

Utilisation of Grey Literature by Researchers of Chemistry in a Nigerian University: A Citation Study

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Abstract

The study aimed at investigating the use of grey literature by postgraduate students of chemistry in Nnamdi Azikiwe University (NAU), Awka. A total of 85 theses submitted to the Department of Chemistry library from 2013 to 2022 were analysed. Six objectives relevant in exploring the utilisation of grey literature by researchers of chemistry were formulated. The research design adopted in this study was bibliometric research design. The findings of the study revealed that out of 4740 citations obtained from the 85 theses, 1380 (29.11%) citations were made to grey literature. It was observed that citations to grey literature increased rapidly in recent time with 89.35% increase. Conference and seminar papers were the most cited sources out of the eleven kinds of grey literature cited. The most cited grey document was World Health Organization report paper with 67 (29.52%) citations. The finding of the study also showed that postgraduate students of chemistry use current material with medium age of 8.35 years. Citations to foreign contributions amount to 644 (27.54%). In conclusion, emphasis was laid on the need for the University Library to gear efforts towards providing adequate current grey literature for teaching and research of Department of Chemistry.

Keywords: Grey Literature, Citation Analysis, Postgraduate Theses, Chemistry Research, Information Sources and University Libraries

Introduction

Research is a vital activity in every field of study. A meaningful or worthwhile research hinges on already existing literature. Researchers are expected to cite all

sources relevant to their work as an acknowledgement to researchers who preceded them. Citation is a reference to published or unpublished work. According to Thomson (2014), citations are the references researchers appended to their works to explicitly show earlier work which they have depended on to conduct their own investigations. These lists of cited works are indicators of importance and can be useful when analysed.

Citation analysis is a mathematical analysis of list of references appended at the end of every information material. According to Regent (2015), citation analysis is the study of the impact and assumed quality of an article, an author or an institution based on the number of times works and/or authors have been cited by others. Citation analysis is performed by counting the number of times a paper or researcher is cited (Meho, 2007). This is based on the assumption that influential scholars and important papers are cited more than others.

Citation analysis is an unobtrusive method that can often be carried out with readily available data (Haffmann & Doucette, 2012). In conducting citation analysis, citation data can be sourced from Web of Science (WOS) citation indexes, Scopus, Google Scholar or databases specific to the subject of research. Some sources however are often inadequately referenced in these databases. They remain unseen to researchers, academics, and students (Kuburat, 2011). These sources form part of the academic library collections because they are highly useful and impactful information sources for researchers and innovators. These sources are referred to as grey literature.

Grey literature has been described from different perspectives. Chilag (1982) and Wood (1984) defined grey literature as all categories of unconventionally

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published material. On the other hand, Auger (1989) sees it as semi-published literature which is not formally listed or priced, but is nevertheless in circulation. Farace (1997), during the Third International Conference on Grey Literature in Luxembourg defined grey literature as that which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers. During the 12th International Conference on Grey Literature held in Prague in 2010, a more widely and currently used definition of grey literature was drafted. It stated that Grey literature stands for manifold document types produced on all levels of government, academics, business and industry in print and electronic formats that are protected by intellectual property rights, of sufficient quality to be collected and preserved by library holdings or institutional repositories, but not controlled by commercial publishers, i.e., where publishing is not the primary activity of the producing body (Schöpfel & Farace, 2010). In the context of this study, grey literature may be seen as print or electronic information resources which are unconventionally or semi-conventionally published and are not available through normal book selling channels.

Information sources that are classified as grey literature include health, scientific, technical, economic, social, and other reports developed in national and private institutions, unpublished conference materials, standards/patents/technical specifications and recommendations, statistical resources, discussion/working papers, factsheets, promotion/advertising/commercial documentation, preprints, preliminary progress and advanced reports, research memoranda, posters, (Rucinski, 2015; Nahotko, 2014; Fatokun & Amusa, 2014; Siegel, 2010). Besides these, they also include unpublished manuscripts, newsletters, academic courseware, laboratory research books, lecture notes, field note and many more. These documents possess common characteristics. According to Omeje (2010) grey literature has the following characteristics: they are unconventionally published, they are not usually available through the conventional sources of book supply, they are not covered by secondary bibliographic services such as indexes, abstracts and bibliographies,

they are difficult to find and acquire. Grey literature contains important scientific and technical information that is rare to be found elsewhere.

Grey literature publications are important materials that libraries (especially academic libraries) should acquire to support research. Although not peer reviewed in most cases, they promote advancement of knowledge and contribute greatly to national development. They are occasionally the sole source for specific research questions (Upex, Terna & Beetseh, 2018). The lack of descriptive referencing and inadequate circulation is therefore a real problem for scientific communication.

There is need, therefore, for university libraries to capture as many locally produced and foreign grey literatures as possible for their parent institutions, regardless of their forms and formats. Citation analysis offers a tremendous range of grey resources. Analysis of citations of post graduate theses will go a long way in identifying grey literature used by researchers. Zipp (1996) indicated that the data derived from research on graduate students provide more than a valuable insight into students' research behaviour. This study, therefore, analysis citations in postgraduate theses of department of Chemistry Nnamdi Azikiwe University, Awka to investigate the use of grey literature by postgraduate students.

Purpose of the Study

The general objective of the study is to investigate the use of grey literature by postgraduate students of department of chemistry in Nnamdi Azikiwe University, Awka. Specifically, the research sought to determine:

- The proportion of cited grey literature in postgraduate theses of Department of Chemistry Nnamdi Azikiwe University, Awka.
- The chronological distribution of citations to grey literature.
- Type of grey literature cited in postgraduate theses of Department of Chemistry.
- Most cited grey materials in postgraduate theses of Department of Chemistry.
- Age of cited grey literature.
- The citations of foreign contributions in postgraduate

theses of Department of Chemistry.

Literature Review

Use of Grey Literature by Postgraduate Students

Information is the pivot upon which the survival of any society rests. It remains the major ingredient in taking decision; and assist in reducing the degree of uncertainty (Okiki & Asiru, 2011). The type of information a user needs depends on the user of the information. Postgraduate students and researchers use a wide range of grey literature for their research. Grey literature often used by postgraduate students includes magazines, conference and seminar papers, report papers, government publications, newspaper, newsletters, theses and dissertations. These sources may be available in print, electronics or audio-visual formats.

The various kinds of grey literature are used by postgraduate students for diverse purposes. Iwara (2015) revealed that newspapers/magazines are used by the respondents (postgraduate students) to find information on diverse facet of the economy such as vacancies, sports, national and internal news as well as literature for academic purpose while theses and dissertations on the other hand serve as guide for academic discourse. Bulletins which contain important reports on new innovations in agriculture are used by researchers in agricultural science to improve the life of peasant farmers while newsletters which convey information that promotes wildlife and natural resources conservation are used by conservation biologist to carryout research for greater environmental awareness.

A good number of grey sources are frequently used by post graduate students to support research. According to Copper, Marsolek, Riegelman, Farrell and Kelly (2019) grey literature in its various forms is produced and utilised by researchers across the disciplines in the sciences, social sciences, and arts and humanities. Findings by Upev, Terna and Beetseh (2018) revealed that calendars and newspapers are accessed at great extent by Postgraduate Students of University of Agriculture Makurdi. Chalabi (2013) in his study asserted that researchers in physics, chemistry and computer science in university of science and technology, Houari Boumediene make greater use

of conference papers for their research. Omeje (2010) expressed similar view as he ascertained that science and technology researchers predominantly use theses, conference papers and technical reports for research.

The use of grey literature by researchers differs from discipline to discipline (Schöpfel, 2010; Chalabi, 2012). Chalabi (2013) revealed that higher level citation of grey literature comes from computer science and the least from chemistry. According to him, the difference is due to the characteristics of information research for each discipline. Muhammad (2014) expresses similar view as he revealed that in technological fields like aeronautics and engineering, grey literature used may include contractor reports, technical reports, product codes and standards, special publications, handbooks and patents that are useful to coordinate activities... In geological and geophysical science, maps and fossil records are among the grey sources used by geologists to support their research.

The modern process of scholarly communication relies heavily on published articles and grey literature. The use of these information sources, however, depends on the extent to which they are made available and accessible. It is relatively difficult to locate, acquire, and access grey sources. Kanu, Agu and Egwuonwu (2020) stated that grey literature resources are produced in high number in Nigerian tertiary institutions, governmental and non-governmental organisations but yet, they are in limited circulation even within the institutions where they are produced. Moreover, neither WOS nor Scopus provide extensive coverage of grey literature. They were not designed to record and track grey literature. Hlwiki, (2012) ascertained that grey literature is difficult to locate or identify they are often locked deep within the 'hidden or invisible' web. There is need, therefore, for university libraries to acquire adequate number of locally produced and foreign grey literature for teaching and research, regardless of their forms and formats.

Empirical Studies

Gupta and Sharma (2021) studied Citation analysis of grey literature in Social Science ETDS submitted in two state universities of Haryana, India from 2011 to 2018. Out of 14,547 citations from 43 different forms of sources, 4606 (31.66%) citations were made from 40 different forms

of grey literature. Report paper was the most cited grey sources with 1344 (9.23%) of total citation and 29.18% of grey literature citation. This is followed by government publication.

Woods et al. (2020) investigated the prevalence and types of grey literature citations in top nursing journals published in 2011 in six top nursing journals selected from the selected List of Nursing Journals. Grey literature made 10.40%. Government publications were cited most with 54.3% citations. This is followed by publications from corporate organisations with 26.8% citations.

Venugopal and Mulla (2018) carried out a study titled Citation Analysis of Grey Literature, Reflected in Dissertations of Library and Information Science during the period 2012–2016. A total of 878 (65.47%) citations out of 1341 citations were made to grey literature. Dissertations were cited most with 203 citations. The second most used Grey Literature is Conference papers accounting to 198 citations. The least used Grey Literature was Government Publications with three citations.

Usman et al. (2017) carried out a bibliometric study on the use of grey literature in the Savannah Journal of Agriculture from 2006 to 2013 excluding those of 2007 and 2010. A total of 2422 citations were analysed out

of which, 693 (28.6%) were grey literature. The year 2011 has the highest (34.7%) of use of grey literature. Conference proceeding was the most used type of grey literature followed by institution repository with 146 (21%).

Methods

The design of the study was bibliometric research design using citation analysis method. The population of the study comprises all the 85 masters theses submitted to the Department of Chemistry, Nnamdi Azikiwe University Awka from 2013 to 2022. Department of Chemistry was purposively chosen because it is a wide area of study and being one of the oldest departments, has produced a reasonable number of master students. Data were collected from citations documented as references in the theses. In order to achieve this, the researcher had to photocopy all the reference pages in the 85 masters theses submitted in the library. The researcher's designed instrument titled "Citation Analysis of Chemistry Theses Document Analysis Guide (CAICTDAG)" was used to record the citations in these theses based on the research questions that guided the study. The citation was manually counted and was analysed using MS Excel. The data were analysed using descriptive statistics of measures of central tendency, frequency distribution and percentages.

Data Analysis and Results

Table 1: Proportion of Cited Grey Literature in Postgraduate Theses of Department of Chemistry

Sources	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total	%
Grey Literature	31	65	79	87	79	156	152	158	282	291	1380	29.11
Other Sources	214	220	320	329	316	334	331	421	437	438	3360	70.89
Total	245	285	399	416	395	490	483	579		729	4740	100

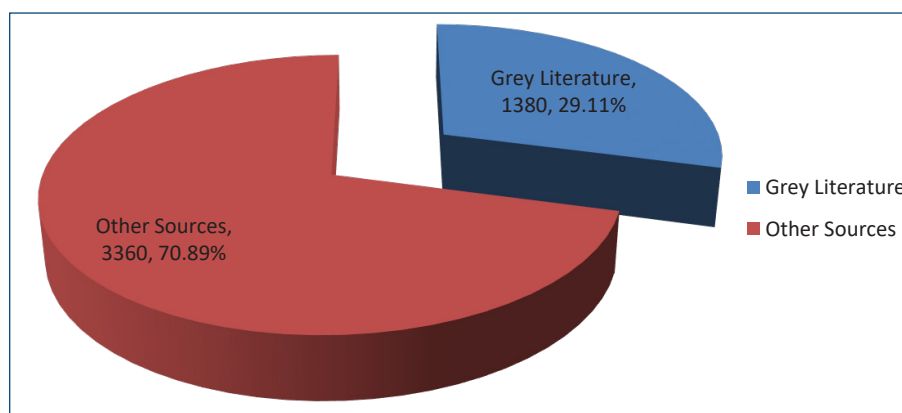


Fig. 1: Pie Chart Showing Proportion of Cited Grey Literature

Table 1 and Fig. 1 show proportion of cited grey literature in postgraduate theses of Department of Chemistry. It could be observed from Table 1 and Fig. 1 that out of 4740

citations, grey literature yielded 1380 (29.11%) citations. Citation to other information sources was 3360 (70.89%).

Table 2: The Chronological Distribution of Citations to Grey Literature

Sources	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
Total	31	65	79	87	79	156	152	158	282	291	1380
%	2.25	4.71	5.72	6.30	5.72	11.30	11.02	11.45	20.44	21.09	100

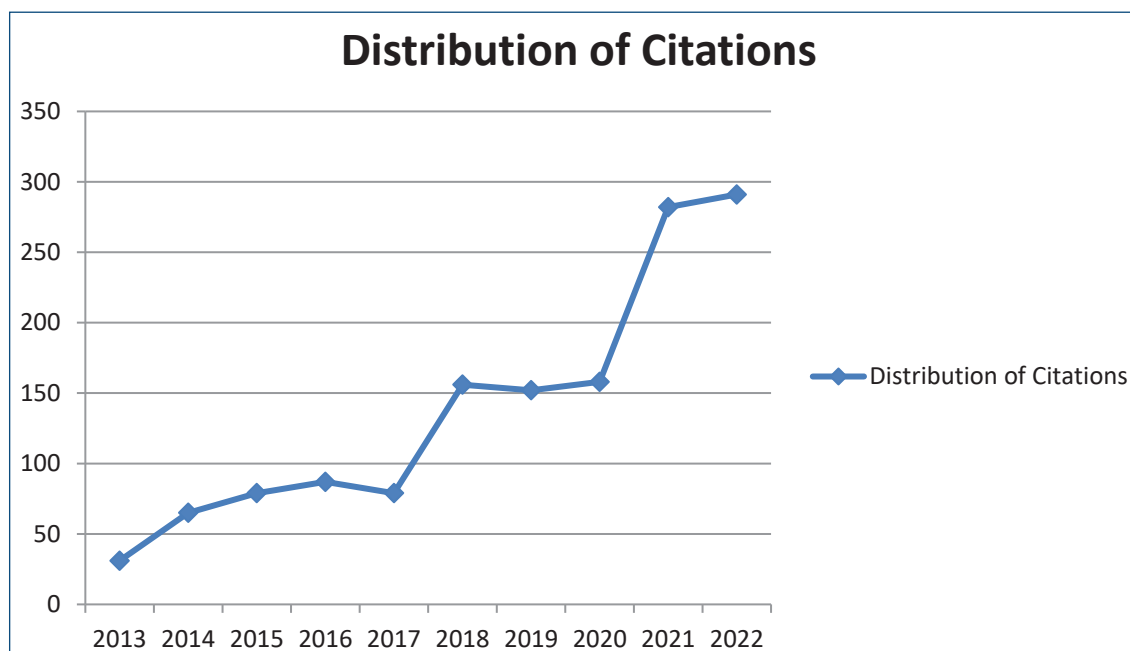


Fig 2: Line Graph Showing Increase in Citations Over Years

Table 2 and Fig. 2 show the chronological distribution of citations to grey literature. It could be observed that citations to grey literature rose swiftly in recent years. For instance, there was significant rise in citation in 2018 and

2021 from 79 to 156 and from 158 to 282, respectively. As a result of that, the percentage increase in citation within the study period rapidly climbed to 89.35%.

Table 3: Type of Cited Grey Literature in Industrial Chemistry Postgraduate Theses

Grey Sources	Con. & Seminar	Gov. Pub	Report Paper	These	Review Paper	Workshop Paper	Lect. Note	Newspaper	Newsletter	Total
No	432	250	227	164	140	86	35	28	182	1380
%	31.30	18.12	16.45	11.88	10.14	6.23	2.54	2.03	13	100

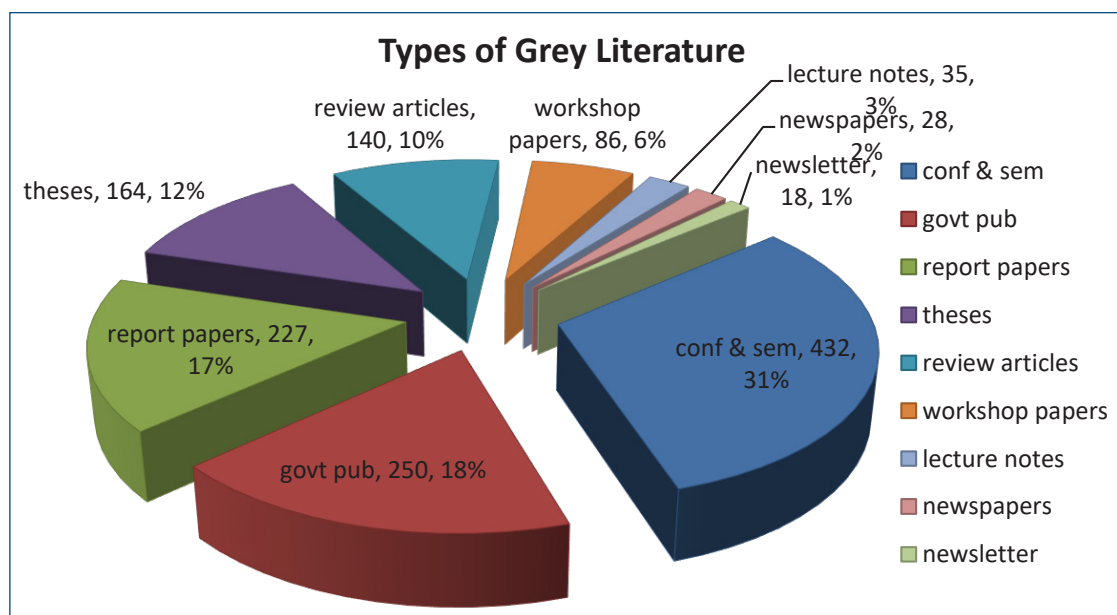


Fig. 3: Pie Chart Showing Types of Cited Grey Literature

Table 2 and Fig. 2 show the type of grey literature cited in postgraduate theses of Department of Industrial Chemistry. It could be observed from Table 2 and Fig. 2 that the grey literature used by postgraduate students of Department of Chemistry includes conference proceedings, seminars papers, Government publications, reports papers, theses and dissertations, review papers, workshop papers, newspapers, lecture notes and newsletters.

Conference proceedings/seminars papers produced 432 (31.30%) citations. This is followed by government publications with 250 (18.12%) citations. Citations to report papers, dissertations and reviews were 227 (16.45%), 164 (11.88%) and 140 (10.14%), respectively. While citations to workshops papers, newspapers and lecture note were 86 (6.23%), 35 (2.54%) and 28 (2.03%), respectively. The least citations were made to Newsletter with 18 (1.30%).

Table 4: Most Cited Grey Materials in Postgraduate Theses of Department of Chemistry

Sr. No.	Conference /Seminar Papers	No of Citation	%
1	Proceedings of the 2 nd Beijin International Symposium	30	6.94
2	Proceedings of Chemical Society of Nigeria Lagos	27	6.25
3	28 th International Conference of Chem Society of Nigeria	26	6.02
4	30 th International Conference of Chem Society of Nigeria	25	5.79
5	International Conference on Climate Change and Economic Sustainability, NAU	24	5.56
6	International Pulp Bleaching Conference, TAPPI	21	4.86
7	Proceedings of VIII International Congress, Belgium	18	4.17
8	Proceedings of 2 nd International Congress on Polymer science	15	3.47 9
9	4 th International Conference on the Chemistry of Cement	13	3.01 10
10	The Proceedings of SPPM, Dhaka	11	2.55
Government Publications			
11	Publication of Federal Ministry of Environment, Nigeria	23	9.2
12	Intergovernmental Panel on Climate Change (IPCC), United Nation's Publication	21	8.4
13	American Public Health Association (APHA) Publication	19	7.6

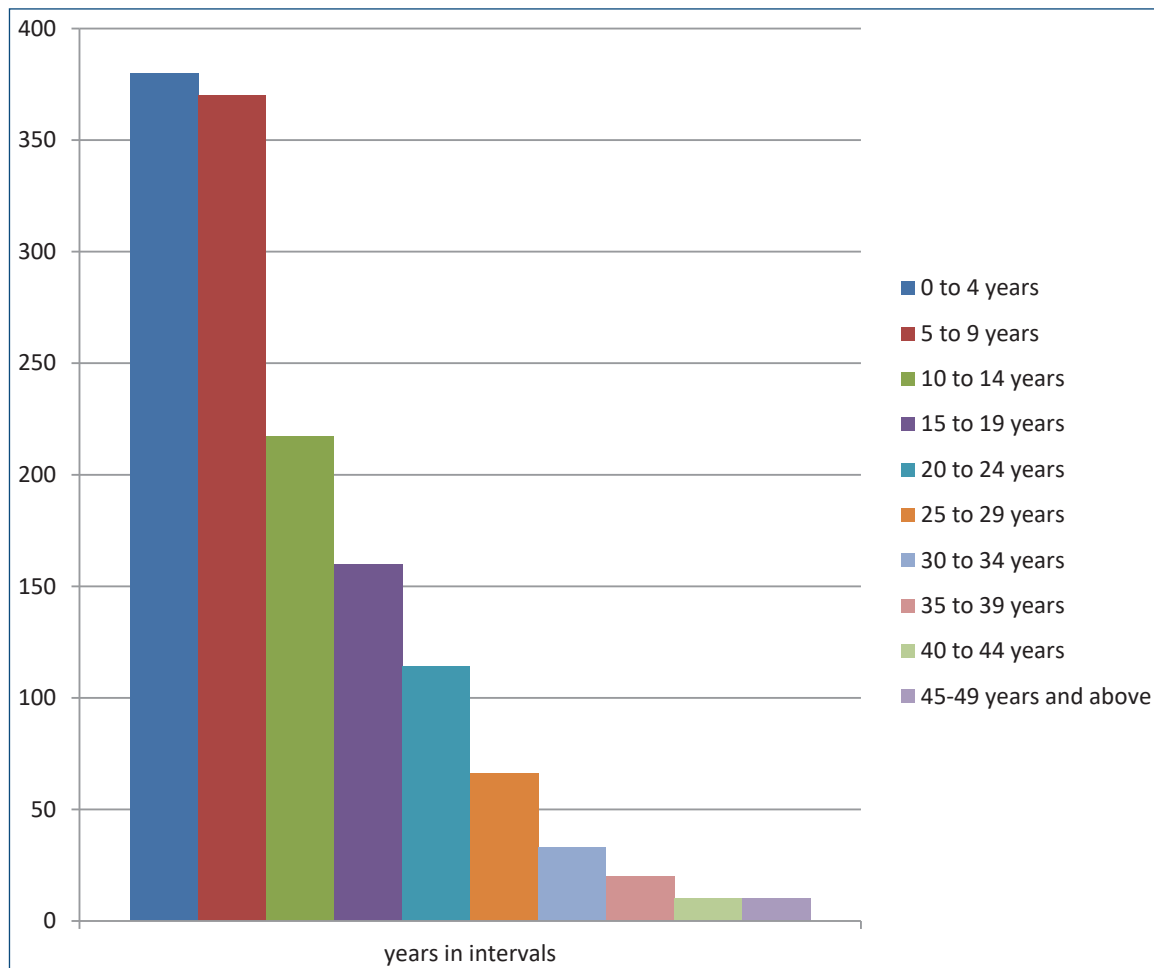
Sr. No.	Conference /Seminar Papers	No of Citation	%
14	American Public Health Association (APHA) Publication	19	7.6
15	Environmental Protection Agency Decree, Federal Government		of
Nigeria Publication		17	6.8
16	National Agency for Food Drug Administration and Control (NAFDAC) Publication, Nigeria	16	6.4
17	Publication of Nigerian Env'tal Study Team (NEST), Ibadan	12	4.8
Report papers			
18	World Health Organization Technical Report	67	29.52
19	International Agency for Research on Cancer (IARC) Report	22	9.69
20	Water Resource Investigation Report	22	9.69
21	United State Environmental Protection Agency (USEPA) Report	17	7.49
22	Report of National Toxicology Programme (NTP)	14	6.17
23	Technical Report Series	13	5.73
Theses and Dissertations			
24	Master of Science Degree thesis on Quantitative Determination of Biogas Composition from Organic Waste and Physiochemical Analysis of Waste. Industrial Chemistry Department, NAU Awka	3	19.51
25	Master thesis on Chemical Analysis of Some Natural River Waters in Imo State. Department of Industrial Chemistry, Imo State University Okigwe, Nigeria	26	15.85
26	Master thesis on Shallow Wells as Supplementary Sources of water in Jos, Nasawara State, Nigeria. Department of Sociology and Planning University of Jos,	22	13.41
27	Physiochemical Parameter of Water and Heavy Metals content of water from Qua Ibo River Estuary. Industrial Chemistry Department, University of Uyo	12	7.32
Review papers			
28	Review of the United Kingdom National Air Quality Strategy	16	11.43
29	Chemical Society Review	14	10.00
30	Co-Ordination Chemistry Review	14	10.00
31	A Review of Materials Letters	11	7.86
Workshop Paper			
32	Workshop Paper Presented at the Society of Chemical	11	12.79

Table four shows most cited grey literature. Sources that had more than ten citations were selected from the list of cited grey literature as the most cited sources (see Appendix C). From the table, the World Health Organization Technical Report ranked 1st with 67 (29.52%) citations. This is followed by Master of Science Degree thesis on Quantitative Determination of Biogas Composition from Organic Waste and Physiochemical Analysis of Waste, Department of Industrial Chemistry, NAU Awka with 32 (19.51%) citations. *Proceedings of the 2nd Beijing International Symposium* ranked 3rd with 30

(6.94%) citations, followed by *Proceedings of Chemical Society of Nigeria Lagos* with 27 (6.25%) citations. The 5th ranked grey materials were 28th International Conference of Chemical Society of Nigeria and Master Thesis on Chemical Analysis of Some Natural River Waters in Imo State Department of Industrial Chemistry, Imo State University, Nigeria. The 7th and 8th most cited grey materials were 30th International Conference of Chemical Society of Nigeria and International Conference on Climate Change and Economic Sustainability, NAU with 25 (5.79%) and 24 (5.56%) citations, respectively.

Table 5: Age of Cited Grey Literature

Age in Interval	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	Total
Total	380	370	217	160	114	66	33	20	10	10	1380
Percentage	27.54	26.81	15.72	11.59	8.26	4.78	2.39	1.45	0.72	0.72	100

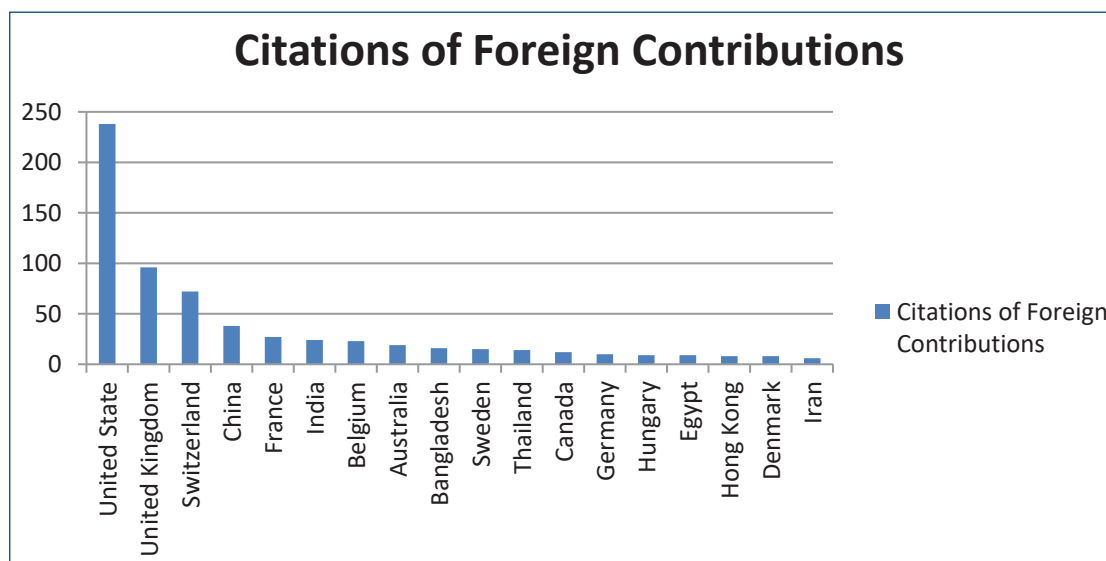
**Fig. 4: Bar Chart Showing Age of Cited Grey Sources**

It could be observed from Table 5 and Fig. 4 above that the highest citation was recorded between 0 and 4 years (less than 5 years) with 380 (27.54%) citations. Citation to grey resources of 5–9 years was 370 (26.81%), while 10–14 years grey sources were cited 217 (15.72%) times.

Grey sources of 15–19 and 20–24 years were cited 160 (11.59%) and 114 (8.26%) times, respectively while grey sources older than 24 years had 10.08% citation. The mean age of cited grey literature was 11.34 years while the medium age was 8.35 years.

Table 6: The Citations of Foreign Contributions in Postgraduate Theses of Department of Chemistry

Sr. No.	Country	Citation	%
1	United State	238	36.96
2	United Kingdom	96	14.91
3	Switzerland	72	11.18
4	China	38	5.90
5	France	27	4.19
6	India	24	3.73
7	Belgium	23	3.57
8	Australia	19	2.95
9	Bangladesh	16	2.48
10	Sweden	15	2.33
11	Thailand	14	2.17
12	Canada	12	1.86
13	Germany	10	1.55
14	Hungary	9	1.40
15	Egypt	9	1.40
16	Hong Kong	8	1.24
17	Denmark	8	1.24
18	Iran	6	0.93
	Total	644	100

**Fig. 5: Bar Chart Showing the Citations of Foreign Contributions**

It could be observed from Table 6 and Fig. 5 that out of 1380 citations to grey resources, 644 (46.67%) citations were made to foreign countries. United State contributed most in postgraduate theses of the Department of Chemistry NAU, Awka with 238 (36.96%) citations. This is followed by United Kingdom with 96 (14.91%) citations.

Switzerland ranked 3rd with 72 (11.18%) citations followed by China with 38 (5.90%) citations. France ranked 5th position with 27 (4.19%) citations. India and Belgium ranked 6th and 7th positions with 24 (3.73%) and 23 (3.57%) citations, respectively. Less than 20% citation was made to other nations.

Summary of Findings

- The findings of the study show that out of 4740 citations made in postgraduate theses of Department of Chemistry, grey literature yielded 1380 (29.11%) citations.
- There was rapid increase in citation to grey literature in recent years. The percentage increase within the period of study was 89.35%.
- The grey literature used by postgraduate students of Department of Chemistry were conference and seminar papers, government publications, Report papers, theses and dissertations, review articles, workshop papers, lecture notes, newspaper and newsletters. Conference and seminar papers yielded the highest number of citations 432 (31.30%). This is followed by government publications with 250 (18.12%) citations. Report papers ranked 3rd with 227 (16.45%) citations.
- The most cited grey material is a report paper titled *World Health Organization Technical Report* with 67 citations and 29.52% citations. This is followed by *Master of Science Degree thesis on Quantitative Determination of Biogas Composition from Organic Waste and Physiochemical Analysis of Waste, Department of Industrial Chemistry, NAU Awka* with 32 (19.51%). *Proceedings of the 2nd Beijin International Symposium* ranked 3rd with 30 (6.94%) citations.
- Grey materials of 0–4 years (less than 5 years) were cited most with 380 (27.54%) citations. Grey materials of 5–9 years had 370 (26.81%) citations. The mean age of cited grey sources was 11.34 years while the medium age was 8.35 years
- Out of 1380 citations to grey resources, 644 (46.67%) citations were made to foreign countries. United State contributed most in postgraduate theses of the Department of Chemistry NAU, Awka with 238 (36.96%) of foreign citations. This is followed by United Kingdom with 96 (14.91) citations. Switzerland ranked 3rd with 72 (11.18%) of foreign citations followed by China with 38 (5.90%) citations.

Discussion of Findings

It could be observed that postgraduate students of Chemistry NAU, Awka make significant (29.11%) use of grey literature, this is in line with the findings of Omeje (2010) who reported that grey literature are significantly used by researchers of science and technology. This may be as a result of the nature of their research which is quite different from those of arts and humanities.

Findings of the study also revealed that conference and seminar papers yielded the highest number of citations with 432 (31.30%) citations. This finding is in line with earlier findings of Chalabi (2013) and Omeje (2010) among others who observed that conference papers are the dominant source of grey literature. The reason may be because some conference proceedings are peer reviewed, indexed and published. Moreover, conference proceedings are considered important primary source of information in science and they are in many cases highly important for promotion and tenure. Also, there are a number of databases which contain details (and occasionally the full-text) of papers from academic conferences (Kanu, Agu & Egwuonwu, 2020). The findings also revealed that citation to government publications was fairly significant with 250 (18.12%) citations. This implies that Chemistry researchers also consider government publications useful for scholarly research.

Interestingly, postgraduate students of Chemistry prefer relatively current grey materials since the medium age of cited grey sources was 8.35 years. This is consistent with the findings of Kimball, Stephens, Hubbard and Pickett (2013) who observed that science researchers cite newer publications frequently.

Conclusion

Grey literature is important materials that academic libraries should acquire to support teaching and research. They promote advancement of knowledge and contribute greatly to national development. The study provides insight into all kinds of grey literature used by postgraduate students of chemistry Nnamdi Azikiwe University, Awka. Efforts should therefore

be geared towards provision of frequently cited grey sources for chemistry research. There is also need to provide researchers in Chemistry with more current grey materials needed for research.

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