



# **ANALYSIS OF MECHANICAL ENGINEERING RESEARCH ACTIVITIES USING BIBLIOMETRIC METHOD: A CASE STUDY OF UNDERGRADUATE PROJECTS**

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## **ABSTRACT**

*This study investigated the citation pattern of Mechanical engineering students in Landmark University, Nigeria. Bibliometric method was adopted, the study covered research projects submitted from 2015 to 2018. All the references of the research projects were examined one after the other and the different types of cited materials were recorded according to the year. It was discovered that the citations was high and multiple authored projects accounted for the highest citations. The results also shows that the citations on the projects increased on yearly basis. It was also revealed that journal articles accounted for the highest number of cited documents, it was also revealed that most of the cited materials are recent. Similarly, the results also shows that the students preferred to cite multiple authored materials, it was also discovered that the degree of collaboration by the students varies. Based on this research, the paper concluded that researchers should continue to investigate this aspect of research so as to improve the research output of the undergraduate projects.*

**Keywords:** Bibliometric Analysis, Research Projects, Undergraduate Students, Mechanical Engineering, Landmark University, Nigeria.

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## 1. INTRODUCTION

Recent studies have established that engineering, especially mechanical and civil engineering undergraduates engaged some other sources of information apart from journals, books and conference proceedings while book consultation is significant among electrical engineering undergraduates (Brush 2015) [4]. Undergraduate students might have had exposure to research culture in the course of their studies but the apparent exercise of understanding of research is usually tested through the project they embark upon at the final year (Aregbesola, Owolabi, Eyiolorunshe, &Idiegbeyan-ose, 2018; Ilo, Idiegbeyan-ose, Adebayo &Osinulu 2015) [2, 10] Information seeking behavior and information literacy are cardinal in any research endeavor. These skills guide researchers to know relevant resources to be used and the ease of locating them. When students do not know how to search for relevant publications and authors, it may lead to insertion of spurious authors. Iroaganachi, Itsekorand Osinulu (2014) [11] noted that care has to be taken by faculty to ensure that this practice is discouraged through effective supervision.

Nkiko and Adetoro (2007) [13]have expressed the need to ensure that proper analysis of works cited in undergraduate projects is done noting that bibliometric analysis of the students' projects is sacrosanct owing to the fact that it is the method engaged for quantitative appraisal of the formats of publications cited in the course of research reports.Grochowski (2014) [7] has pointed out that citation analysis is a tool that establishes the impact of a publication considering how frequent other authors make reference to it; it also authenticates the quality of a work based on the quality of journal that publishes it; and it also exposes the wideness of citation of a work in a particular field. The importance of citation analysis therefore cannot be overemphasized.

### 1.1. Objective of the Study

- To establish quantitative growth of cited documents
- To know the average citation counts per research project in Mechanical Engineering
- To compare citation pattern of single-authored research with multi-authored research in Mechanical Engineering
- To investigate cited bibliographic forms
- To investigate the types of cited materials often use in Mechanical Engineering research projects
- To find out the chronological distribution of cited materials
- To find out the age of cited materials
- To examine the authorship pattern of cited documents in the literature of Mechanical Engineering

## 2. REVIEW OF RELATED LITERATURE

Analysis of citations in undergraduate projects has been a subject that has garnered interest of scholars based on the fact that undergraduates are assumed to be new mostly 'first-timers' in the art of research and they should be well guided to avoid unnecessary embarrassment. (Yusuf &Owolabi 2017; Idiegbeyan-ose, Nkiko&Osinulu2016) [17, 9]. The pertinence of citation analysis has been tied to its capacity to highlight the quality of an author, the article and the institution, relying on the frequency of citation and the platform of publication (Fordham University Libraries 2018) [5].The importance of citation analysis has even gone beyond undergraduate research works. A study by Gupta and Khare (2013) [8] investigated

cited works in doctoral theses of doctoral students in Library and Information Science and found that journal materials constituted majority of cited materials by postgraduate students. High importance has been attached to citation analysis by faculty, institutions and management of higher institutions (Boshoff and Akanmu 2017; Kotzé 2016) [3, 12].

On order to measure the information literacy of undergraduate students of applied science, Wilkes and Gurney (2009) [16] carried out an investigation employed a structured questionnaire to examine first year applied science undergraduate students' perceptions of information, it was found that less of scholarly and peer reviewed articles were used by students while the most preferred source of information by the student were searched engines such as Google which has high results but low specificity and relevance. Another study established high dependence on search engines that are not electronic library resources and the authenticity of such sources may not be very reliable noting that many of them are blogs which focus more on individuals' opinion (Gadd, Baldwin and Norris 2010) [6].

Findings from some studies have revealed that undergraduate students do not intentionally look out for specific materials but engage whatever information sources that is available for the research activities. Okoye and Okoye (2017) [14] found that undergraduate students used books mostly for their final year research projects. Aliyu (2018) [1] investigated the citation analysis of doctoral students from University of Maiduguri and found that majority of the cited publications for their theses were journals, while books were next. In academic environment, journals are expected to be consulted more because they are current in nature due to constant research results being reported in them. From the review of literature it is evident that undergraduates are not specific about their sources but postgraduate students' appear to cite more from journals.

### 3. METHODOLOGY

The study adopted Bibliometric method. A citation analysis of research projects submitted by graduates of the Department of Mechanical Engineering, Landmark University, Omu-Aran, Nigeria was conducted. The study covered research projects submitted from 2015 to 2018. All the references of the research projects were examined one after the other and the different types of cited materials were recorded according to the year. The data were manually collected from the references of each research projects. MS Excel sheet was used to code and analyse the data. Data collected included type of number of each project's author, document cited, number of authors of cited materials, difference between the year of publication of cited document and the research project.

### 4. DATA ANALYSIS AND DISCUSSION

#### 4.1. Distributions of Citations

Table 1 shows yearly submission of research projects in the Department of Mechanical Engineering from 2015-2018. There were 1,129 citations in 49 research projects. Most of which were multi-authored projects 34 (69.4%) and recorded the most citations 363 (32.2%) in 2017. The highest number of research projects (17) were submitted in 2017 and the least number of research projects 6 were submitted in 2018. The average citations for each project was 23.0 across the years under consideration. Even though the average citations in 2017 were the least (21.4), average citations in 2018 increased significantly and had the highest average citations (29.8). The multi-authored nature of the research projects could explain the highest average citation recorded in 2018 despite recording the lowest number of research projects submission. Paradoxically, single-authored projects had higher average citations (23.5) than multi-authored projects (22.9). This implies that single-authored projects more

likely to consult more literature and therefore have higher citations compare with multi-authored projects in the field of Mechanical Engineering.

**Table 1** Submission of research projects by year, project type and average number of citations

Year	Research projects	Total Citations (%)	Total Average citations	Single-author projects			Multi-author projects		
				No. of projects	Citations	Average citations	No. of projects	Citations	Average citations
2015	11	249 (22.1)	22.6	7	190	27.1	4	59	14.8
2016	15	338 (29.9)	22.5	6	131	21.8	9	207	23.0
2017	17	363 (32.2)	21.4	2	31	15.5	15	332	22.1
2018	6	179 (15.9)	29.8	-	-	-	6	179	29.8
	49	1,129	23.0	15	352	23.5	34	777	22.9

Furthermore, Table 2 presents the distribution of citations according to various bibliographic forms. A total of 1,129 citations were found in the research projects of Mechanical Engineering from 2015 to 2018. Journals comprise the highest citations 412 (36.5%); followed by Internet/e-resources 238 (21.1%); books citations 199 (17.6%); conference proceedings 88 (7.8%); other documents such as working paper, workshop/seminar paper, newspaper e.t.c 78 (6.9%); theses/dissertation 67 (5.9%); and reports 47 (4.2%). The citations recorded for journals, internet/e-resources and books indicate that they are the important source to spread scientific and technical information. Also, other documents such as working paper, workshop/seminar paper, standards, manual, newspaper, patentse.t.c have been used more by research project authors as compared to technical and annual reports and thesis/dissertation. The use of journals across showed an increase from 2015 which was 40.2% of the total citations to 46.9% in 2018. For internet resources there was a continuous increase in citation from 11.2% in 2015, to 29.2% in 2017 and declined in 2018 to 7.8%. However, the use of reports continuously reduced from 8.0% in 2015 to 0.0% in 2018. While other documents increased continuously from 0.0% in 2015 to 16.8% in 2018.

**Table 2** Distribution of citations according to bibliographic form

Information source	2015 (%)	2016 (%)	2017 (%)	2018 (%)	No. of citation	% of citations
Book	24 (9.6)	117 (34.6)	35 (9.6)	23 (12.8)	199	17.6
Journal	100 (40.2)	89 (26.3)	139 (38.3)	84 (46.9)	412	36.5
Internet/E-resources	28 (11.2)	90 (26.6)	106 (29.2)	14 (7.8)	238	21.1
Conference proceedings	39 (15.7)	20 (5.9)	10 (2.8)	19 (10.6)	88	7.8
Reports	20 (8.0)	16 (4.7)	11 (3.0)	0 (0.0)	47	4.2
Thesis/dissertation	38 (15.3)	5 (1.5)	15 (4.1)	9 (5.0)	67	5.9
Others	0 (0.0)	1 (0.2)	47 (12.9)	30 (16.8)	78	6.9
Total	249 (100)	338 (100)*	363 (100)*	179 (100)*	1,129	100

\*Approximated

## 4.2. Chronological Distribution of Citations

Table 3 indicates that the highest number (27.7%) of the total citation are documents published during 2013-2016. This is followed by publications before 2001 (23.3%), 23.1% during 2009-2012, 13.3% during 2005-2008 and 8.7% during 2001-2004. However, documents published in 2017 and 2018 are the least cited (3.9%). Low percentage of materials published between 2017 and 2018 could be explained by the years these projects were conducted and the fewer number of submitted projects within this period.

**Table 3** Chronological distribution of cited materials

Year	Citations	Percentage
2000 and Below	263	23.3
2001-2004	98	8.7
2005-2008	150	13.3
2009-2012	261	23.1
2013-2016	313	27.7
2017 and Above	44	3.9
Total	1,129	100

### 4.3. Age of Cited Documents

The age of the cited documents was determined by calculating the difference between the submission year of the research project and the cited documents. As shown in Table 4, most cited materials (52.3%) were published within the last 10 years. Materials published in the last 5 years before the projects were written had the highest citation in the students' projects (34.7%). This is followed by materials published between 6 to 10 years. Even though as much as 16.1% of cited materials were published in more than 25 years before the research projects were conducted. Specifically, multi-author projects contain older literature than single-author projects. For instance, 17.4% of cited materials in multi-author projects as against 12.8% recorded in single-author projects were published in over 25 years before the projects were conducted. It appears Mechanical Engineering students prefer current literature, but there is need for increased citations of current literature. This implies that recent developments and studies were considered and noticed by these students before conducting their research projects.

**Table 4** Age of cited documents

Year	Single-author projects		Multi-author projects		Citations	Percentage
	Citations	%	Citations	%		
Less or equal to 5	99	30.9	293	36.2	392	34.7
6-10	66	20.6	133	16.4	199	17.6
11-15	29	9.1	69	8.5	98	8.7
16-20	36	11.3	83	10.3	119	10.5
21-25	49	15.3	90	11.1	139	12.3
26 and above	41	12.8	141	17.4	182	16.1
Total	320	100	809	100*	1,129	100*

\*Approximated

Table 5 shows the authorship pattern of the studied research projects. It was found that Mechanical Engineering students prefer to cite multiple authored materials for their research projects writing (50.1%) to single authored materials (35.6%). Similar studies earlier conducted such as Subramanyam (1983) [15] found that the degree of collaboration is higher in technical fields like Engineering than humanities. Even though the rate the students cited multiple author material reduces from 65.5% in 2015 to 44.4% in 2016 and 45.5% in 2017, cited materials with no authors increased from 5.6% to 25.6% within the same period. However, there are fluctuations in the authorship pattern across the 4 years under consideration.

**Table 5** Yearly distribution of authorship pattern

Pattern of authorship	Citations (%)				
	2015	2016	2017	2018	Total
No author/ author not given	14 (5.6)	40 (11.8)	93 (25.6)	11 (6.1)	158/ (14.0)
Single author	72 (28.9)	148 (43.8)	105 (28.9)	77 (43.0)	402 (35.6)
Two authors	38 (15.3)	95 (28.1)	65 (17.9)	34 (19.0)	232 (20.5)
Three authors	35 (14.1)	32 (9.5)	56 (15.4)	22 (12.3)	145 (12.8)
More than three authors	90 (36.1)	23 (6.8)	44 (12.1)	35 (19.6)	192 (17.0)
Total no. of multiple authors	163 (65.5)	150 (44.4)	165 (45.5)	91 (50.8)	569 (50.1)
Total citations	249 (100)	338 (100)	363 (100)*	179 (100)	1,129

\*Approximated

#### 4.4. Degree of Collaboration

Table 6 shows the degree of collaboration in research projects in Mechanical Engineering. This was calculated by using Subramanyam's formula. According to Subramanyam (1983) [15], collaboration can be defined as follows:

$$C = \frac{N_m}{N_m + N_s}$$

Where

C = degree of collaboration in a discipline,

$N_m$  = number of multiple-authored research papers in the discipline published during a year,

$N_s$  = number of single-authored research papers in the discipline published during the same year.

As shown in table 6, the degree of collaboration in this study is 0.59. As indicated in table 6, the highest degree of collaboration was recorded in 2015 (0.69). While 2016 has the lowest degree of collaboration (0.50). Furthermore, the degree of collaboration clearly varies from one year to the other throughout the study's coverage. The visibility and productivity of researcher is determined by the extent of collaboration

**Table 6** Degree of authors' collaboration

Year	Single author ( $N_s$ )	Multiple authors ( $N_m$ )			Degree of collaboration (C)
		Two authors	Three authors	More than three authors	
2015	72	38	35	90	0.69
2016	148	95	32	23	0.50
2017	105	65	56	44	0.61
2018	77	34	22	35	0.54
Average					0.59

## 5. CONCLUSION

The importance of bibliometric analysis cannot be overemphasized. It establishes the impact of a publication considering how frequent other authors make reference to it, and at the same time it authenticates the quality of a work, and the recency of the cited materials. Therefore researchers should continue to investigate this aspect of research so as to improve the research output of the undergraduate projects.

## 6. RECOMMENDATIONS

- The university library should continue to acquire recent materials both in prints and electronic formats.
- The Department of Mechanical engineering/ University management should encourage multiple authored projects as it tend to be more quality than single authored. However, each author contribution should be identified and justified.
- The University library in collaboration with Mechanical Engineering department should increase sensitization programme literature review, citations and references.

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