The Journal of Academic Librarianship 41 (2015) 613–620

Contents lists available at ScienceDirect

The Journal of Academic Librarianship

Citation Analysis of Masters' Theses and Doctoral Dissertations: Balancing Library Collections With Students' Research Information Needs

Deborah A. Becker *, Elisha R.T. Chiware

Cape Peninsula University of Technology, PO Box 1906, Bellville 7530, South Africa

ARTICLE INFO

Article history:
Received 30 April 2015
Accepted 26 June 2015
Available online 29 July 2015

Keywords:
Bibliometrics
Citation study
Dissertation
Engineering
Thesis
Science and technology education

ABSTRACT

This study analyses 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 analysis included establishing the types of materials, differences between resources used across the departments within the faculty, the journals referenced most frequently and the holdings of such titles by the library and lastly the age, language and country of publication of journal articles referenced. The study used a bibliometric approach using various indicators to analyze the citation patterns. The conclusion of the study shows that both masters' and doctoral students are utilizing resources provided by the library and that the most used resources were journals, followed by books. The study is unique in that it provides a pattern of how both masters' and doctoral students cite resources in their studies. It is also important in that it provides CPUT Libraries with information on how well utilized its resources are as well as pointing to possible areas of strengthening the holdings. The study concludes that together with other approaches, citation analysis still remains one of the most important tools to assess the usefulness of library holdings for postgraduate students' research activities.

INTRODUCTION

The growth and development of engineering education is an important agenda for the South African government in the growth and development of its infrastructure in order to support a growing economy. Government has been targeting the training of more engineering students to support its infrastructural development programs. However the output rates from traditional, comprehensive and technology universities have been low. This is due in part to the low number of school graduates who qualify to enroll for engineering disciplines at various institutions and the high dropout rates at most of the higher education institutions in the country (Case, 2004).

The result of a merger between two technikons in the post-independence re-organization of the higher education landscape in South Africa, the Cape Peninsula University of Technology (CPUT) is one of the six universities of technology in the country — offering mainly skills-based courses at certificate, diploma and Bachelor of Technology levels. Students undertaking postgraduate studies at Master of Technology (MTech) and Doctor of Technology (DTech) levels at CPUT constitute about 7% of the total enrolment of 34,000 students and are playing a key role in increasing the research activities at the university. The University also has a number of specialized research units and centers in various disciplines and has started appointing research chairs — who bring along postgraduate and post-doctoral students to their units. Collaborative research with colleagues at other national and international institutions has been growing in the last five years, supported mainly by sound research infrastructure and good funding models both from government and the institution.

One of six faculties at CPUT, the Faculty of Engineering is made up of eight departments and covers a broad range of engineering disciplines including: Construction Management and Quantity Surveying, Chemical Engineering, Civil Engineering & Surveying, Clothing & Textile Technology, Electrical, Electronic and Computer Engineering, Industrial & Systems Engineering, Maritime Studies and Mechanical Engineering.

Library resources which include some of the leading electronic full text databases to support science and technology education like Science Direct, IEEE, ACM Digital Library, Cement and Concrete Databases, ICE Virtual Library, Engineering Village, Textile Technology Complete as well as eBooks, print books, electronic journals, the Institutional Repository and other information resources, form part of the large collections that assist students, lecturers and research units in their work. The level of utilization of these resources is often the concern of not only the university library but also the various university budget committees responsible for resource allocations as a meaningful return on investment that must be shown in order to continue with the expensive journal and database subscriptions as well as the purchase of expensive engineering text books and resources. Library budgets have been a target for cuts

* Corresponding author.
E-mail addresses: beckerd@cput.ac.za (D.A. Becker), chiwaree@cput.ac.za (E.R.T. Chiware).

http://dx.doi.org/10.1016/j.acalib.2015.06.022
0099-1333/

and many libraries are being forced to cut back on essential resources. The introduction of 14% value added tax on imported electronic information resources has added pressure to South African university libraries.

The use of citation analysis as a bibliometric technique in libraries is an established credible way of assessing library collections, generating core lists of publications, and identifying items for possible selection, cancelation or storage (Abeyrathne, 2015; Enger, 2009; Johnson, 2009). According to Eckel (2009), citation analysis of science and engineering journal literature has been used by librarians primarily as a means of guiding journal collection development and local collection use and strength. Citation analysis is also being used for developing book collections (Enger, 2009). Several techniques are applied and vary from assessing the types of resources used, the frequency of citation, and the age of items cited to existence of cited resources in library holdings.

The citation analysis of theses and dissertations is one way of applying these methods and several studies in varying disciplines have been carried out to help establish students' citation characteristics (Gadd, Baldwin, & Norris, 2010) and patterns and use the results to improve reference instruction as well as identifying gaps in library collections and even justifying expenditure in financially constrained environments. Stephens, Hubbard, Pickett, and Kimball (2013) points out that there are few citation analyses involving engineering publications or engineering faculty research. Pancheshnikov (2007, p. 675) also notes that "fewer publications pertain to student theses and dissertations, or both groups of users and very few contain comparative data". In South Africa there are a number of studies on citation analysis (Afful & Janks, 2013; Naude, Rensleigh, & du Toit, 2005; Swanepoel, 2008) covering analysis of theses and dissertations across disciplines, but none cover engineering as a single discipline and more research is required to determine how postgraduate students and researchers in engineering and other disciplines are using various institutional information resources held by their libraries or more importantly their overall patterns of citation behavior. This study will add to that body of knowledge in the South African science and technology postgraduate education and research and hopefully stimulate more similar research.

This study sought to analyze the relationship between postgraduate students' information needs and the library's holdings by analyzing citations used in masters' theses and doctoral dissertations. Citation analysis is an important tool in assessing collection value and identifying gaps and building cases for retention or cancelation of journals and also for determining the value of monographic collections within CPUT Libraries.

LITERATURE REVIEW

The literature on citation analysis of masters' and doctoral dissertations covers a range of indicators which include types (e.g., journal articles, books, technical reports, websites, gray literature, government documents, etc.) of resources used by researchers. This also includes their age, country of publication, language, disciplines and holdings of specific libraries.

Differentiation of resources in the citation analyses of masters' theses and doctoral dissertations in engineering postgraduate studies and other disciplines is one of the indicators used by researchers (Eckel, 2009; Fransen, 2012; Gadd et al., 2010; Young, 2014). According to Stephens et al. (2013, p. 452) "objectives, methodologies, and subject granularity of these studies differ, but characterization of the formats types is common". In most studies the citation evaluations look at the use of books, journals, websites, reports, conference proceedings, theses and dissertations, lecture notes and special reports (Gadd et al., 2010). In many of these studies monographs, journals, websites and conference papers are the most widely used resources. Some of the studies (Eckel, 2009) show that researchers can get access to a broader range of sources than in the past because they are stored and available on the open web. These include information from government documents, gray literature, technical reports, and trade magazines. This is a positive development as some of these publications were never really easily accessible to students before the internet age.

Disciplinary categorization is an important aspect in citation analysis of masters' theses and doctoral dissertations. According to Waugh and Ruppel (2004, p. 277) "recent studies reflect an apparently growing trend among student researchers to cross-discipline boundaries when conducting reviews of literature" in social sciences and related fields. In vocational and technical education the pattern does not reflect interdisciplinary citations and shows that students tend to use resources in their specific fields. In his study on engineering and computer science research Fransen (2012) shows that computer science students tend to cross cite while engineering students do not. The conclusion then is that engineering students tend to use resources in their field. Eckel (2009, p. 11) on engineering students also confirms "an overreliance on certain sources by some authors and shows numerous examples of both master's and doctoral students citing the same journal over and over again". The study by Johnson (2014, p. 29) shows a difference by department and that students in the electrical engineering field rely more on "conference proceedings than their peers in other departments, while civil engineering students used more government documents than other students".

The age of resources also forms an important element of citation analysis in postgraduate students' utilization of library resources. Nabe and Imre (2008) note that "citation studies of dissertations in the sciences are infrequent" and that in the few studies that "have been done little or no data analysis on the age of citations" is provided. The literature shows varying time spans for citation analyses in different disciplines and Dulle et al. (2004) quote a study by Snyder & Bonzi (1998) that reports the age of cited publications among disciplines as follows: all disciplines (13 years); Asian studies (19.1 years); art (16.8 years); chemistry (11.1 years); geology (13.3 years); economics (8.8. years) and sociology (10.9 years). An analysis by Eckel (2009, p. 9) between engineering masters' theses and doctoral dissertations shows "that sources less than five years old made up a higher percentage of masters' references than doctoral students references". The study further points out that the "average age of scholarly journals and monographs was higher for dissertations than for theses". Fransen's (2012) study on literature use in engineering and computer science dissertations and theses shows that for engineering in general and civil engineering in particular, the average age of journal citations was 12 years. There seems to be a variation in age ranges across disciplines which may be influenced by many other contributing factors including the structure and nature of the research being undertaken. The Nabe and Imre (2008) study also demonstrates that "conventional wisdom that the sciences rely disproportionately on current sources of research is not accurate at least in the disciplines of plant biology and zoology". Williams and Fletcher (2006), show that the age of information sources cited varies within the engineering discipline and that older materials are more often cited in mechanical, aerospace and chemical engineering while more recent materials are cited in industrial engineering.

The one area of greatest importance to library managers is how well collections of a particular library are being utilized by their students and staff and hence the importance of evaluating what internal resources have been used in various research projects. This area of analysis assists library managers in decision-making with regard to the current and future collection management strategies especially in times of resource constraints. Feyereisen and Spoiden (2009) conclude in a study on this subject that "numbers are informative but will never be sufficient to mechanically evaluate a journal's utility". Citation analysis then should be part and parcel of a more holistic approach to determining the usefulness of resources within a given environment as several critical factors also count in the final decisions made on retention or cancelation of subscriptions.

Citation analyses based on the Law of Scattering or the 80/20 rule in which 80% of citations come from 20% of the cited journals is another important and useful approach in bibliometric studies. In engineering, Stephens et al. (2013) cites a number of studies which show that 9.6% of the journal titles cited accounted for half of all journal citations (Williams & Fletcher, 2006); half of all journal citations in engineering theses and dissertations come from 11% and 7% of journals cited respectively (Kriz,1984) 10% of journals accounted for 50.4% of citations (Garfield, 1976). These studies show that in engineering citation patterns do not adhere to the 80/20 rule.

According to Chikate and Patil (2008) the "geographical analysis of citations provides information about countries active in a subject field and their relative distribution of resources also forms part of citation analysis". The leading countries of origin of most types of publications are the USA, UK, Canada and Australia (Keat & Kaur, 2008). The language of the resources used is also an important indicator in citation analysis and the majority of studies in English speaking countries point to dominance of papers in English as being the most used language (Keat & Kaur, 2008).

This study will contribute to the overall body of knowledge on the subject matter, to a better understanding of the use of, and gaps in collections in engineering as well as providing strategic information for the decision making process and in justifying the continued expenditure on expensive information resources for supporting teaching, learning and research activities. The study focused on a university of technology library and the important engineering field that is of importance to the development and growth of the South African economy.

RESEARCH OBJECTIVES

Masters' theses and doctoral dissertations completed for higher degrees in the Engineering Faculty at CPUT were studied and analyzed in order to determine the citation patterns of students. The study also attempted to establish the level of utilization of collections both in print and electronic format held by CPUT Libraries. The objectives included the following:

- To determine the types of materials used by masters' and doctoral students when writing their theses and dissertations
- To identify the differences between resources used by masters' and doctoral students and across the departments within the faculty
- To identify the journals, books, reports and other items referenced most frequently and the holdings of such titles by the library
- To determine the publication period, country of publication and language of journal articles referenced.

METHODOLOGY

The study is based on a quantitative approach and uses the Bibliometrics technique of citation analysis to evaluate references in masters' theses and doctoral dissertations in the Faculty of Engineering at CPUT. The theses and dissertations evaluated were drawn from the Institutional Repository, Digital Knowledge that preserves and curates the university's intellectual outputs including theses and dissertations, research articles, conference proceedings, scholarly journals, technical reports and many other related outputs. The Institutional Repository was used as it is the only visible tool providing full-text access to the theses and dissertations.

The theses and dissertations used in the study were a random sample selected from those available via Digital Knowledge and cover:

- Masters' theses and doctoral dissertations
- All departments within the Faculty of Engineering
- The period 2005–2014.

The references were checked and note was taken of the format of the item cited, for example journal, book proceeding or online resource. Other formats identified included emails, personal interviews, course notes, conference papers, government publications, national and international standards, manuals and guides, technical reports and technical notes. The analysis further included the checking of each journal title to see if it was available via the electronic subscriptions of the library. The date of each listed journal article was also recorded.

All the above data was collected per department in order to determine if there were any differences in the types of materials used by students within the different departments of the Faculty of Engineering.

Further analysis of the journal titles was done following these four methodological procedures:

1. Checking journal titles against the EBSCO A–Z list which lists all titles to which the library provides access, both in print and online as well as some open access titles;
2. Checking the journal titles against the 2014 accredited IBSS, ISI and Department of Higher Education and Training (DHET) journal lists for both accreditation and country of origin;
3. The remaining titles were checked against WorldCat to determine country of origin and online access;
4. A general search was done for titles not covered by the above in order to determine country of origin and online access.

All collected data was loaded into EXCEL and analyzed using functionality provided within this environment.

RESULTS AND DISCUSSION

Of the eight departments in the Faculty of Engineering, six have master students and four support doctoral students. According to University statistics the number of post-graduate degrees conferred for each department for the years 2005–2014 are shown in Table 1:

Of the 285 higher degrees conferred, 201 are currently available on Digital Knowledge. The remaining 84 (including many doctoral dissertations) are either still being sourced or are awaiting scanning. In order to have a truly representative sample, 101 theses and dissertations of those available online were selected for analysis. The random selection of theses resulted in the following numbers of theses and dissertations per year and department being analyzed for this study (Table 2).

REFERENCED LITERATURE TYPES

The initial analysis divided the list of references into five categories, namely, books, proceedings, online resources, journals and other. Books and journals included both printed and electronic titles while online resources included both references to websites as well as online documents (basically all references with a URL), excluding journals and books. Whether published as a journal, series or as stand-alone volumes all proceedings were included in the proceedings category. The category for "other" included all items (emails, personal interviews, course notes, conference papers, government publications, national and international standards, manuals and guides, technical reports and technical notes) which were not categorized as books, proceedings, online resources or journals (Graph 1).

The above graph clearly indicates that journals were the most used resource, followed by books and items in the "Other" category. As indicated by Olatokun and Makinde (2009), there are a number of possible reasons for this, including ease of access, currency of the articles and the qualitative research included in articles. Journal articles are more easily accessible due to online availability, especially when such is provided via the library, and off-campus or remote access. In a recent survey by CPUT Libraries to determine students' library use and behavior, 19% of students who responded to the question asking their main reason for visiting the library stated that they did so in order to access databases

Table 1
Post-graduate degrees conferred.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Masters'											
Chemical	7	5	1	3	5	4	6	8	7	4	50
Civil	0	1	0	0	2	0	1	0	2	1	6
Construction	7	0	1	2	1	3	0	1	1	2	18
Electrical	4	6	5	5	14	10	19	17	18	1	99
Industrial	0	0	0	9	7	11	3	9	1	0	40
Mechanical	6	5	1	2	6	5	7	5	4	0	41
Doctoral											
Chemical	1	0	0	1	2	0	0	0	2	0	6
Civil	0	0	0	1	0	0	0	0	0	0	1
Electrical	0	1	1	0	2	2	3	2	1		13
Mechanical	1	0	1	0	0	2	0	5	1	1	11
Total	26	18	10	23	39	37	39	47	37	9	285

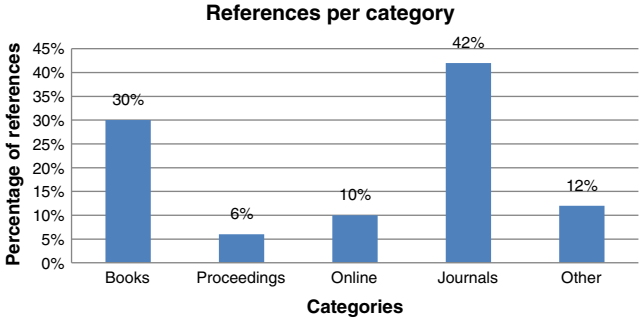
Table 2
Selection per department.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Masters'											
Chemical	2	4	2	0	3	1	0	0	2	0	14
Civil	0	0	0	1	1	0	1	0	1	1	5
Construction	5	0	0	1	0	2	0	0	0	1	9
Electrical	4	2	4	1	11	1	2	2	0	1	28
Industrial	0	0	0	6	6	3	0	3	0	0	18
Mechanical	4	2	2	1	1	1	2	3	2	0	18
Doctoral											
Chemical	0	0	0	0	0	0	0	0	0	2	2
Electrical	0	0	2	0	1	0	0	0	0	0	3
Mechanical	0	0	0	0	0	0	0	0	0	1	1
Total	15	8	10	10	23	8	5	8	5	6	98

and 12% indicated that they did so to access e-books. The division of usage between books and journals was greatly influenced by the items cited by doctoral students who had a larger percentage of journal citations (Table 3).

Unlike the findings by Olatokun and Makinde (2009) who indicated that only 1% of references were for web resources, the study of CPUT engineering theses shows that 10% of the resources were web-based. These included both websites and documents, but excluded journal, proceeding and book titles available online. The library provides separate and dedicated study spaces for masters' and doctoral students, providing computers for access to electronic resources (including e-journals and e-books) as well as space for laptop usage. As recorded on the library statistics database this area was well-supported by students with over 16,000 visits in 2014, possibly supporting the high number of references to electronic materials.

Books made up 30% of the references. This is consistent with the findings of Kushkowski and Parsons (2003) who indicated that 23.7% of the citations in the theses they checked were books, but contradicted Nkiko and Adetoro (2007) who found that books were cited most often. Each author had cited at least one book title on how to write a thesis. Although no analysis of references for books was done, a sample of the references by chemical engineering students was analyzed. Of the 192 books referenced, 66 were available in the library and 14 were available online. Three online book series were also referenced. At CPUT Libraries, the Inter-Library Loan (ILL) service is restricted to post-graduate students and staff. During 2014 only 385 books were received on request from other libraries. This is partially due to the library's policy of purchasing items for which multiple ILL requests are placed thereby enriching the collection; and partially due to the availability of online materials.



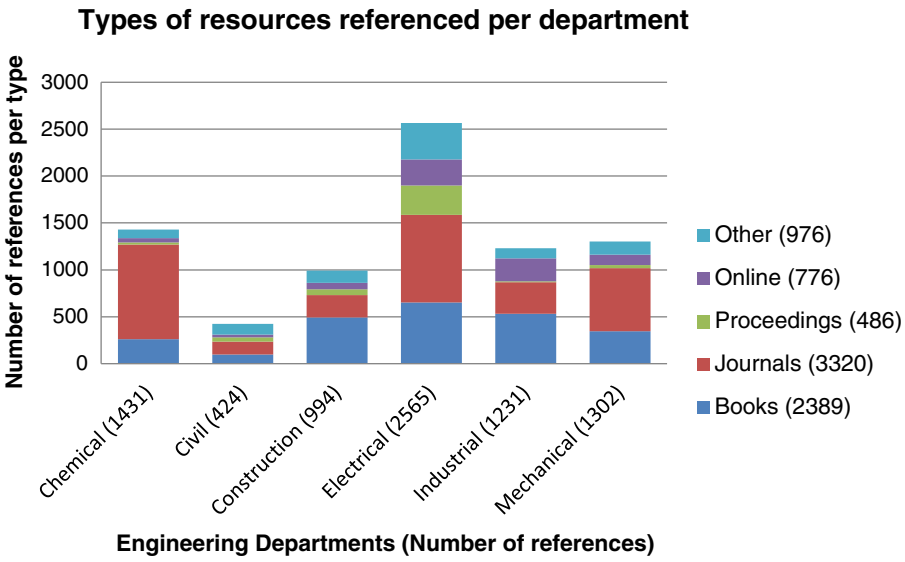
Graph 1. References per category.

RESOURCE USE BY DEPARTMENT

Further analysis indicated a clear difference in the types of resources used by students in the various departments. Young (2014) found that in some fields in engineering, less than 50% of the references were for journal articles. This finding was supported at CPUT where the highest percentage of journal citations was 54% by mechanical engineering students followed by chemical engineering students with 48%. Students studying construction management made the least use of journals, with only 25% of their references coming from this category.

Table 3
Number of citations.

	No. of authors	Journal citations	Book citations
Doctoral	5	738	210
Masters'	96	2582	2180



Graph 2. Resources referenced per department.

The graph below demonstrates that:

- Civil engineering students used mostly resources from the "other" category (31%) followed closely by journals (30%);
- Students in the construction management and industrial engineering departments cited mostly books with 41% and 40% respectively;
- Industrial engineering students used the highest percentage of online resources (19%).
- Proceedings were used mostly by electrical engineering students (14%) and the least by industrial engineering students (1%) followed by mechanical engineering students (2%).
- Civil engineering students used the most items not categorized as either books or journals with 48% of their references made up from proceedings, online resources or "other", followed by electrical engineering with 39% and construction management with 35% (Graph 2).

These figures show that engineering students use a variety of resources when researching their thesis topics.

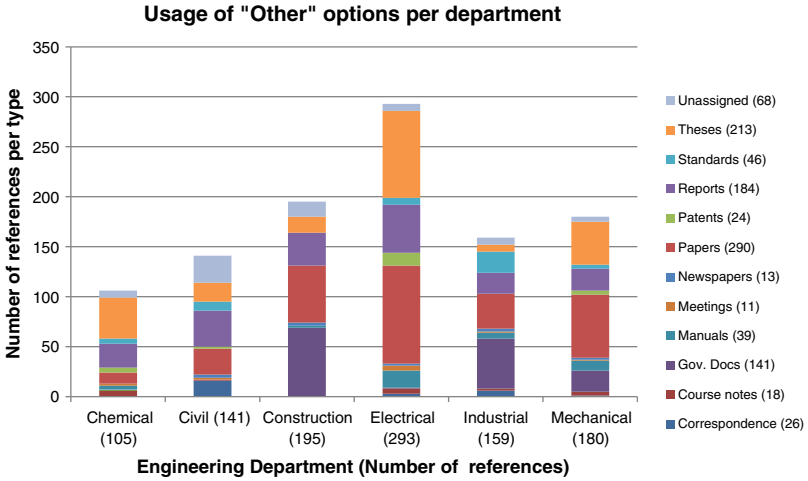
The category "other" was broken down into various sub-categories, including:

- Correspondence (email and personal interviews);
- Course notes (which included study notes and handouts);
- Government documents included white and green papers, acts, legislations and regulations as well as government publications and parliamentary speeches. This category was heavily used by construction engineering students followed by those from industrial engineering.
- National and international standards as well as patents were mostly cited by industrial and electrical engineering students respectively;
- Manuals included guides, data sheets and handbooks;
- Papers included articles presented at conferences as well as unpublished journal articles. With 98 references, electrical engineering students had the highest number of references to papers presented at conferences.
- Reports included technical reports and technical notes;
- Meetings were written meeting notes or minutes;
- Theses included both those accessed electronically and in print

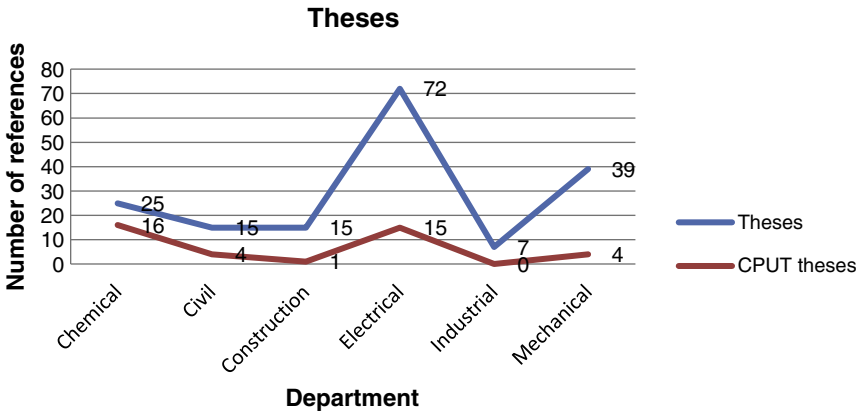
There were still a few items that could not be placed in any of the selected categories or were too infrequently referenced to have an allocated category. These were placed in an "unassigned" category (Graph 3).

The breakdown of the references for these categories per department indicates that:

- Chemical (39%) and electrical engineering (31%) students have the largest ratio of references to theses;



Graph 3. Usage of "other" options per department.



Graph 4. Use of theses.

- Government documents are more often cited by construction management (35%) and industrial (32%) students;
- Electrical and mechanical engineering students refer to papers most often with each having 35% of these references;
- With 30%, civil engineering students have the most references to reports;
- Overall, papers (27%), theses (20%) and reports (17%) are referenced most often.

Of all the departments only industrial engineering did not refer to any CPUT theses while chemical engineering students had the most references to CPUT theses (Graph 4).

YEAR OF PUBLICATION OF CITATIONS

When checking the references, there was little distinction in the use of resources from 2005 to 2014. However, it was found that the use of a resource type is not consistent, for example chemical engineering students did not reference any online resources in 2005 or 2013; however they had a high number of references for these resources in 2009.

The main area of change during this period was in the recording of citations. Changes included the selection of a single style which was used throughout (rather than a mixture of styles), consistent use of italics for indicating journal titles and more complete referencing. In earlier years, information was often incomplete, with some references lacking basic information such as the article title, journal volume numbers, place of publication or publishers of book titles.

Table 4
Journals referenced.

Number of theses checked	101
Referenced journals (titles)	1140
Number of references (journal articles)	3320
Number of titles provided by CPUT Libraries	895
Number of online titles	958
Number of accredited titles	758

USE OF COLLECTIONS HELD BY THE LIBRARY

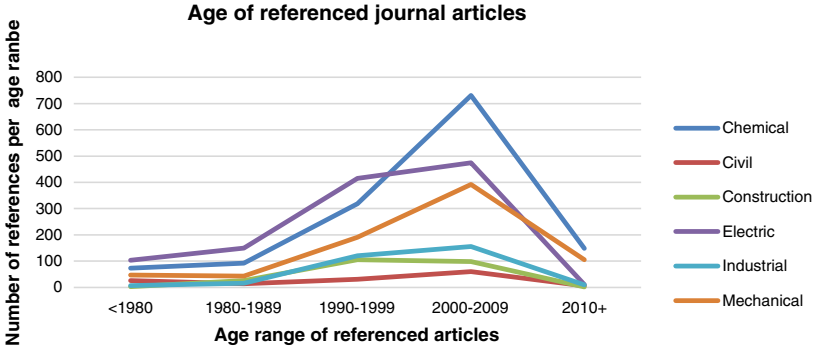
CPUT Libraries provide access to approximately 79% of all the journal titles used by students for their theses while 84% of the titles used were available online. These two factors support the argument by Olatokun and Makinde (2009) that ease of access is a contributing factor to the large number of journal references (Table 4).

It was noted that students tended to use many more items published between 2000 and 2009 indicating that currency is a factor in selecting articles (Olatokun & Makinde, 2009). Doctoral students had a very high number of references published after 2009, with 16% of their references belonging to this time frame compared to 5% of those of masters' students. Based on the graph below, only construction management had more references for articles published in any period other than 2000–2009. For all the other departments, the largest number of articles referenced fall within this period (Graph 5).

The oldest reference cited in a thesis or dissertation was for *Archives of Psychology* (1932), by industrial engineering masters' students.

A breakdown per country indicates that titles published in 42 counties were used, with titles from the United States of America used most often followed by the United Kingdom and the Netherlands. According to the SCImago (n.d.) journal rankings, the five countries with the most citations for engineering are China, United States, Japan, Germany and the United Kingdom (Table 5).

The table above clearly illustrates that the students favored journals from Europe with very few from the Asian and Australasian region.



Graph 5. Age of referenced articles.

Table 5
Usage per country.

Africa & Middle East	No. titles	Americas	No. titles	Asia & Australasia	No. titles	Europe	No. titles
Egypt	2	Brazil	9	Australia	10	Austria	1
Iran	3	Canada	8	China	12	Bulgaria	2
Jordan	1	Hawaii	1	India	11	Czech Republic	2
Kenya	7	United States	461	Japan	14	Denmark	1
Nigeria	1			Malaysia	5	Finland	1
Saudi Arabia	1			New Zealand	1	France	6
South Africa	21			Pakistan	3	Germany	40
Tanzania	1			Singapore	6	Ireland	1
Turkey	8			South Korea	6	Italy	3
				Taiwan	3	Lithuania	3
				Thailand	3	Netherlands	124
						Poland	10
						Romania	1
						Russia	8
						Spain	2
						Sweden	2
						Switzerland	20
						United Kingdom	294
Total	45	Total	479	Total	74	Total	521

Within the titles from the United States 58 were published by the IEEE. Although only 21 South African journals were cited, South Africa was listed as the country with the fifth most titles cited. The country of publication could not be identified for 14 titles and six titles had been discontinued and were not included in the table.

The extensive use of journals from Europe and the United States supports the hypothesis suggested by Chikate and Patil (2008) that students (especially doctoral students) prefer journals which are published in first world or developed countries. Generally these countries publish more scientific titles than developing countries which might nullify the argument; however China, although one of the leading publishers of scientific journals, does not have many titles cited by CPUT engineering students who tend to use more Japanese titles.

Very few foreign language titles are used. Journals in Portuguese are the most frequently cited, followed by journals in French. Selection of titles in these languages is understandable as CPUT has many post graduate students from Portuguese and French speaking African countries such as Angola, Cameroon, Democratic Republic of Congo, Gabon and Ghana.

FREQUENTLY USED TITLES

As can be expected, based on data already discussed, the top 10 journals used by CPUT engineering students originate in the United States, United Kingdom and the Netherlands (Table 6).

No titles used by industrial engineering appear in the list of the top five titles. The title most used by these students was *International Journal of Quality and Reliability Management* with 17 citations. The most referenced South African journal was *South African Journal of Psychology* (16 citations) followed by *South African Journal of Higher Education* (8 citations). The high usage of these titles indicates how engineering students at CPUT use titles from other disciplines within their research and tends to dispute Fransen's (2012) claim that engineering students do not cite resources outside their discipline

534 titles were referenced only once and 299 twice. 74 were referenced more than 10 times.

CONCLUSION

The library at CPUT provides about 79% of the cited information resources. The study shows that more electronic resources are being utilized by postgraduate students and that journals are the most cited information resource held by the libraries. Johnson (2014) concludes however that in terms of collection building the increased use of journals does not necessarily justify a massive move of resources from book purchases to journal subscriptions as the pattern may change due to the emergence of eBooks and their addition to library collections. There is also evidence that more recent publications are being utilized in the postgraduate studies' outputs and the web is increasingly becoming an important source for information for students. Although doctoral students have many more references and cite mainly journal articles, the masters' students cite more monographs.

Librarians need to continuously work with postgraduate students in order to encourage them to fully utilize valuable resources in the holdings. The study shows that with an 80% utilization of library holdings there is need to continue working with postgraduate students so as to maintain this level of usage. The challenge always comes when the library budget has to be cut and such results will assist in pointing to areas that need to be reduced. The growth of the internet and web resources is also proving to be an important alternative source of

Table 6
Most used journal titles.

Journal title	Masters'						Doctoral	Total
	Chemical	Civil	Construction	Electrical	Industrial	Mechanical		
Water Science and Technology	6	15		51			22	94
Journal of Membrane Science	84					1		85
Water Research	1	3		51			21	76
Food Hydrocolloids	42						20	62
Biotechnology and Bioengineering	22			20			6	48
Journal of food engineering	20	1		1			14	36
Automatica				23			9	32
Computers and Chemical Engineering	11		2	15			3	31
Acta Materialia						28		28
Chemical engineering science	12	1		8			6	27

information for postgraduate students as they have access to materials which could not be easily obtained before the advent of the web.

The results of this study provide CPUT Libraries and the university research community with more insight into the patterns of use of library holdings. The study however was limited to one discipline; engineering and a more holistic study will provide a global picture of the overall utilization of resources and provide information for better collection development and management.

REFERENCES

Abeyrathne, D.K. (2015). Citation analysis of dissertations for collection development. *Collection Building, 34*(2), 30–40. http://dx.doi.org/10.1108/CB-11-2014-0055.

Afful, J.B.A., & Janks, H. (2013). The politics of citation: An analysis of doctoral theses across disciplines. *Critical Approaches to Discourse Analysis Across Disciplines*, *6*(2), 193–200 (Retrieved from http://cadaad.net/journal).

Case, J.M. (2004). *Issues facing engineering education in South Africa.* 3rd African Regional Conference on Engineering Education, Pretoria, South Africa, September, 2006 (Retrieved from http://www.aeea.co.za/i/i/ARCEE3.pdf).

Chikate, R.V., & Patil, S.K. (2008). *Citation analysis of theses in library and information science submitted to University of Pune: A pilot study*. Library philosophy and practice (Retrieved from http://www.webpages.uidaho.edu/~mbolin/chikate-patil.htm).

Dulle, F.W., Lwehabura, M.J.F., Dulle, F.W., Lwehabura, M.J.F., Matovelo, D.S., & Mulimila, R.T. (2004). Creating a core journal collection for agricultural research in Tanzania: Citation analysis and user opinion techniques. *Library Review*, *53*(5), 270–277. http://dx.doi.org/10.1108/00242530410538418.

Eckel, E.J. (2009). The emerging engineering scholar: A citation analysis of theses and dissertations at Western Michigan University. *Issues in Science and Technology Librarianship* (Retrieved from http://www.istl.org/09-winter/refereed.html).

Enger, K.B. (2009). Using citation analysis to develop core book collections in academic libraries. *Library & Information Science Research*, *31*, 107–112.

Feyereisen, P., & Spoiden, A. (2009). Can local citation analysis of masters' and doctoral these help decision-making about management of the collection of periodicals? A case study in psychology and education sciences. *The Journal of Academic librarianship*, *35*(6), 514–522.

Fransen, J. (2012). Literature use in engineering and computer science research: An analysis of works cited in dissertations and theses. *Issues in Science and Technology Librarianship* (Retrieved from http://www.istl.org/12-fall/refereed3.html).

Gadd, E., Baldwin, A.N., & Norris, M. (2010). The citation behavior of civil engineering students. *Journal of Information Literacy*, *4*(2), 37–49.

Garfield, E. (1976). *Characteristics of highly cited publications in the engineering sciences. In: Essays of an information scientist. Current Comments, 12 (March 22)* Philadelphia: ISI Press.

Johnson, P. (2009). *Fundamentals of collection development and management* (2nd ed.). Chicago: IL: American Library Association.

Johnson, P.C. (2014). Dissertations and discussions: Engineering graduate student research resource use at New Mexico State University. *Collection Building*, *33*(1), 25–30 (Retrieved from http://dx.doi.org/10.1108/CB-09-2013-0037).

Kriz, H. M. (1984). *Library Management Implications of Journal Citation Patterns in Engineering Doctoral Dissertations.* ERIC Document ED243481.

Keat, Y.C., & Kaur, K. (2008). Citation study of library and information science dissertations for collection development. *Malaysian Journal of Library and Information Science, 13*(2), 29–47.

Kushkowski, J.D., & Parsons, K.A. (2003). Master's and doctoral thesis citations: Analysis and trends of a longitudinal study. Retrieved from http://works.bepress.com/jeffrey_kushkowski/4

Nabe, J., & Imre, A. (2008). Dissertation citations in organismal biology at Southern Illinois University at Carbondale: Implications for collection development. *Issues in Science and Technology Librarianship* (Retrieved from http://www.istl.org/08-fall/refereed.html).

Naude, F., Rensleigh, C., & du Toit, A.S.A. (2005). Analysis of citation of Web-based information resources by UNISA academic researchers. *South African Journal of Information Management*, *7*(3), 1–14.

Nkiko, C., & Adetoro, N. (2007). *Pioneer bachelor degree: Citation analysis of Covenant University students' research projects library philosophy and practice.* (Retrieved from http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1151&context=libphilprac).

(Not referenced in-text) Olatokun, W.M., & Makinde, O. (2009). *Citation analysis of doctoral works submitted to the Department of Animal Science.* Library philosophy and practice. Nigeria: University of Ibadan (Retrieved from http://www.webpages.uidaho.edu/~mbolin/olatokun-makinde.pdf).

Pancheshnikov, Y. (2007). A comparison of literature citations in faculty publications and student these as indicators of collection use and a background for collection management at a university library. *Journal of Academic Librarianship, 33*(6), 674–683.

SCImago Journal and country rank (retrieved from http://www.scimagojr.com/countryrank.php).

Snyder, H., & Bonzi, S. (1998). Pattern of self-citation across displines (1980-1989). *Journal of Information Science*, *24*(6), 431–435.

Stephens, J., Hubbard, D.E., Pickett, C., & Kimball, R. (2013). Citation behavior of aerospace engineering faculty. *The Journal of Academic Librarianship*, *39*, 451–457. http://dx.doi.org/10.1016/j.acalib2013.09.007.

Swanepoel, A.J. (2008). Citation analysis of theses and dissertations submitted at the Tshwane University of Technology. *South African Journal of higher Education*, *22*(5), 1097–1113.

Waugh, C.K., & Ruppel, M. (2004). Citation analysis of dissertation, thesis, and research paper references in workforce education and development. *The Journal of Academic Librarianship*, *30*(4), 276–284.

Williams, V.K., & Fletcher, C.L. (2006). Materials used by master's students in engineering and implications for collection development: A citation analysis. *Issues in Science and Technology Librarianship* (Retrieved from http://www.istl.org/06-winter/refereed1.html).

Young, Brian (2014). What do engineering researchers cite? A citation analysis study of sixteen engineering journals. *Issues in Science and Technology Librarianship* (Retrieved from http://www.istl.org/14-winter/refereed4.html).