest number of theses submitted was in 2004 with (14). The year 2003 produced the highest number of citations with (3085) followed by 2006 with (2302) whiles the year 2007 produced the lowest number of citations was in 2007. Journal articles were the most cited information material with 6278 (59.90%) counts. This was followed by books with 1914 (18.09%) counts, conference papers with 1006 (9.51%) counts, miscellaneous with 516 (4.88%) counts, theses and dissertations with 351 (3.32%) counts, government documents with 269 (2.54%) counts and technical reports and standards with 208 (1.97%) counts. Previous studies have also confirmed journal articles as the most cited information material, some of which include (Sudhier and Kumar (2010); Eckel (2009); Kushkowskki, Parsons and Wiese (2003) and Gohain and Saikia (2014). The most researched area of study was agricultural biochemistry & nutrition with 12 theses whiles the least researched area of study was poultry nutrition and animal products and meat science with 1 theses each.

Ezema (2016) studied scholarly communication behaviour in language research theses in Nigeria with the aim to strengthen the collection development policy in linguistics research.
Using bibliometric and informetric indicators, a total of 87 theses and dissertations submitted from 2005 to 2014 at the Department of Linguistics and Nigerian Languages, University of Nigeria, Nsukka were examined. The findings from the study was that 2009 recorded the highest number of theses with 12 (13.8%) counts whiles 2005 recorded the lowest number of theses with 6 (6.9%) counts. There was a total of 5084 bibliographic references that were extracted from the theses with an average of 58.4 citations per theses. Books/monographs were the most cited information sources with 3232 (63.6%) citation counts. This was followed by journals with 909 (17.9%), theses and dissertations with 408 (8.0%), conference/seminar papers with 332 (6.5%), lecture notes with 49 (1.0%), reports with 44 (0.9%), government publications with 35 (0.7%), news publication with 32 (0.6%), interview with 19 (0.4%), inaugural lectures with 17 (0.3%) and mimeograph with 7 (0.1%). The finding that books were the most cited information source concurred with the findings by Uçak and Umut (2009); Kavitha and Sivaraj (2014) and Mishra, Gawde and Solanki (2014).

Fasae (2012) used the citation analysis approach to analyse (52) Masters’ dissertations and (16) Doctoral theses submitted to the Department of Agricultural Economics and Extension, Federal University of Technology Akure, Nigeria. The study focused on information materials cited by Masters and doctoral students, distribution of citations by year, most frequently cited journals, age of cited materials, types of authorship, highest and lowest citations by individual dissertation and thesis. The findings of the study revealed that a total of 4227 citations were generated from both the theses and dissertations. Distribution of citation according to the type of materials also revealed that journals were the most cited material with 1478 (34.97%) counts followed by books with 1063 (25.15%) counts. Web resources were the least cited material with 63 (1.49%) counts. The most cited journal was the Journal of Agricultural Economics with (104) citations whiles the least cited journals was Agricultural System, Food Policy and...
Nigerian Agricultural Development Studies with (8) citations each. With the age of materials it was discovered that the most cited materials were 16 & above years old with 1902 (45.00%) counts whiles the least cited materials were below 5 years with 475 (11.24%) counts.

In a study in South Africa, Becker & Chiware (2015) used the bibliometric approach to analyse the citation patterns of Masters’ theses and Doctoral dissertations between 2005 and 2014 in the Faculty of Engineering at the Cape Peninsula University of Technology (CPUT). The research objects of the study focused on establishing the types of materials used, differences between resources used across the departments within the faculty, the most frequently referenced journals and the holdings of such titles by the library, age of material and the language and country of publication of journal articles referenced. The findings of the study indicated that Masters' and Doctoral students are utilizing resources provided by the library. The most cited resources were journals, followed by books. The study also provided a pattern of how both masters' and doctoral students cite resources in their studies and it provided CPUT Libraries with information on how well utilized its resources are as well as pointing to possible areas of strengthening their holdings. The researchers postulated that together with other approaches, citation analysis still remains one of the most important tools to assess the usefulness of library holdings for postgraduate student’s research activities.

In another study in Nigeria, Nkiko and Adetoro (2007) used citation analysis to analyse undergraduate research projects of students submitted to Covenant University, Nigeria. From the study it was discovered that a total of 14,655 citations were generated with an average of 26.3 citations per research project. The study revealed that books were the most cited information source with 7802 (53.3%) counts. This was followed by journals with 3687 (25.1%) counts, internet and e-resources with 1138 (7.7%) counts, newspapers with 583 (3.9%) counts, conference proceedings with 542 (3.7%) counts, unpublished project/dissertation with
504 (3.4%) counts and grey literature with 399 (2.7%) counts. The finding that books were the most cited information source concurred with the findings by Kavitha and Sivaraj (2014); Mishra, Gawde and Solanki (2014) and Angammana and Jayatissa (2015). With the age of the material cited it was observed that the period 2001 - 2006 had the highest citations with 5,357 (36.5%) counts followed by 1990 - 1995 with 4,054 (27.6%) counts, 1996 - 2000 with 4,032 (27.5%) counts and then 1989 and below been the least with 1,214 (8.35%) counts. This clearly shows that students preferred citing current literature. Finally the researchers further noted that the analysis will afford the institutions library with an opportunity through which it can evaluate its collection since it reflects on the research interests of its students.

Egberongbe (2003) used the citation analysis method to analyse the literature used in political science doctoral theses and dissertations in the University of Lagos from 1990 - 2000. The results of the study showed that researchers cited textbooks more than journals in their research publications. Recommendations were also made for a discipline based collections development policy.

2.12.3 Bibliometric Studies in Ghana

Sam and Tackie (2007) analysed (67) Master of Arts dissertations from the Department of Information Studies, University of Ghana from 1998 to 2004 using the citation analysis approach. The research objectives were to find out the patterns in the use of different types of information sources, the most cited material type, local availability of the most frequently cited journals, currency of the cited materials and the most cited subject areas. The findings of their study revealed that the most cited material were books and monographs with 969 (43.8%) counts. This was followed by journal articles with 550 (24.9%) counts whiles unpublished materials was the least cited material with 4 (0.2%) counts. The most common research area
among graduate students was information technology followed by evaluation of information services. On the other hand reading habits was an inactive research area. From the study the authors are of the view that citation analysis is a helpful tool for evaluating the use of library materials, with implications for collection management and development.

In another study in Ghana, Fosu and Alemna (2006) analysed Masters dissertations which focused on studying the University of Ghana Balme Library from 1998 - 2005. The goal of the study was to find out whether the management of the Universities Library had carried out the suggestions from the various dissertations submitted. Their analysis looked at the form, type and year of dissertation, subject and whether it was written by Balme Library staff or not. The findings from their study indicated that the suggestions in the dissertations had not been carried out by the library because management was not even aware of the findings and suggestions made in these dissertations. The researchers put across some suggestions to help overcome the problem. This included the need for staff of the Balme Library to supervise some of such dissertations or, failing this, and/or the need for the management of the library to, at least, be made aware of studies and recommendations relating to the Balme Library.

Kankam (2014), undertook a bibliometric analyses of 44 undergraduate dissertations from the African University College of Communications Ghana which were submitted during the 2011/2012 academic year to the Sam Quaicoe library. The analysis focused mainly on the areas of research, number of dissertations by course, year-wise distribution of references and bibliographical forms of citations. The findings of his study revealed that females had 27 dissertations representing (61.4%) as against males with 17 dissertations representing (38.6%). This finding is however in direct contrast to the findings by Kavitha and Sivaraj (2014) and Mishra, Gawde and Solanki (2014) who found out that the males Ph.D. students enrolled at Vikram University from 1975 - 2007 published more theses than the female students. With the
subject distribution of dissertations publicity/advertising dominated with (40.9%). This was followed by public relations with (31.80%), participatory communications with (11.40%), others with (9.10%) whiles the least subject area was development communication with (6.80%). The study further revealed that 11-20 references had the highest frequency with 17 (38.6%) followed by 1-10 and 21-30 references with 11 (25.0%) counts respectively, 31-40 references with 43 (6.8%) counts and 40 and above references had the lowest with 2 (4.6%) counts. The most cited bibliographic form of material was books/book chapters with 377 citations whiles the least cited material was newspapers with 10 citations. A finding which concurs with other findings by Kavitha and Sivaraj (2014); Mishra, Gawde and Solanki (2014) and Angammana and Jayatissa (2015) where books were the most cited bibliographic form of material. Finally with the age of the cited material it was discovered that publications published before year 2000 and 2012 were the most cited with 274 and 149 citations respectively whiles the least cited year was 2002.

Imoro (2017), undertook an in-depth bibliometric analysis of the citation patterns of Ph.D. theses submitted to the University of Cape Coast from 2005 to 2016. The theses were obtained from the Africana section of the Sam Jonah Library. The findings of his study revealed that male students dominated their female counterparts with 28 (80.0%) and 7 (20.0%) of the Ph.D. theses respectively. Also, Ph.D. theses within the range of 201 - 300 pages were the highest with 17 (48.60%) counts. Agriculture was the most researched subject area with 11 (31.4%) counts. A total of 6,458 citations were analysed with the citation range of Ph.D. theses within the range of 101 - 200 dominating with 17 (48.6%) counts. Again the majority (73.3%) of journals cited by Ph.D. students could be accessed through the Sam Jonah Library’s subscribed online databases. The study point out that even though usage of these databases were high
among Ph.D. students, there was the need for greater awareness and training in the use of these databases.

2.13 Conclusion

The literature reviewed shows that there have been several bibliometric studies both locally and abroad. The literature looked at the various laws associated with bibliometrics, types of bibliometrics, its applications and indicators as well as its importance and limitations. The literature also looked at the various subfields related to bibliometrics and the purpose of citations. Again the literature revealed that bibliometrics as an evaluation tool has existed for a very long time with many libraries taking advantage of its benefits as a tool in research evaluation. Furthermore the literature also looked at citation analysis, another bibliometric approach, which has assisted libraries and information centres in the management of their collections to satisfy user needs, helping in the management of their resources as well as the removal of obsolete materials. Studies from Dickinson, Gunningham and Boyd, 2009; Kimball, Stephens, Hubbard and Pickett, 2013; Kohn and Gordon, 2014 confirmed the significance of citation analysis as a tool in collection management. Bibliometric studies on theses outside Africa, Africa and Ghana were also reviewed. Some of which included (Sam and Tackie, 2007; Fasae, 2012; Hsieh, Chuang and Wang, 2013; Kankam, 2014; Angammana and Jayatissa, 2015; Becker & Chiware, 2015). The most common finding from these studies was that the most cited information sources were journals and books. Finally another issue that emerged from the literature was that there are few articles written on bibliometric studies on theses in Ghana. Therefore this study contributes to knowledge and adds to the literature of bibliometric studies on theses in Ghana. The study focused on the bibliometric analysis of theses at the SNAS, UG.
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CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

Kothari (2004) defines the research methodology as “a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically.” (p. 8). This chapter explains and justifies the research methodology used in achieving the research objectives for this study. It begins with the research design, the population, sample size and sampling techniques. It also looks at the instrumentation employed for data collection, data collection procedures and the data analysis and presentation of results are also highlighted.

3.2 Research Design

The research design provides the blueprint for a detailed outline of the research investigation. It provides the framework that seeks answers to the research questions. The research design can be likened to a sketch by an artist. It looks at how a research will be undertaken, how data will be collected for the research investigation, the instruments that will be used, and how the collected data will be analysed and interpreted. The study used the bibliometric method to analyse M.Phil and Ph.D. theses publications by graduate students theses at SNAS, UG from 2008 - 2016 using the INIS database as the source of data.

3.2.1 Bibliometrics as a Research Method

A research method is defined as a particular way of studying something in order to discover new information about it or understand it better (Cambridge dictionary online, 2017). Bibliometrics refers to the application of statistical methods to the study of bibliographic data
(Merriam-Webster’s online dictionary, 2017). This study employed the bibliometric method to statistically analyse and obtain data on the graduate students theses at the SNAS, UG from 2008-2016 using the INIS database. It combined both the descriptive and evaluative bibliometric approaches.

3.3 Selection of Subjects

3.3.1 Population

Kothari (2004) postulates that, “All items in any field of inquiry constitute a ‘Universe’ or ‘Population’” (p.55). Fraenkel, Wallen and Hyun (2012) are of the view that the population “is the group of interest to the researcher, the group to whom the researcher would like to generalize the results of the study” (p.92). For this study, the population was all theses published in Ghana and indexed in the INIS database. The population for the study was five hundred and thirty eight (538) theses records. This is illustrated in figure 3.1 below

Figure 3.1: Population For The Study

Source: International Nuclear Information System (INIS) repository search
3.3.2 Sample Size

According to Kothari (2004) “The respondents selected should be as representative of the total population as possible in order to produce a miniature cross-section. The selected respondents constitute what is technically called a sample” (p.55).

The sample size for the study was four hundred and fourteen (414) theses indexed in the INIS database. These constituted the theses publications from SNAS that were indexed in the INIS database.

3.3.3 Sampling Technique

The study used the purposive sampling technique. According to Connaway and Powell (2010) “At times, it may seem preferable to select a sample based entirely on one’s knowledge of the population and the objectives of the research”. (p.119). Therefore in agreement with the views of Connaway and Powell (2010), the researcher used this sampling technique to arrive at this sampling size.

The justification for this sampling technique was that some of the theses publications from the population (538) were not published at SNAS and since the researcher knows the specific sample to use from the population i.e. theses publications from SNAS, the sampling technique used allowed the researcher to identify and retrieve (414) theses publications from SNAS which were available on the INIS database to answer the research questions. However the major drawback with this sampling technique is that the judgment of the researcher can sometimes be in error (Fraenkel, Wallen and Hyun, 2012).
3.4 Data Collection Instrument

The instrument used for data collection in the study is explained below:

3.4.1 Database

A database is a systematically organised or structured repository of indexed information usually as a group of linked data files that allows easy retrieval, updating, analysis and output of data stored usually in a computer (Business Dictionary Online, 2017).

The INIS database was used to collect data to answer the research questions. It is an online bibliographic database which contains information on all aspects of the peaceful applications of nuclear science and technology.

3.4.2 Search Query Language

According to the webopedia online technology dictionary (2017), a query language refers to a specialised language for requesting information from a database. The INIS database was considered appropriate for the study because of its easy and friendly user navigation in filtering out a query. In retrieving the relevant records for the study, the advanced search page was selected from the INIS advanced search page.

Using the query builder tab the Country of publication was first selected from the list box and Ghana typed into the corresponding box. Then in the same interface add another was selected to generate a second list box before selecting Record Type and then Thesis/Dissertation after which the search button was then clicked to display the search results. After going through the steps above the search query language to retrieve the required records and answer the research
questions was as follows: **country:Ghana AND recordtype:Thesis/Dissertation.** This is illustrated in figure 3.2 below.

**Figure 3.2: Search Query Language**

![Search Query Language](image)

**Source:** International Nuclear Information System (INIS) repository search

### 3.4.3 Downloading and verification of data

After the search results were generated the records were selected and the selection button clicked on. The export button was selected next which brought up a drop down menu to choose the format in which to export the records. Microsoft excel spreadsheet was the preferred format for downloading the data. According to the ACP computer training and consultancy Private Limited (2013), microsoft excel spreadsheet is capable of storing huge amounts of data, up to a million rows by 16,000 columns. This enables users to analyze large amounts of data. With flexible filtering, searching and sorting tools, users are able to find and examine vast
information quickly. Combined with tables and graphs, seemingly endless data can be presented in a tangible and solid way.

Bibliographical access points that were taken into account before exporting the data into Microsoft Excel spreadsheet were as follows: title, author, publication year, source, record type, subject category, country/organisation, descriptors (DEI and DEC), country/organisation, subject category and INIS volume. The records were then downloaded and verified to ensure that all the theses records were published in Ghana and at the SNAS University of Ghana. Records that did not meet the criteria were excluded from the analysis. This then become the master list for the analysis. The bibliographic access points chosen and the exporting of data to Microsoft Excel is illustrated in figures 3.3 and 3.4 below.

Figure 3.3: Bibliographic Access Points Chosen

Source: International Nuclear Information System (INIS) repository search
Figure 3.4: Exporting of data to Microsoft excel

Source: International Nuclear Information System (INIS) repository search

3.5 Presentation of Data Analysis

Data analysis involves the process of evaluating data using analytical and logical reasoning to examine each component of the data provided. This form of analysis is just one of the many steps that must be completed when conducting a research experiment. Data from various sources is gathered, reviewed, and then analysed to form some sort of finding or conclusion (Business Dictionary Online, 2017). The master list in Microsoft excel spreadsheet were then analysed, presented and illustrated using descriptive statistics such as frequency, graphs and charts. Based on the research questions, the worksheets created from the master list included year of publication, qualification, gender, department, subject, qualification and subject, figures, pages, tables, references and descriptors.
References


CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION OF FINDINGS

4.1 Introduction

This chapter provides the analysis of the data and the presentation of the findings of the statistical and quantitative approach using the bibliometric method to analyse the M.Phil. and the Ph.D. theses at SNAS, UG from (2008 - 2016) using the INIS database.

Connaway and Powell (2010) are of the view that “Statistical analysis, or “statistics,” is concerned with the development and application of methods and techniques for organizing and analyzing data (usually quantitative) so that the reliability of conclusions based on the data may be evaluated objectively in terms of probability” (p.261).

This study did not employ the use of human subjects using a questionnaire. A search query was rather used to extract the required data from the INIS database. Out of a total of 538 theses records retrieved from the INIS database, 414 were from SNAS and these were used for the analysis. The chapter has been organized under the following major sub-headings:

1. Number of Graduate Student Theses by Year.
2. Academic Qualifications Awarded.
3. Gender Distribution of Graduate Students.
4. Distribution of Theses by Academic Department.
5. Subject Coverage of Theses.
6. Page Range, Figures and Tables and Citations in Theses
7. Frequently Used Keywords Assigned by The Indexer
4.2 Number of Graduate Student Theses by Year

Figure 4.1 shows the yearly analysis of theses publications by graduate students from SNAS.

**Figure 4.1 - Distribution of Theses by Year**

Yearly analysis of publications enables one to understand the direction, growth and fall of such publications over a period. From figure 4.1 above, the yearly analysis of theses shows that the highest number of theses publications were in the years 2013 and 2015 with 63 (15.21%) counts each. This was followed by 2010 with 53 (12.80%) counts, 2016 with 52 (12.56%) counts, 2012 with 50 (12.07%) counts, 2014 with 41 (9.90%) counts, 2011 with 39 (9.42%) counts, 2009 with 43 (8.21%) counts and 2008 with 19 (4.58%) counts. The average number of theses for each year was 46.
4.3 Academic Qualifications Awarded

This section looks at the type of academic qualification awarded and the yearly trend of these qualifications.

4.3.1 Type of Academic Qualification

Figure 4.2 shows the type of academic qualifications that were awarded at SNAS.

**Figure 4.2 - Type of Academic Qualification**

The findings (Figure 4.2) above reveals that a total of 414 academic qualifications were awarded over the period (2008 - 2016). These academic qualifications were postgraduate qualifications namely the Ph.D. and the M.Phil. M.Phil. accounts for the highest number of theses with 377 (91.06%) counts followed by the Ph.D. with 37 (8.93%) counts.
4.3.2 Type of Academic Qualification Awarded by Year

Table 4.1 shows the type of academic qualification that was awarded each year.

Table 4.1 - Type of Academic Qualification Awarded by Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Ph.D</th>
<th>Percentage (%)</th>
<th>M.Phil</th>
<th>Percentage (%)</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>-</td>
<td>-</td>
<td>19</td>
<td>5.03</td>
<td>19</td>
</tr>
<tr>
<td>2009</td>
<td>-</td>
<td>-</td>
<td>34</td>
<td>9.01</td>
<td>34</td>
</tr>
<tr>
<td>2010</td>
<td>3</td>
<td>8.10</td>
<td>50</td>
<td>13.26</td>
<td>53</td>
</tr>
<tr>
<td>2011</td>
<td>4</td>
<td>10.81</td>
<td>35</td>
<td>9.28</td>
<td>39</td>
</tr>
<tr>
<td>2012</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>13.26</td>
<td>50</td>
</tr>
<tr>
<td>2013</td>
<td>4</td>
<td>10.81</td>
<td>59</td>
<td>15.64</td>
<td>63</td>
</tr>
<tr>
<td>2014</td>
<td>10</td>
<td>27.02</td>
<td>31</td>
<td>8.22</td>
<td>41</td>
</tr>
<tr>
<td>2015</td>
<td>7</td>
<td>18.91</td>
<td>56</td>
<td>14.85</td>
<td>63</td>
</tr>
<tr>
<td>2016</td>
<td>9</td>
<td>24.32</td>
<td>43</td>
<td>11.40</td>
<td>52</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td>100.00</td>
<td>377</td>
<td>100.00</td>
<td>414</td>
</tr>
</tbody>
</table>

The findings (Table 4.1) above shows the yearly trend of the type of academic qualification at SNAS. With the M.Phil. theses, the year 2013 had the highest number of awards with 59 (15.64%) counts. This was followed by the year 2015 with 56 (14.85%) counts, 2010 and 2012 with 50 (13.26%) counts each, 2016 with 43 (11.40%) counts, 2011 with 35 (9.28%) counts, 2009 with 34 (9.01%) counts and 2008 with 19 (5.03%) counts.

The Ph.D. theses on the other hand had the year 2014 having the highest number of awards with 10 (27.02%) counts. This was followed by the year 2016 with 9 (24.32%) counts, 2015 with 7 (18.91%) counts, 2013 and 2011 with 4 (10.81%) counts each, 2010 with 3 (8.10%) counts and 2008, 2009 and 2012 recorded no Ph.D. award.
4.4 Gender Distribution of Graduate Students

This section looks at the gender distribution of graduate students, gender distribution by year and the gender distribution by academic qualification.

4.4.1 Gender of Graduate Students

Figure 4.3 shows the gender distribution of graduate students at SNAS.

Figure 4.3 - Gender Distribution of Graduate Students

From the findings in (figure 4.3) above, the analysis of theses by gender at SNAS revealed that out of the 414 theses published, males had 330 (79.71%) counts with their female counterparts having 84 (20.29%) counts which was almost four times the number of male graduate students.

4.4.2 Gender Distribution By Year

Table 4.2 shows the gender distribution of graduate students at SNAS by year.
Table 4.2 - Gender of Graduate Students By Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Male</th>
<th>Percentage (%)</th>
<th>Female</th>
<th>Percentage (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>17</td>
<td>5.15</td>
<td>2</td>
<td>2.38</td>
<td>19</td>
</tr>
<tr>
<td>2009</td>
<td>29</td>
<td>8.78</td>
<td>5</td>
<td>5.95</td>
<td>34</td>
</tr>
<tr>
<td>2010</td>
<td>45</td>
<td>13.63</td>
<td>8</td>
<td>9.52</td>
<td>53</td>
</tr>
<tr>
<td>2011</td>
<td>31</td>
<td>9.39</td>
<td>8</td>
<td>9.52</td>
<td>39</td>
</tr>
<tr>
<td>2012</td>
<td>33</td>
<td>10.00</td>
<td>17</td>
<td>20.23</td>
<td>50</td>
</tr>
<tr>
<td>2013</td>
<td>53</td>
<td>16.06</td>
<td>10</td>
<td>11.90</td>
<td>63</td>
</tr>
<tr>
<td>2014</td>
<td>34</td>
<td>10.30</td>
<td>7</td>
<td>8.33</td>
<td>41</td>
</tr>
<tr>
<td>2015</td>
<td>53</td>
<td>16.06</td>
<td>10</td>
<td>11.90</td>
<td>63</td>
</tr>
<tr>
<td>2016</td>
<td>35</td>
<td>10.60</td>
<td>17</td>
<td>20.23</td>
<td>52</td>
</tr>
<tr>
<td>Total</td>
<td>330</td>
<td>100.00</td>
<td>84</td>
<td>100.00</td>
<td>414</td>
</tr>
</tbody>
</table>

The findings (table 4.2) above shows that the highest number of male graduate students was in 2013 and 2015 with 53 (16.06%) counts. This was followed by 2010 with 45 (13.63%) counts, 2016 with 35 (10.60%) counts, 2014 with 34 (10.30%) counts, 2012 with 33 (10.00%) counts, 2011 with 31 (9.39%) counts, 2009 with 29 (8.78%) counts and 2008 with 17 (5.15%) counts.

For females, 2012 and 2016 had the highest number of graduate students with 17 (20.23%) counts. This was followed by 2015 and 2013 with 10 (11.90%) counts, 2011 and 2010 with 8 (9.52%) counts, 2014 with 7 (8.33%) counts, 2009 with 5 (5.95%) counts and 2008 with 2 (2.38%) counts.

4.4.3 Gender Distribution by Academic Qualification

Table 4.3 shows the gender distribution of graduate students at SNAS by academic qualification.

Table 4.3 - Gender Distribution of Academic Awards

<table>
<thead>
<tr>
<th>Gender</th>
<th>Ph.D.</th>
<th>Percentage (%)</th>
<th>M.Phil.</th>
<th>Percentage (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>32</td>
<td>86.48</td>
<td>298</td>
<td>79.04</td>
<td>330</td>
</tr>
<tr>
<td>Female</td>
<td>5</td>
<td>13.51</td>
<td>79</td>
<td>20.95</td>
<td>84</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td>100.00</td>
<td>377</td>
<td>100.00</td>
<td>414</td>
</tr>
</tbody>
</table>
The findings (table 4.3) indicates that male graduate students awarded with Ph.D. awards were 32 (86.48%) counts whiles female graduate students were 5 (13.51%) counts. For M.Phil. awards male graduate students had 298 (79.04%) counts whiles their female counterparts had 79 (20.95%).

4.5 Distribution of Theses by Academic Department

This section looks at the distribution of theses by academic department, frequency distribution of departments with regard to gender and distribution of departments with regard to M.Phil. and Ph.D. theses.

4.5.1 Number of Theses by Academic Department

Figure 4.4 shows the distribution of theses by academic department.

Figure 4.4 - Theses Count by Academic Department

The findings (figure 4.4) above shows that the Department of Nuclear Sciences and Applications had the highest number of theses with 134 (16.66%) followed by the Department of Nuclear Engineering with 85 (15.94%).
Applications had the highest number of Theses with 134 (33.68%) counts. This was followed by the Department of Nuclear Engineering with 85 (20.53%) counts, Department of Medical Physics with 69 (16.6%) counts, Department of Nuclear Agriculture and Radiation Processing with 66 (15.95%) counts and the Department of Nuclear Safety and Security with 60 (14.49%) counts.

4.5.2 Frequency Distribution of Departments with Regard to Gender

Table 4.4 shows the distribution of department with regard to gender.

**Table 4.4 - Distribution of Academic Department by Gender**

<table>
<thead>
<tr>
<th>Department</th>
<th>Male</th>
<th>Percentage (%)</th>
<th>Female</th>
<th>Percentage (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dept. of Medical Physics</td>
<td>59</td>
<td>17.87</td>
<td>10</td>
<td>11.90</td>
<td>69</td>
</tr>
<tr>
<td>Dept. of Nuclear Agriculture and Radiation Processing</td>
<td>41</td>
<td>12.42</td>
<td>25</td>
<td>29.76</td>
<td>66</td>
</tr>
<tr>
<td>Dept. of Nuclear Engineering</td>
<td>74</td>
<td>22.42</td>
<td>11</td>
<td>13.09</td>
<td>85</td>
</tr>
<tr>
<td>Dept. of Nuclear Safety and Security</td>
<td>47</td>
<td>14.24</td>
<td>13</td>
<td>15.47</td>
<td>60</td>
</tr>
<tr>
<td>Dept. of Nuclear Sciences and Applications</td>
<td>109</td>
<td>33.03</td>
<td>25</td>
<td>29.76</td>
<td>134</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>330</strong></td>
<td><strong>100.00</strong></td>
<td><strong>84</strong></td>
<td><strong>100.00</strong></td>
<td><strong>414</strong></td>
</tr>
</tbody>
</table>

Table 4.4 above is the frequency distribution of departments with regards to gender. For male graduate students the majority, 109 (33.03%) counts were in the Department of Nuclear Sciences and Applications. The rest in descending order are 74 (22.42%) were in the Department of Nuclear Engineering, 59 (17.87%) were in the Department of Medical Physics, 47 (14.24%) were in the Department of Nuclear Safety and Security and 41 (12.42%) were in the Department of Nuclear Agriculture and Radiation Processing.

For female graduate students the majority, 25 (29.76%) counts were in the Department of
Nuclear Sciences and Applications and Department of Nuclear Agriculture and Radiation Processing respectively. The rest in descending order are 13 (15.47%) were in the Department of Nuclear Safety and Security, 11 (13.09%) were in the Department of Nuclear Engineering and 10 (11.90%) were in the Department of Medical Physics.

4.5.3 Distribution of Departments with Regard to M.Phil. Theses

Table 4.5 shows the distribution of departments with regards to M.Phil. theses.

Table 4.5 - Distribution of Department With Regard to M.Phil. Theses

<table>
<thead>
<tr>
<th>Department</th>
<th>(M.Phil.) Count</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dept. of Nuclear Sciences and Applications</td>
<td>119</td>
<td>29.70</td>
</tr>
<tr>
<td>Dept. of Nuclear Engineering</td>
<td>77</td>
<td>20.98</td>
</tr>
<tr>
<td>Dept. of Nuclear Agriculture and Radiation Processing</td>
<td>64</td>
<td>17.43</td>
</tr>
<tr>
<td>Dept. of Medical Physics</td>
<td>63</td>
<td>17.16</td>
</tr>
<tr>
<td>Dept. of Nuclear Safety and Security</td>
<td>54</td>
<td>14.71</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>377</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Table 4.5 above is the distribution of departments with regards to M.Phil. theses. The majority, 119 (29.70%) counts of graduate students were in the Department of Nuclear Sciences and Applications. The rest in descending order are 77 (20.98%) were in the Department of Nuclear Engineering, 64 (17.43%) were in the Department of Nuclear Agriculture and Radiation Processing, 63 (17.16%) were in the Department of Medical Physics and 54 (14.71%) were in the Department of Nuclear Safety and Security.

4.5.4 Distribution of Departments With Regard to Ph.D. Theses

Table 4.6 shows the distribution of departments with regard to Ph.D. theses.
Table 4.6 - Distribution of Department With Regard to Ph.D. Theses

<table>
<thead>
<tr>
<th>Department</th>
<th>(Ph.D.) Count</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dept. of Nuclear Sciences and Applications</td>
<td>15</td>
<td>40.54</td>
</tr>
<tr>
<td>Dept. of Nuclear Engineering</td>
<td>8</td>
<td>21.62</td>
</tr>
<tr>
<td>Dept. of Medical Physics</td>
<td>6</td>
<td>16.21</td>
</tr>
<tr>
<td>Dept. of Nuclear Safety and Security</td>
<td>6</td>
<td>16.21</td>
</tr>
<tr>
<td>Dept. of Nuclear Agriculture and Radiation Processing</td>
<td>2</td>
<td>5.40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>37</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Table 4.6 is the distribution of departments with regards to Ph.D. theses. The majority, 15 (40.54%) counts of graduate students were in the Department of Nuclear Sciences and Applications. The rest in descending order are 8 (21.62%) were in the Department of Nuclear Engineering, 6 (16.21%) were in the Department of Nuclear Safety and Security and Department of Medical Physics respectively and 2 (5.40%) were in the Department of Nuclear Agriculture and Radiation Processing.

4.6 Subject Coverage of Theses

This section looks at the number of theses by subject and subject coverage of academic qualifications.

4.6.1 Number of Theses By Subject

For the analysis of the subject coverage of postgraduate theses the INIS/ETDE (Energy Technology Data Exchange) subject categories and scope descriptions (ETDE/INIS joint reference series no. 2) were used (IAEA, 2002). According to the (IAEA, 2002) the INIS/ETDE “defines the subject categories and provides the scope descriptions to be used for categorization of the nuclear literature for the preparation of INIS input by national and regional centres. Together with volumes of the INIS Reference Series and ETDE/INIS joint reference
series it defines the rules, standards and practices and provides the authorities to be used in the International Nuclear Information System” (p.3).

In analysing the subject coverage of theses, some of the records had more than one subject category assigned in which case the first subject category was used in the analysis. Table 4.7 shows the distribution of theses by subject.

Table 4.7 - Number of Theses By Subject

<table>
<thead>
<tr>
<th>Subject Areas</th>
<th>Count</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied life sciences</td>
<td>82</td>
<td>19.80</td>
</tr>
<tr>
<td>Environmental sciences</td>
<td>61</td>
<td>14.73</td>
</tr>
<tr>
<td>Radiation protection and dosimetry</td>
<td>61</td>
<td>14.73</td>
</tr>
<tr>
<td>Radiology and nuclear medicine</td>
<td>54</td>
<td>13.04</td>
</tr>
<tr>
<td>Specific nuclear reactors and associated plants</td>
<td>51</td>
<td>12.31</td>
</tr>
<tr>
<td>Geosciences</td>
<td>29</td>
<td>7.00</td>
</tr>
<tr>
<td>Chemistry (inorganic, organic, physical, analytical chemistry, radiochemistry and nuclear chemistry)</td>
<td>28</td>
<td>6.76</td>
</tr>
<tr>
<td>Engineering</td>
<td>13</td>
<td>3.14</td>
</tr>
<tr>
<td>Isotopes and radiation sources</td>
<td>12</td>
<td>2.89</td>
</tr>
<tr>
<td>Materials science</td>
<td>5</td>
<td>1.20</td>
</tr>
<tr>
<td>General studies of nuclear reactors</td>
<td>4</td>
<td>0.96</td>
</tr>
<tr>
<td>Management of radioactive wastes and non-radioactive wastes from nuclear facilities</td>
<td>4</td>
<td>0.96</td>
</tr>
<tr>
<td>Nuclear physics and radiation physics</td>
<td>4</td>
<td>0.96</td>
</tr>
<tr>
<td>Particle accelerators</td>
<td>2</td>
<td>0.48</td>
</tr>
<tr>
<td>Biomass fuels</td>
<td>1</td>
<td>0.24</td>
</tr>
<tr>
<td>Instrumentation related to nuclear science and technology</td>
<td>1</td>
<td>0.24</td>
</tr>
<tr>
<td>Mathematical methods and computing</td>
<td>1</td>
<td>0.24</td>
</tr>
<tr>
<td>Petroleum</td>
<td>1</td>
<td>0.24</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>414</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

The finding (Table 4.7) above revealed that applied life sciences was the most researched subject area by postgraduate students with 82 (19.80%) counts. This was followed in descending order by environmental sciences and radiation protection and dosimetry with 61 (14.73%) counts each, radiology and nuclear medicine with 54 (13.04%) counts, specific
nuclear reactors and associated plants with 51 (12.31%) counts, geosciences with 29 (7.00%) counts, chemistry including inorganic, organic, physical, analytical chemistry and radiochemistry and nuclear chemistry with 28 (6.76%) counts, engineering with 13 (3.14%) counts and isotopes and radiation sources with 12 (2.89%) counts.

Others are materials science with 5 (1.20%) counts, general studies of nuclear reactors, management of radioactive wastes and non-radioactive wastes from nuclear facilities, nuclear physics and radiation physics all with 4 (0.96%) counts each, and particle accelerators with 2 (0.48%) counts.

The least most researched subject areas were biomass fuels, instrumentation related to nuclear science and technology, mathematical methods and computing and petroleum with 1 (0.24%) counts each.

4.6.2 Subject Coverage of Academic Qualifications

Table 4.8 shows the subject coverage of Ph.D. theses.

Table 4.8 - Subject Coverage of Ph.D. Theses

<table>
<thead>
<tr>
<th>Subject Areas</th>
<th>Ph.D.</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental sciences</td>
<td>9</td>
<td>24.32</td>
</tr>
<tr>
<td>Specific nuclear reactors and associated plants</td>
<td>8</td>
<td>21.62</td>
</tr>
<tr>
<td>Radiology and nuclear medicine</td>
<td>5</td>
<td>13.51</td>
</tr>
<tr>
<td>Applied life sciences</td>
<td>4</td>
<td>10.81</td>
</tr>
<tr>
<td>Geosciences</td>
<td>3</td>
<td>8.10</td>
</tr>
<tr>
<td>Radiation protection and dosimetry</td>
<td>3</td>
<td>8.10</td>
</tr>
<tr>
<td>Engineering</td>
<td>2</td>
<td>5.40</td>
</tr>
<tr>
<td>Isotopes and radiation sources</td>
<td>2</td>
<td>5.40</td>
</tr>
<tr>
<td>Chemistry (inorganic, Organic, Physical, Analytical Chemistry, Radiochemistry and Nuclear Chemistry)</td>
<td>1</td>
<td>2.70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>37</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>
The findings (Table 4.8) shows that the Ph.D. theses was limited to a few subject areas. Environmental sciences was the most researched subject area with 9 (24.32%) counts. This was followed by specific nuclear reactors and associated plants with 8 (21.62%) counts, radiology and nuclear medicine with 5 (13.51%) counts, applied life sciences with 4 (10.81%) counts, geosciences and radiation protection and dosimetry with 3 (8.10%) counts each and engineering and isotopes and radiation sources with 2 (5.40%) counts each. The least most researched subject area was chemistry including inorganic, organic, physical, analytical chemistry, radiochemistry and nuclear chemistry with 1 (2.70%) counts.

Table 4.9 is the subject coverage of M.Phil. theses.

Table 4.9 - Subject Coverage of M.Phil. Theses

<table>
<thead>
<tr>
<th>Subject Areas</th>
<th>M.Phil</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied life sciences</td>
<td>78</td>
<td>20.68</td>
</tr>
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<td>Radiation protection and dosimetry</td>
<td>58</td>
<td>15.38</td>
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<tr>
<td>Environmental sciences</td>
<td>52</td>
<td>13.79</td>
</tr>
<tr>
<td>Radiology and nuclear medicine</td>
<td>49</td>
<td>12.99</td>
</tr>
<tr>
<td>Specific nuclear reactors and associated plants</td>
<td>43</td>
<td>11.40</td>
</tr>
<tr>
<td>Chemistry (inorganic, organic, physical, analytical chemistry, radiochemistry and nuclear chemistry)</td>
<td>27</td>
<td>7.16</td>
</tr>
<tr>
<td>Geosciences</td>
<td>26</td>
<td>6.89</td>
</tr>
<tr>
<td>Engineering</td>
<td>11</td>
<td>2.91</td>
</tr>
<tr>
<td>Isotopes and radiation sources</td>
<td>10</td>
<td>2.65</td>
</tr>
<tr>
<td>Materials science</td>
<td>5</td>
<td>1.32</td>
</tr>
<tr>
<td>General studies of nuclear reactors</td>
<td>4</td>
<td>1.06</td>
</tr>
<tr>
<td>Management of radioactive wastes and non-radioactive wastes from nuclear facilities</td>
<td>4</td>
<td>1.06</td>
</tr>
<tr>
<td>Nuclear physics and radiation physics</td>
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<td>1.06</td>
</tr>
<tr>
<td>Particle accelerators</td>
<td>2</td>
<td>0.53</td>
</tr>
<tr>
<td>Biomass fuels</td>
<td>1</td>
<td>0.26</td>
</tr>
<tr>
<td>Instrumentation related to nuclear science and technology</td>
<td>1</td>
<td>0.26</td>
</tr>
<tr>
<td>Mathematical methods and computing</td>
<td>1</td>
<td>0.26</td>
</tr>
<tr>
<td>Petroleum</td>
<td>1</td>
<td>0.26</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>377</td>
<td>100.00</td>
</tr>
</tbody>
</table>
The findings (Table 4.9) revealed that the M.Phil. theses was spread across a large number of subject areas. Applied life sciences was the most researched subject area with 78 (20.68%) counts. This was followed by radiation protection and dosimetry with 58 (15.38%) counts, Environmental sciences with 52 (13.79%) counts, radiology and nuclear medicine with 49 (12.99%) counts, specific nuclear reactors and associated plants with 43 (11.40%) counts, chemistry including inorganic, organic, physical, analytical chemistry, radiochemistry and nuclear chemistry with 27 (7.16%) counts, geosciences with 26 (6.89%) counts, engineering with 11 (2.91%) counts, isotopes and radiation sources with 10 (2.65%) counts and materials science with 5 (1.32%) counts.

Others are general studies of nuclear reactors, management of radioactive wastes and non-radioactive wastes from nuclear facilities and nuclear physics and radiation physics with 4 (1.06%) counts each and particle accelerators with 2 (0.53%) counts. The least most researched subject areas were biomass fuels, instrumentation related to nuclear science and technology, mathematical methods and computing and petroleum with 1 (0.26%) counts each.

4.7 Page Range, Figures, Tables And Citations In Theses

This section looks at the page range, figures, tables and citations in theses by postgraduate students of SNAS.

4.7.1 Page Range

In determining the page range of postgraduate theses, all the page numbers of the 414 theses records retrieved from the INIS database were grouped into page ranges of (51 - 100, 101 - 150, 151 - 200 and 200 and above pages). Figure 4.5 shows the page range of theses.
From the analysis the findings (Figure 4.5) above shows that the page range of theses with 101 - 150 pages was the highest with 206 (49.75%) counts. This was followed by theses with the page range of 51 - 100 pages with 131 (49.75%) counts, page range of 151 - 200 pages with 50 (12.07%) counts and the least been theses with 201 and above pages with 27 (6.52%) counts. The total number of pages for all the postgraduate theses was 51,403 pages with an average of 124.16.

4.7.2 Figures

The figures in the 414 theses records retrieved from the INIS database were analysed by grouping them into ranges of (1 - 15, 16 - 30, 31 - 45 and 46 and above figures). Figure 4.6 shows the figures found in theses.
The findings (Figure 4.6) above revealed that theses with figures within the range of 1 - 15 were the highest with 179 (43.23%) counts. This was followed by theses with figures within the range of 16 - 30 with 154 (37.19%) counts, 31 - 45 figures with 54 (13.04%) counts. Theses having 46 and above figures were the least with 27 (6.52%) counts.

4.7.3 Tables

In analysing the tables in the 414 theses records retrieved from the INIS database, they were grouped into ranges of (1 - 15, 16 - 30 and 31 and above tables). Figure 4.7 shows the tables found in theses.
The findings (Figure 4.7) above revealed that theses with tables within the range of 16 - 30 were the highest with 297 (71.73%) counts. This was followed by theses with tables within the range of 1 - 15 with 97 (23.42%) and theses with tables within the range of 31 and above been the least with 20 (4.83%) counts.

4.7.4 Citations

This section looks at the number of citations used in theses by year and the range of citations used in M.Phil. and Ph.D. theses.

4.7.4.1 Number of Citations Used in Theses By Year

The yearly breakdown of citations by year shows that theses published in 2010 used the highest number of citations with 5,477. This was followed by theses published in 2015 with 5,173 citations, theses published in 2013 with 4,821 citations, theses published in 2016 with 4,601 citations, theses published in 2012 with 4,205 citations, theses published in 2014 with 3,832 citations, theses published in 2011 with 3,362 citations, theses published in 2009 with 2,527 citations and 2008 using the least number of citations with 1,650 citations. The total number of citations used by theses was 23,710.
citations in the 414 M.Phil. and Ph.D. theses by postgraduate students was 35,648 citations with an average of 86.10 citations. The findings are shown in table 4.10 below.

Table 4.10 - Citations Used in Theses By Year

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Theses</th>
<th>No. of Citations</th>
<th>Average Citations Per Theses</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>19</td>
<td>1,650</td>
<td>86.84</td>
</tr>
<tr>
<td>2009</td>
<td>34</td>
<td>2,527</td>
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<td>2010</td>
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<td>5,477</td>
<td>103.33</td>
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<td>2011</td>
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<td>3,362</td>
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</tr>
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<td>2012</td>
<td>50</td>
<td>4,205</td>
<td>84.10</td>
</tr>
<tr>
<td>2013</td>
<td>63</td>
<td>4,821</td>
<td>76.52</td>
</tr>
<tr>
<td>2014</td>
<td>41</td>
<td>3,832</td>
<td>93.46</td>
</tr>
<tr>
<td>2015</td>
<td>63</td>
<td>5,173</td>
<td>82.11</td>
</tr>
<tr>
<td>2016</td>
<td>52</td>
<td>4,601</td>
<td>88.48</td>
</tr>
<tr>
<td>Total</td>
<td>414</td>
<td>35,648</td>
<td>86.10 (Average)</td>
</tr>
</tbody>
</table>

4.7.4.2 Range of Citations Used in M.Phil. and Ph.D. Theses

In analysing the range of citations in the 414 postgraduate student theses records retrieved from the INIS database, they were grouped into ranges of (1 - 50, 51 - 100, 101 - 150, 151 - 200 and 201 and above citations). Table 4.11 shows the range of citations in M.Phil. and Ph.D. theses.

Table 4.11 - Range of Citations in M.Phil. and Ph.D. Theses

<table>
<thead>
<tr>
<th>No. of Citations</th>
<th>M.Phil.</th>
<th>Percentage (%)</th>
<th>Ph.D.</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 50</td>
<td>113</td>
<td>27.29</td>
<td>3</td>
<td>8.10</td>
</tr>
<tr>
<td>51 - 100</td>
<td>167</td>
<td>40.33</td>
<td>7</td>
<td>18.91</td>
</tr>
<tr>
<td>101 - 150</td>
<td>59</td>
<td>14.25</td>
<td>7</td>
<td>18.91</td>
</tr>
<tr>
<td>151 - 200</td>
<td>28</td>
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<td>29.72</td>
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<tr>
<td>201 and above</td>
<td>10</td>
<td>2.41</td>
<td>9</td>
<td>24.32</td>
</tr>
<tr>
<td>Total</td>
<td>414</td>
<td>100.00</td>
<td>37</td>
<td>100.00</td>
</tr>
</tbody>
</table>
From (Table 4.11), M.Phil. theses, citations within the range of 51 - 100 recorded the highest number of postgraduate theses with 167 (40.33%) counts. This was followed by theses with citations within the range of 1 - 50 citations with 113 (27.29%) counts, theses with citations within the range of 101 - 150 citations with 59 (14.25%) counts, theses with citations within the range of 151 - 200 citations with 28 (6.76%) counts and theses with citations within the range of 201 and above citations with 10 (2.41%) counts.

On the other hand for Ph.D. theses, citations within the range of 151 - 200 recorded the highest number of theses with 11 (29.72%) counts. This was followed by theses with citations within the range of 201 and above citations with 9 (24.32%) counts, theses with citations within the range of 51 - 100 and 101 - 150 citations with 7 (18.91%) counts each and theses with citations within the range of 1 - 50 citations with 3 (8.10%) counts.

4.8 Frequently Used Keywords Assigned By The Indexer

According to Feather and Sturges (2003), a keyword is “a word that succinctly and accurately describes the subject, or an aspect of the subject, discussed in a document” (p. 341). The winfibre plus software was used by the subject specialist to describe each research topic when indexing and abstracting theses to be forwarded to the INIS secretariat for onward transmission into the INIS database.

The keywords were assigned by the indexer through reading the title of the research topic, abstract, research objectives and the methodology. Out of the 414 theses retrieved from the INIS database, a total of 4960 keywords were assigned by the indexer with an average of 11.98 keywords per thesis. Table 4.12 shows the most frequently used keywords assigned by the indexer.
<table>
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<th>Frequency</th>
<th>No.</th>
<th>Keywords</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
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<td>uranium</td>
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<td>35</td>
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<td>evaluation</td>
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The findings (table 4.12) above shows the most frequently used keywords assigned by the indexer (at least occurring 8 times and above). The top ten most used keywords assigned by the indexer was radiation protection with (189) keywords. The rest is radiation doses with (125) keywords, ions with (108) keywords, water with (86) keywords, doses with (80) keywords, Ghana with (71) keywords, neutron activation analysis with (68) keywords, risk assessment with (66) keywords, public health with (63) keywords and safety with (58) keywords.
**References**


CHAPTER FIVE

DISCUSSION OF FINDINGS

5.1 Introduction

Annesley (2010), postulates that “the purpose of the discussion section is to explain what your results mean and what contribution your paper makes to the field of study” (p. 1674).

The study looked at the bibliometric analysis of M.Phil. and Ph.D. theses from the School of Nuclear and Allied Sciences, University of Ghana from (2008 - 2016). This chapter will discuss the research findings in relation to the research objectives and the existing literature.

In discussing the findings this chapter will be arranged under the following headings: number of graduate student theses by year, academic qualifications awarded, gender distribution of graduate students, distribution of theses by academic department, subject coverage of theses, page range, figures and tables and citations in theses and frequently used keywords assigned by the indexer (subject specialist).

5.2 Number of Graduate Student Theses By Year

The findings revealed that the majority of theses were published in the years 2015 and 2013 respectively with 63 theses each. Furthermore, the smallest number of theses were published in 2008 with 19 theses.

In a bid to find out the yearly publication trend of graduate theses, the findings depicts a constant rise and fall in the number of theses published over the period (2008 - 2016). The number of theses increased from (19 to 53) from (2008 - 2010) and then decreased from (53 to
38) from (2010 - 2011). It again increased from (39 to 63) from (2011 - 2013) and then decreased from (63 to 41) from (2013 - 2014). Finally there was another increase from (41 to 63) from (2014 - 2015) before a decrease from (63 to 52) from (2015 - 2016).

This finding on the constant rise and fall in the number of theses concurs with the findings of Kumar, Sah and Singh (2013) who found out that in both Kumaun University and Delhi University the distribution pattern of doctoral theses was uneven from 2000 to 2004 showing increasing trends and then decreasing trends.

Again, findings by (Aliyu and Abba, 2009; Ezema, 2016; Tsafe and Aliefo, 2008; Bohra and Devi, 2015; and Mahapatra and Sahoo, 2004) have also shown a similar trend in the rise and fall in the number of theses published each year from the respective institutions that they investigated.

This trend in the constant rise and fall in the number of theses published each year may be attributed to the yearly increase in the academic user fees for prospective students by the University of Ghana (UG) which might have affected enrolment thereby contributing to the trend seen in figure 4.1.

Another reason could be that due to the yearly increment in the academic user fees charged by the University of Ghana (UG), prospective students/ nuclear scientists who want to build their profession in the nuclear field through reading nuclear science programs choose to enrol in Universities in Ghana offering similar nuclear related programs with less expensive academic fees.

Another reason could be that prospective students might have applied for admission and scholarship from Universities outside of the country to pursue nuclear related programs since
they cannot fund the programs on their own by enrolling at SNAS due to the yearly increment in the academic user fees charged by the University of Ghana.

Furthermore this could also be due to the fact that programs in the sciences by nature are expensive on their own in comparison with programs in the humanities and the yearly increment in academic user fees charged by the University of Ghana makes them even more expensive.

5.3 Academic Qualifications Awarded

The researcher wanted to know the type of postgraduate academic qualifications awarded at SNAS. From the findings revealed that a total of 414 academic qualifications were awarded over the period (2008 - 2016). The M.Phil. theses formed the majority with 377 theses. On the other hand the Ph.D. theses formed the minority with 37 counts. The big difference between the M.Phil. and Ph.D. theses could be attributed to the fact that the entry level requirement in becoming a Scientific Officer is having a master’s degree in a nuclear science related academic program and as such established technicians and technologists who want to upgrade themselves in the nuclear science profession as well as students looking to start a career as a Scientific Officer enrolled to pursue the M.Phil. and this might have accounted for the high number of M.Phil. theses.

On the other hand, the low numbers in the Ph.D. theses could be due to the fact that for some years now, the University of Ghana has chosen to make Ph.D. programs at its institution to be full fee paying an option which is very expensive than the regular option since the government provides no subsidy for this option thereby making the fees to be very high. Due to this, prospective students who might have qualified to gain admission to pursue these Ph.D.
programs are left disappointed since it is only the rich and those who can afford to pay these high fees who enrol in these programs thereby accounting for the low numbers over the period.

Another factor for the low numbers in the Ph.D. theses could be attributed to the fact that while students offering similar Ph.D. programs in Ghana spend three years to complete, students at the University of Ghana rather spend 4 years and this might have made prospective students to opt for the other institutions due to the period involved.

Another finding was that the type of academic qualification awarded by year revealed that there were no Ph.D. awards in 2008, 2009 and 2012. For the non-availability of Ph.D. awards in 2008 and 2009 this could be as a result of the fact that Ph.D. programs take about 3 to 4 years to complete. For the year 2012 the non-availability of Ph.D. might be as a result of no graduate student completing the program in that academic year.

From the findings the researcher also agrees with the findings by Kumar, Sah and Singh (2013) that universities should encourage and motivate students for doing Ph.D. programs since the young generation are not much interested in doing Ph.D. after completion of the Masters degree.

5.4 Gender Distribution of Graduate Students

The results from the study revealed that out of the 414 theses that were published at SNAS during the period 2008 - 2016, male and female students had 300 and 84 theses respectively.

This gender gap can be as a result of the fact that the general admission of students into nuclear sciences and application programmes is skewed towards males than females. The subject area involves the application of mathematics and due to the weak foundation in mathematics starting from the pre-school days through to adulthood, mathematics as a subject is an area females in
the Ghanaian society are less likely to pursue than their male counterparts thereby accounting for the low numbers of female postgraduate students in the nuclear sciences field.

This findings on the gender distribution of graduate students in the current study is consistent with the findings of Bohra and Devi (2015); Kavitha and Sivaraj (2014); Mishra, Gawde and Solanki (2014); Kumar, Sah and Singh (2013) and Ramachandran (2012) who all reported that the majority of the male students were more than the female students in their respective studies investigated.

The findings on the gender of graduate students by year is consistent with the findings discussed earlier in section 5.2.

Another finding on the gender distribution by academic qualification also revealed that Female students were more interested in pursuing the M.Phil. programs rather than the Ph.D. programs. This could be as a result of the fact that the female students consider the M.Phil. programs to be less rigorous than the Ph.D. programs. Hence after completion of the M.Phil. program most of these females don’t aspire to pursue the Ph.D. programs in the future. It could also be due the fact that a lot of women by the time they might aspire to pursue a Ph.D. program are burdened with raising up their children hence the difficulty in combining school with parenting which thereby creates the disparity between themselves and their male counterparts.

5.5 Distribution of Theses By Academic Department

The findings revealed that out of the five established departments at SNAS, the majority of postgraduate students theses were published at the Department of Nuclear Sciences and Applications with 134 counts. The IAEA (n. d.) states that the Department of Nuclear Sciences and Applications is a more diverse department which spreads across a number of significant
socio-economic sectors such as health, food and agriculture, environment, water resources and industry. The IAEA (n. d.) further reiterates that in each of the socio-economic sectors, Scientists from the IAEA together with experts from Member States work together in meeting their development needs through Nuclear science, technology and innovation.

The high enrolment of postgraduate students at this department may therefore be attributed to the broad nature of this department and its importance in nation building.

Again the findings on the distribution of academic department by gender, distribution of departments with regard to M.Phil. theses and distribution of departments with regards to Ph.D. theses all had the Department of Nuclear Sciences and Applications having the highest number of theses published and this is consistent with the findings discussed above in (section 5.5).

5.6 Subject Coverage of Theses

The findings revealed that the subject coverage of postgraduate theses at SNAS was spread across 18 subject areas. The most researched subject area was applied life sciences with 82 theses. The preference for this subject area could be attributed to the fact that Ghana’s nuclear research focus is geared towards agriculture since it is one of the major engines of growth whereby the country gets a substantial amount of foreign exchange earnings.

This finding corroborates with the findings of Agyeman and Bilson (2015) in another study using the INIS database where they argued that the high publication count in the area of applied life sciences was expected because agriculture continues to be the main-stay and backbone of the Ghanaian economy and like other developing countries a lot of human and material resources are channelled into that sector.
This finding is also contrary to the findings by Santos et.al. (n.d.) who analysed theses published at the Instituto De Pesquisas Nucleares - São PAULO Brazil using the INIS/ETDE (Energy Technology and Data Exchange) manual as the data source and found out that the theses spread across 33 subject categories with material science having the highest number of theses with (243).

Another finding is also dissimilar to the findings by Kademani, Kumar, Sagar and Kumar (2006) who revealed in their study that Indian Nuclear scientists contributed 23,033 of publications to the subject area of physics.

Also another finding made by the researcher on the subject coverage of theses revealed that the least most researched subject areas had 1 theses each. They include Biomass Fuels, Instrumentation Related to Nuclear Science and Technology, Mathematical Methods and Computing and Petroleum. The least interest by postgraduate students in these subject areas could be as a result of the fact that these subject areas were less interesting to do research in.

Another finding on the subject coverage of M.Phil. theses revealed that applied life sciences was the most researched subject area with 78 theses published whiles biomass fuels, instrumentation related to nuclear science and technology, mathematical methods and computing and petroleum were the least subject areas with 1 theses each. This finding is consistent with the findings discussed above in (section 5.6).

Another useful finding from the study was on the subject coverage of (Ph.D.) theses. The findings showed that environmental sciences was the most researched (Ph.D.) research area with 9 theses whiles chemistry (inorganic, organic, physical, analytical chemistry, radiochemistry and nuclear chemistry) were the least most researched (Ph.D.) research area area with 1 theses each.
For environment sciences, the findings confirms that (Ph.D.) students saw the importance of studying these subject areas because the environment has been recently impacted negatively in areas such as illegal mining, pollution of water bodies, air and land pollution, indiscriminate logging etc. and through the use of nuclear techniques their research findings could go a long way to help curb the problem. For chemistry, the findings could be as a result of the fact that postgraduate students were less interested in studying the subject area.

5.7 Page range, Figures, Tables and Citations in Theses

This section discusses the findings on the page range, figures, tables and citations in theses by postgraduate students of SNAS.

5.7.1 Page Range

The findings indicated that theses within the range of 101 - 150 pages was the highest with 206 counts whiles theses within the range of 201 and above pages was the lowest with 27 counts.

For theses within the range of 101 - 150 pages the high theses count could be due to the fact that the requirement by the school of graduate studies, UG for the number of pages for an M.Phil. thesis is up to a maximum of 150 pages and since the M.Phil. theses accounted for the majority of theses 377 (refer to section 4.3.1) this could explain why the page range of (101 - 150) was the highest.

On the other hand for theses within the range of 201 and above pages the low figures could be due to the fact that the requirement by the School of Graduate Studies, University of Ghana for the number of pages for a Ph.D. thesis of Ghana is more than 200 pages and since the Ph.D. theses accounted for the minority of theses 37 (refer to section 4.3.1) this could explain why the page range of (201 and above pages) was the lowest.
5.7.2 Figures and Tables

The findings revealed that figures within the range of 1 - 15 tables had the highest number of theses with 179 counts whiles tables within the range of 16 - 30 had the highest number of theses with 297 counts.

One important finding observed was that the higher range of tables (16 - 30) had a higher number of theses (279) than the higher range of figures (1 - 15) with 179 theses. This preference could be due to the fact that postgraduate students prefer tables since they are able to organise raw data better for scientific research than figures.

5.7.3 Citations

The study revealed that the highest number of citations used by postgraduate students of SNAS in their theses was in 2010 with 5477 citations with 2009 having the lowest number of citations used with 1650 citations. This could be attributed to several factors among which are the number of theses published, the availability of information sources for the research topic and the subject area in which the program was done.

In a bid to find out the range of citations by postgraduate M.Phil. and Ph.D. students it was revealed that the highest number of M.Phil. postgraduate theses were within the range of 51 - 100 citations with 167 counts whiles the lowest number of M.Phil. postgraduate theses were within the range of 201 and above citations with 10 counts. Ph.D. theses on the other hand had the highest number of postgraduate theses within the range of 151 - 201 citations with 11 counts whiles the lowest number of Ph.D. postgraduate theses were within the range of 1 - 50 with 3 counts. The Ph.D. theses used a higher citation range than the M.Phil. theses. This difference could be as a result of the fact that the Ph.D. programme is a more rigorous academic
programme than the M.Phil. programme as it takes a longer period twice the M.Phil. programme to complete and students are also likely to consult more literature sources in doing their theses write-up which requires more pages than the M.Phil. programme.

5.8 Frequently Used Keywords Assigned By The Indexer

The finding disclosed that the top ten most used keywords assigned by the indexer (subject specialist) was as follows: radiation protection was the most assigned keyword with (189) counts. This was followed by radiation doses with (125) keywords, ions with (108) keywords, water with (86) keywords, doses with (80) keywords, Ghana with (71) keywords, neutron activation analysis with (68) keywords, risk assessment with (66) keywords, public health with (63) keywords and safety with (58) keywords.

The high frequency for the keyword (radiation protection) could be attributed to the fact that SNAS is designated as the IAEA Regional centre for training in radiation protection since October 2011 and this might have drawn interest from several postgraduate students from home and abroad who enrolled at SNAS to undertake research studies on the subject matter (radiation protection) thereby accounting for it been the most frequently indexed keyword by the indexer (subject specialist).

This finding is dissimilar to the findings by Kademani, Kumar, Sagar and Kumar (2006) who used a scientometric approach to study dimensions of nuclear science and technology research in India from 1970 - 2002 using the INIS database and found out that the most frequently assigned keyword by the indexer was gamma radiation with (4076) keywords.
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CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter provides an overview of the main research results, draws conclusion from the key findings and then offers a set of recommendations based on those main research findings. The study analysed 414 M.Phil. and Ph.D. theses publications by graduate students at SNAS, UG from (2008 - 2016) using the INIS database as the source of data.

6.2 Summary of Findings

The findings emanating from the study are summarised below.

6.2.1 Number of Graduate Student Theses By Year

An analysis of the number of graduate student theses by year revealed that the highest number of theses published at SNAS were in the years 2013 and 2015 with 63 counts each. The lowest number of theses published at SNAS was in 2008 with 19 counts and the average number of theses for each year was 46. The yearly pattern of theses published at SNAS also showed a constant rise and fall in the number of theses.

6.2.2 Academic Qualifications Awarded

An analysis of the (414) academic qualifications awarded at SNAS revealed that SNAS published more Master of Philosophy (M.Phil.) theses with 377 (91.06%) counts than the Doctor of Philosophy (Ph.D.) with 37 (8.93%) counts. The years 2013 and 2008 had the highest and lowest number of (M.Phil.) awards with 59 (15.64%) and 19 (5.03%) counts respectively.
The year 2014 had the highest number of Ph.D. awards with 10 (27.02%) counts while the years 2008, 2009 and 2012 recorded no Ph.D. awards.

6.2.3 Gender Distribution of Graduate Students

The results of the gender distribution of graduate students at SNAS revealed that Male students were four times the number of their female counterparts with 330 (79.71%) and 84 (20.29%) counts respectively. The highest number of male students graduated in 2013 and 2015 with 53 (16.06%) counts each while the lowest number of male students graduated in 2008 with 17 (5.15%) counts. The highest number of female students graduated in 2012 and 2016 with 17 (20.23%) counts each while the lowest number of female students graduated in 2008 with 2 (2.38%) counts. Ph.D. awards for male and female students were 32 (86.48%) and 5 (13.51%) counts respectively. On the other hand M.Phil. awards for male and female students were 298 (79.04%) and 79 (20.95%) counts respectively.

6.2.4 Distribution of Theses By Academic Department

The results of the distribution of theses by academic department at SNAS revealed that the Department of Nuclear Sciences and Applications had the highest number of theses with 134 (33.68%) counts while the Department of Nuclear Safety and Security had the lowest number of theses with 60 (14.49%) counts. With regards to the distribution of academic department by gender, the majority of male graduate students were in the Department of Nuclear Sciences and Applications with 109 (33.03%) counts whiles the minority, 41 (12.42%) counts were in the Department of Nuclear Agriculture and Radiation Processing. On the other hand the majority of female graduate students were in the Department of Nuclear Sciences and Applications and the Department of Nuclear Agriculture and Radiation Processing with 25 (29.76%) counts each whiles the minority, 10 (11.90%) were in the Department of Medical Physics. The majority,
119 (29.70%) of M.Phil. awards were from the Department of Nuclear Sciences and Applications whiles the minority 54 (14.71%) were in the Department of Nuclear Safety and Security. On the other hand for Ph.D. awards, 54 (14.71%) were from the Department of Nuclear Safety and Security whiles the minority 2 (5.40%) were from the Department of Nuclear Agriculture and Radiation Processing.

6.2.5 Subject Coverage of Theses

The results of the distribution of theses by academic department at SNAS revealed that Applied Life Sciences was the most researched subject area by postgraduate students with 82 (19.80%) counts whiles biomass fuels, instrumentation related to nuclear science and technology, mathematical methods and computing and petroleum were the least most researched subject areas with 1 (0.24%) count each. An analysis of the theses by qualification showed that for M.Phil. theses, applied life sciences was the most researched subject area with 78 (20.68%) counts whiles the least most researched subject areas were biomass fuels, instrumentation related to nuclear science and technology, mathematical methods and computing and petroleum with 1 (0.26%) count each. On the other hand for Ph.D. theses, environmental sciences was the most researched subject area with 9 (24.32%) counts whiles the least most researched subject area was chemistry including inorganic, organic, physical, analytical chemistry, radiochemistry and nuclear chemistry with 1 (2.70%) counts.

6.2.6 Page Range, Figures, Tables and Citations in Theses

The results of the page range, figures, tables and citations in theses at SNAS revealed that theses with a page range of 101 - 150 pages were the highest with 206 (49.75%) counts whiles theses with 201 and above pages were the lowest with 27 (6.52%) counts. The total number of pages for all the postgraduate theses was 51,403 pages with an average of 124.16. Theses with
figures within the range of 1 - 15 were the highest with 179 (43.23%) counts whiles theses having 46 and above figures were the least with 27 (6.52%) counts. Theses with tables within the range of 16 - 30 were the highest with 297 (71.73%) counts whiles theses having tables within the range of 31 and above been the least with 20 (4.83%) counts. The yearly breakdown of citations by year showed that theses published in 2010 used the highest number of citations with 5,477 whiles the year 2008 used the least number of citations with 1,650 citations. The total number of citations in the 414 M.Phil. and Ph.D. theses by postgraduate students was 35,648 citations with an average of 86.10 citations. M.Phil. theses with citations within the range of 51 - 100 and 201 and above citations recorded the highest and lowest number of theses with 167 (40.33%) and 10 (2.41%) counts respectively. On the other hand Ph.D. theses with citations within the range of 151 - 200 and 1 - 50 citations recorded the highest and lowest number of theses with 11 (29.72%) and 3 (8.10%) counts respectively.

6.2.7 Frequently Used Keywords Assigned By The Indexer

The results of the frequently used keywords assigned by the indexer revealed that out of the 414 theses retrieved from the INIS database, a total of 4960 keywords were assigned by the indexer with an average of 11.98 keywords per thesis. The top ten most used keywords assigned by the indexer was radiation protection with (189) keywords. The rest is radiation doses with (125) keywords, ions with (108) keywords, water with (86) keywords, doses with (80) keywords, Ghana with (71) keywords, neutron activation analysis with (68) keywords, risk assessment with (66) keywords, public health with (63) keywords and safety with (58) keywords.
6.3 Conclusion

The study analysed M.Phil. and Ph.D. theses publications by graduate students at SNAS, UG from (2008 - 2016) using the INIS database as the source of data. It is important that authorities from the University of Ghana, GAEC and the IAEA address issues emanating from the study which are affecting the running of the graduate school especially with regards to enrolment, academic degrees and gender inequality. Also, these recommendations would benefit the GAEC library tremendously and make it better placed to be more resourced to provide for the needs of its users including the academic faculty members and students at SNAS. Finally the activities of INIS will also be greatly enhanced and the visibility of the database greatly improved as well.

6.4 Recommendations

With regard to the outcomes of the study, the following recommendations are made:

6.4.1 Gaining Autonomy From The University of Ghana

The findings revealed that there was a constant fluctuation in the number of theses published at SNAS over the period. There were many Master of Philosophy (M.Phil.) theses published with few Doctor of Philosophy (Ph.D.) awards. Most of the academic faculty were trained at SNAS. Besides the laboratories and equipment used for practical training are also provided by GAEC. SNAS also has its own accommodation for students in place. It is therefore recommended that SNAS gains autonomy from the UG, the parent University by becoming an autonomous University. This will enable SNAS to run its own academic programs and take decisions that will benefit its smooth running and management in the long run. It will also help SNAS to accelerate the plans already in place for a nuclear power plant to be added to the
energy mix for Ghana. Again SNAS could also introduce non-science related programs in the future which could also boast enrolment. Autonomy will also help it to have control over the fees charged for the various academic programs and thereby making it reasonably affordable for the general public which will boost enrolment. Again, this will also benefit prospective Doctor of Philosophy (Ph.D.) students who previously couldn’t afford to pursue the program and also help to curb the loss of human resource expertise in the field. Finally, establishing an autonomous university would also help SNAS to collaborate better with the Nuclear Regulatory Authority (NRA) in fulfilling its mandate as a regulatory authority as SNAS would therefore become a centre to train personnel and issue certification as well as to create awareness and increase sensitization on nuclear safety, security, safeguards and radiation protection.

6.4.2 Introducing Nuclear and Allied Sciences Programs at The Undergraduate Level

To promote interest in the Nuclear and Allied sciences programs and meet the manpower needs of the country, SNAS could introduce undergraduate programs in Nuclear and Allied sciences field at the bachelor’s degree level. Relevant programs such as petroleum engineering, electrical and electronics engineering, computer engineering, materials engineering, civil engineering and mechanical engineering could be rolled out to add to the existing programs offered at SNAS. This could serve as an entry point for those interested in pursuing a career in the field and would go a long way to boost interest in the subject area at a lower academic level than what exists currently at the M.Phil. and the Ph.D. levels. Having these undergraduate programs will also help to increase enrolment at SNAS as well as increase the number of theses/dissertations records that Ghana processes and forwards to the INIS secretariat for input into the INIS database which will also improve the countries worldwide visibility in the nuclear sciences field.
6.4.3 Women Empowerment and Gender Equality

The findings revealed that the ratio of female students who pursued the M.Phil. and the Ph.D. programs at SNAS was not encouraging. It is therefore recommended that women should be made to play a more active role in the Nuclear Science field by encouraging them to pursue postgraduate programs within the field as well as teaching. Preference should also be given to females who don’t meet the cut-off point for the program in-take. Also organizing regular sensitization campaign programs, debates and quizzes especially in female dominated high schools and also at the Junior High School level to educate them on the subject area will also help to bridge the gender gap in the long run.

6.4.4 International Nuclear Information System

The INIS search interface allows for the selection of ten (10) records at a time and up to a combined total of 250 records for export into microsoft excel. This makes the selection of huge number of records cumbersome. To make the INIS database more flexible in selecting records, it is recommended that the INIS secretariat reviews this anomaly and make the selection of records user friendly by making it limitless.

6.4.5 Undertaking Research

There are about 67, 294 theses and dissertations publications that have been added to the INIS database from member states and organisations. However there is rarely any research that has been done by these member states and organisations to analyse these theses and dissertations publications sent to the INIS database. It is therefore recommended that INIS liaison officers from member states and organisations undertake bibliometric studies on theses and dissertations publications from their various centres thereby contributing to the body of
knowledge on bibliometric studies particularly in the field of nuclear science and technology worldwide.

6.4.6 Removing Copyright Obstacles

Due to copyright requirements, electronic copies of theses published at SNAS are sent to the digitization section of the Balme Library, University of Ghana for onward upload unto the Universities institutional repository before the links to these documents are added to the GAEC digital library. The GAEC library however sends the abstract of theses published at SNAS to the INIS secretariat in Vienna, Austria for onward submission to the INIS database. Users of INIS who find a preferred theses published at SNAS have to search the GAEC online digital library for links to the full text. This make accessibility to information cumbersome and complex. There is therefore the need for SNAS to gain autonomy which will benefit the GAEC library in having autonomy to be able to send the full text theses to the INIS database and also upload them directly onto its digital library to serve its user needs more efficiently.

6.4.7 Training of Indexers (Subject Specialist)

The subject specialists at the GAEC library who process records for Input onto the INIS database have to take advantage of training programmes such as the INIS training seminar and nuclear knowledge management programmes organised by the IAEA. This will practically help them to improve and develop their indexing skills better.

6.4.8 Resourcing The GAEC Library

An academic library cannot serve the needs of its faculty and students better without a well resourced library. SNAS has relied more on the Balme library at the University of Ghana as it is currently under the University. If SNAS gains autonomy from the University of Ghana it
will help to shift the central focus onto the GAEC library as the institutional library thereby helping the library to get the necessary resources required to operate as the Institutional library and provide for the needs of its users including the academic faculty members and students at SNAS.

6.4.9 Areas of Future Research

The study analysed M.Phil and Ph.D. theses publications at the SNAS, UG from (2008 - 2016) using the INIS database. Nevertheless, further studies could be done in the future to find out the preferred bibliographic forms for referencing theses by students at SNAS, UG. This study adopted the bibliometric method using the INIS database as source of data. It will be very interesting to subject this study to a manual document counting approach to compare the research findings. Also, it could be of interest in studying knowledge management practices at SNAS and GAEC.
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## APPENDIX

### THESES USED FOR THE STUDY

<table>
<thead>
<tr>
<th>No.</th>
<th>Title of Thesis</th>
<th>M.Phil./ Ph.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A comparative study between the performance characteristics of Optically Stimulated Dosimeters (OSL) and Thermoluminescence Dosimeters (TLD)</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>2</td>
<td>A comparative study of radiofrequency emission from roof top mobile phone base station antennas and tower mobile phone base antennas located at some selected cell sites in Accra, Ghana</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>3</td>
<td>A comparative study of the effect on irradiation and chemical preservatives on fresh-cut mangoes</td>
<td>M.Phil.</td>
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<tr>
<td>4</td>
<td>A comparative study of the use of radiation and other preservatives for the preservation of fresh snails (Achatina achatina and archachatina marginita)</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>5</td>
<td>A study on the properties of blended regenerated spent catalyst and cement sandcrete blocks</td>
<td>M.Phil.</td>
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<tr>
<td>6</td>
<td>A study to compare the motorised wedge output factor of an elekta synergy linear accelerator with reference data (TPS data)</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>7</td>
<td>A theoretical and experimental dose rate study at a multipurpose gamma irradiation facility in Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>8</td>
<td>A theoretical study of Copper-64 and Copper-67 production using cyclotron</td>
<td>M.Phil.</td>
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<td>9</td>
<td>A theoretical study of stopping power and range for low energy protons in some selected materials</td>
<td>M.Phil.</td>
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<tr>
<td>10</td>
<td>A theoretical study of the production of Technetium-99M (99MTC) using a Cyclotron</td>
<td>M.Phil.</td>
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<tr>
<td>11</td>
<td>Aerosols characterisation and pollution source apportionment in Aboesi Airshed: impact assessment</td>
<td>Ph.D.</td>
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<tr>
<td>12</td>
<td>Analysis and control of reactivity adjuster rods of a miniature neutron source reactor</td>
<td>M.Phil.</td>
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<tr>
<td>13</td>
<td>Analysis of macroscopic fluid flow in Ghana Nuclear Research Reactor -1 by computational fluid dynamics</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>14</td>
<td>Analysis of reactivity temperature coefficient for light water moderated HEU-UO14 and LEUO2 lattices of MNSR</td>
<td>M.Phil.</td>
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<td>No.</td>
<td>Title of Thesis</td>
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<tr>
<td>15</td>
<td>Analysis of residence time distribution using radioactive tracer technique for a waste treatment unit at Tema Oil Refinery</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>16</td>
<td>Analytical and numerical solution of standard k-e (Kinetic Energy and Dissipation ) equations for convective heat transfer in turbulent fluid flow in a tube</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>17</td>
<td>Anatomical, germination and in vitro studies on shea tree (Vitellaria paradoxa,) seed</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>18</td>
<td>Assessment of the shielding integrity of Co – 60 gamma- ray scanner at Aflao border, Ghana.</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>19</td>
<td>Assessing the Effectiveness of Limestone from Oterkpolu Area in the Eastern region of Ghana as a Suitable Adsorbent for Water Dechlorination</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>20</td>
<td>Assessing the levels of mercury in selected mining communities in the East Akim Municipality of Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>21</td>
<td>Assessment of a general methodology for the analysis of natural circulation stability with water at supercritical pressure</td>
<td>Ph.D.</td>
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<tr>
<td>22</td>
<td>Assessment of atmospheric aerosol content in Abuesi: a suburban Coastal community in Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>23</td>
<td>Assessment of Atrazine contamination in water and soil in Ghana: A preliminary study in the Yilo Krobo and Mfantsiman Districts</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>24</td>
<td>Assessment of atrazine levels in Kintampo-North and Techiman municipalities in the Brong Ahafo Region of Ghana</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>25</td>
<td>Assessment of Bivalves as potential bioindicator of heavy metal pollution along Ghana's coast using Instrumental Neutron Activation Analysis</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>26</td>
<td>Assessment of black carbon concentrations in ambient air due to the use of biomass for cooking in the Kassena-Nankana East District of the Upper East Region</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>27</td>
<td>Assessment of changes in the aroma and sensory profile of dawadawa due to modification in fermentation conditions</td>
<td>M.Phil.</td>
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<tr>
<td>28</td>
<td>Assessment of design and shielding in some selected conventional x-ray and computed tomography (CT) facilities in Burkina Faso</td>
<td>Ph.D.</td>
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<tr>
<td>29</td>
<td>Assessment of doses from natural radioactivity levels in different species of timber from some parts of the Western Region of Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>30</td>
<td>Assessment of gamma irradiation heating and damage in miniature neutron source reactor vessel using computational methods and SRIM - TRIM code</td>
<td>M.Phil.</td>
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<td>Title of Thesis</td>
<td>M.Phil./Ph.D.</td>
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<tr>
<td>31</td>
<td>Assessment of health risks due to toxic metals and naturally occurring radioactive materials in the Birim river in East Akim Municipality of the Eastern Region Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>32</td>
<td>Assessment of heavy metal concentrations in water, sediment and biota (fish and crabs) samples from the Densu Delta</td>
<td>M.Phil.</td>
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<tr>
<td>33</td>
<td>Assessment of heavy metal contamination of dust at some selected fuel filling stations in Accra</td>
<td>M.Phil.</td>
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<td>34</td>
<td>Assessment of heavy metal contamination, levels in topsoil at selected auto-workshops in Accra, Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>35</td>
<td>Assessment of heavy metals introduced into food through milling process: health implications</td>
<td>M.Phil.</td>
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<tr>
<td>36</td>
<td>Assessment of indoor radon activity concentration levels in two districts of the Upper West region of Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>37</td>
<td>Assessment of levels of inhalable particulate matter in ambient air at Legon-Adenta road construction site</td>
<td>M.Phil.</td>
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<td>38</td>
<td>Assessment of levels of mercury in human breast milk in Obuasi Municipality</td>
<td>M.Phil.</td>
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<td>39</td>
<td>Assessment of levels of occupational exposure to electromagnetic fields to workers in television stations in Accra-Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>40</td>
<td>Assessment of levels of occupational exposure to extremely low frequency electric and magnetic fields in data centres in Greater Accra Region - Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>41</td>
<td>Assessment of levels of occupational exposure to magnetic fields and ultraviolet radiation among welders in Greater Accra Region - Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>42</td>
<td>Assessment of mean glandular dose to patients from digital mammography systems</td>
<td>M.Phil.</td>
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<td>43</td>
<td>Assessment of mercury levels in different environmental matrices in communities impacted by artisanal gold mining in the Asutifi District of Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>44</td>
<td>Assessment of naturally occurring radioactive materials and trace elements in playgrounds of selected basic schools in the Ga-East municipal district, Accra, Ghana</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>45</td>
<td>Assessment of occupational and public exposures due to natural radioactivity in saline water, saline soil and salt from Panbros Salt Industry Limited in the Greater Accra Region of Ghana</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>46</td>
<td>Assessment of organochlorine pesticides and atrazine residues in Maize Produced in Ghana using GC-ECD/ GC-MS</td>
<td>M.Phil.</td>
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<tr>
<td>47</td>
<td>Assessment of productivity and water use efficiency in three maize (zea mays L.) varieties in Kwabenya-Atomic area</td>
<td>M.Phil.</td>
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<tr>
<td>48</td>
<td>Assessment of public and occupational exposure to extremely low frequency fields within the vicinity of electricity transmission substations in the Greater Accra Region of Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>49</td>
<td>Assessment of radiation dose due to fluoroscopic procedures in patients at some selected facilities in the Greater Accra Region, Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>50</td>
<td>Assessment of radiation dose to patients during Single Photon Emission Computed Tomography (SPECT) 99m Tc-Sestamibi Myocardial Perfusion Imaging (MPI)</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>51</td>
<td>Assessment of radiation doses to patients undergoing digital x-ray In orthopaedic examination at the radiology department, Korle Bu Teaching Hospital</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>52</td>
<td>Assessment of radiation leakage from microwave ovens in some selected homes in the Greater Accra Region of Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>53</td>
<td>Assessment of scintigraphic image quality in Single Photon Emission Computed Tomography (SPECT) using jaszczak phantom</td>
<td>M.Phil.</td>
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<tr>
<td>54</td>
<td>Assessment of the effect of beam modifiers on skin dose for external beam radiotherapy using Gafchromic EBT2 film</td>
<td>M.Phil.</td>
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<tr>
<td>55</td>
<td>Assessment of the effect of washing and boiling on the levels of pesticide residues in vegetables cultivated in Akuapem North Municipality</td>
<td>M.Phil.</td>
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<tr>
<td>56</td>
<td>Assessment of the level of environmental pollution due to leachate migration from the closed Mallam SCC waste disposal site Accra-Ghana</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>57</td>
<td>Assessment of the levels of N-(Phosphonomethyl) glycine glyphosate in selected glyphosate-based herbicides on the Ghanaian market</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>58</td>
<td>Assessment of the properties of disused sealed radioactive sources for disposal in a borehole facility</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>59</td>
<td>Assessment of the reliability of thermal-hydraulic and neutronics parameters of Ghana research reactor-1 control systems</td>
<td>M.Phil.</td>
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<tr>
<td>60</td>
<td>Assessment of the structural shielding integrity of some selected computed tomography facilities in the Greater Accra Region of Ghana</td>
<td>M.Phil.</td>
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<tr>
<td>61</td>
<td>Assessment of waste management options in the oil and gas industry in Ghana using nuclear analytical techniques</td>
<td>M.Phil.</td>
</tr>
<tr>
<td>62</td>
<td>Assessment of water quality of the Odaw river catchment using hydrochemistry and stable isotope techniques</td>
<td>M.Phil.</td>
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<td>63</td>
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