Publishing patterns at the Cape Peninsula University of Technology

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We report on the publishing and collaborative patterns of researchers in the applied sciences and engineering disciplines at a technological university in South Africa, Cape Peninsula University of Technology. The study focused on works published over a 10-year period (2005–2014) and was based on citations of peer-reviewed literature from Scopus. The results showed a steady growth in research outputs in science and technology at the university. There has also been a growing trend of international collaboration in certain disciplines. This scoping study serves as a benchmark for similar studies.

Introduction

The aim of this paper was to present publishing patterns of science researchers in the applied sciences and engineering disciplines at Cape Peninsula University of Technology (CPUT). While the university is not yet classified as a research-intensive institution, its research outputs have been growing since its inception in 2005, which was the result of the merger of two technical colleges. Historically, research at South African technical colleges was not a priority as the focus was more on skills training and development. But since 1994, and the subsequent mergers of various institutions in the mid-2000s, the growth and development of research activities in these former technical colleges has been growing, partly as a result of the new mandates of such institutions.

The rapid growth of research output at CPUT is a result of sustained efforts to grow the institutional research landscape in response to government's reorientation of science and technology through: research, technology and innovation policies, strong research governance systems, increased research funding, recruitment of highly skilled staff, research infrastructure development and building synergies within the university's structures to provide the necessary support to researchers. The development of the research technology, innovation and partnerships blueprint,[1] establishment and appointment of several top-rated researchers as research chairs, participation in various international research collaborative programmes as well as mentoring and supporting young researchers and growing the number of postgraduate students and postdoctoral positions, have all contributed towards a rich research environment within the institution. Since the inception of CPUT, research has been growing in many areas, most notably in Applied Sciences and Engineering. The focus now is to steer the university's research activities towards multi-disciplinary research focus areas. These focus areas are:

- Bio-economy and biotechnology
- Space science and technology
- Energy
- Climate change and environment
- Human and social dynamics, including issues related to service delivery
- Economic growth and international competitiveness
- Design for sustainability

There is growing interest in studies on bibliometric analysis, journal impact and collaborative research patterns in African universities and research institutions as a result of various demands and the desire to align with global trends. Given the importance of the global rankings of universities based on research outputs and the demand by funders regarding the impact of research on development, there is a need to evaluate the relevance and impact of the research outputs in African institutions. It is also important to determine the overall impact they are making towards economic and social development on the continent. Such studies will contribute towards research and development projects as well as the uptake of research outputs, especially in areas of greatest need such as poverty alleviation, health care, increased food production, appropriate technology uptake and the general improvement of the lives of people in African countries. The studies on African scientific publishing patterns point to a preference by established and renowned researchers to publish in leading global journals as well those that are nationally accredited, as is the case in South Africa where the Department of Higher Education and Training offers subsidies based on publishing in certain accredited journals and recognised lists.[2]

It has become a national norm for researchers in tertiary education institutions to publish and publishing is part of the performance management and promotion criteria of several institutions on the continent. Other factors contributing to increased research activities and outputs include increased funding, significant policy changes, improved research infrastructure (both human and physical), information and communications technology resources, open, free and low cost access to peer reviewed literature and research capacity building training,[3] and increased collaborative opportunities with colleagues in well-resourced institutions abroad. According to Li et al.[4], maintaining high levels of research productivity is essential for researchers' careers if they are to impact the knowledge community through citations and establish reputations as scholars. In Latin America, Holmgren and Schnitzer[5] attributed the increased scientific productivity to the strong scientific developments in many countries in the region during the 1990s. The contribution also came from increased funding to the most productive scientists

through international cooperation with scientists from Europe and the United States and collaboration among scientists within Latin America.

Journal rankings remain an important factor in the lives of researchers and academic communities. Various methods are applied to determine both author and journal productivity and these methods range from citation studies to perception and market test studies. The most common tools used are citation abstracts and indexes, opinion surveys and the analysis of journal holdings.[6] Pouris[7] points out that scientometric studies, in general, and collaboration studies, in particular, are in an embryonic stage. Furthermore, he emphasises that even South Africa, which is a major producer of research publications on the continent, produces few publications in scientometrics.

Literature review

Publishing trends in developing countries

Researchers in any field tend to follow established publishing patterns because they want to gain as much impact as is possible. This approach is driven by institutional demands, as the impact factor is often one of the few measures that universities look at when considering the quality of a researcher's work. The importance given to established and respected journal titles also supports the tendency to follow established publishing patterns. Several studies on publishing patterns of researchers in developing countries show that the majority prefer to publish in foreign journals.[8] The visibility of the overall scientific research output from developing countries in general, and African countries in particular, is still very low in global terms although the recent past has shown an increased growth. Many contemporary commentators and analysts argue that scientific research in Africa is lagging far behind other regions in the world and is in dire need of large investments in order to catch up with other developing regions.[9] Competition with established researchers from developed countries is high for entry into established journal titles. In addition, in most cases, the fields of research by African researchers are not viewed as important for global audiences and hence their marginalisation in leading journals. The alternative is often national journals which are poorly represented in international citation tools, resulting in poor visibility of the researchers, their outputs[10] and impact. There is an increasing trend to publish in open access journals and again, some of these suffer the same fate as titles published in developing countries. In terms of research output, however, there are high outputs, notably from rising giants like China, India and Brazil, as well as some of the major countries in southeast Asia and in Africa, where Egypt, Nigeria and South Africa are notably the continent's publishing powerhouses, contributing about 80% of the continent's scientific output.[11]

Although notable achievements have been made in some developing regions, Latin America and Africa included, gaps still exist[5] and there is still reason to push for greater achievement.

Scientific research collaboration

Scientific research is becoming increasingly global, interdisciplinary and collaborative in nature[12,13] and critical to scientific practice.[14] It is widely assumed that collaboration in research is a positive development and that it should be encouraged.[15] In addition to high funding levels in the fields of science and technology, improved and changing communication channels, as well as the mobility of researchers, have all enabled collaboration at a global level.[16] In recent years, increased collaboration has been viewed as good practice that improves institutional performance and global rankings of universities. Other benefits, such as attracting good researchers and more funding, are all well documented.[17]

Ynalvez and Shrum[14] see scientific collaboration as emanating from the social structure of relations among knowledge producers and successful research projects, translating into new resources that facilitate knowledge generation or the attainment of specified objectives.

One of the most common and well established forms of scientific research collaboration is co-authorship, which can be effectively traced and analysed through bibliometric studies.[16] Co-authorship increasingly creates networks that reveal certain features of the participating academic communities.[18] According to Bidault and Hildebrand[19], these arrangements have become prevalent in research and development activities where organisations are seeking partnerships to complement their own technological capabilities. Co-authorships have several advantages for researchers in both developed and developing environments. Li et al.[4] note that co-authoring with prolific scholars helps researchers develop centralities and in turn, generate higher numbers of citations. However, Wagner and Leydesdorff[20] indicate that there is still no full explanation for the rapid growth in scientific international research collaboration. In trying to find answers to this, they tested the hypothesis that international collaboration is a self-organising network and that the growth of co-authorships can be explained based on the organising principle of preferential attachment, although the attachment mechanism deviates from an ideal power law.

Collaboration by African researchers can be viewed from different perspectives. According to Pouris and Ho[21], African researchers' collaboration with international partners has grown dramatically by 66% over a recent five-year period. The analysis by these authors shows a dominance of research areas in the medical and natural resources fields. The main drivers of these collaborations are the availability of resources and interests outside the continent i.e. international imperatives that often favour group rather than individual research. Onyancha and Maluleka[22] have shown in a study on collaborative research in sub-Saharan Africa that knowledge production through collaboration among regional countries is minimal and contributes only a small percentage when compared to collaboration with countries in other parts of the world.

Research on collaboration among the Southern African Development Community's (SADC) fifteen countries shows that only 3% of outputs between 2005 and 2008 were jointly authored by researchers from two or more SADC countries (intra-regional collaboration), and only 5% of the papers were jointly authored by researchers from African countries outside the SADC region.[23] This is not an ideal trend as there are many opportunities for more cooperation given the relative levels of development within the region, as well as better infrastructure and funding compared with the rest of the continent. According to Sooryamoorthy[24], 'the existing networks with SADC and NEPAD (New Partnership for African development) have turned out to be unsuitable for want of resources, preventing effective collaboration'. This could also be a sign of a lack of a regional strategy to approach research and development in a more integrated manner within the development community. In addition, the little intra-regional collaborative research that is taking place is largely funded by external donors, again showing that external forces are the key drivers of collaboration among African scholars.

Collaboration and publications in South Africa

According to Baker[2], the South African scholarly publishing landscape is required to tackle the realities of global science publishing, maintain its existing strengths and have the foresight, based on practical experience, to create a future of safety and stability for the country's best scholarly journals in an unsafe and ever competitive world. Interdisciplinary research in and amongst South African research and academic institutions requires in-depth analysis. Sooryamoorthy[25] points to the growing trend of collaborative research among South African scientists and indicates that this collaboration is mostly international, compared to domestic ventures and that publication seems to be a decisive factor. While institutions might want to safeguard their territories, there is need at all levels to encourage inter-institutional collaborations. In some scientific and technological disciplines, collaboration is active and is producing good results; however, additional areas need to be identified to make this more meaningful.

Leading researchers in South Africa and other leading African research countries like Egypt, Algeria, Morocco and Nigeria, have a tendency to help the introduction of new knowledge into their countries through collaboration, because they are better connected to external sources of knowledge than less competent researchers.[26] The limitation of resources is a feature in the making of such decisions as are the international partners who prefer to work with well-established scholars as a means of advancing the knowledge frontier.

South Africa, the highest producer of publications on the continent, has a collaboration rate of 53% – far higher than fellow BRICS countries which reflect lower rates of collaboration: 25% for Brazil, 20% for India and 23% for China.[27] Barnard et al.[26] point out that this trend runs the risk of world-class researchers completely disconnecting themselves from the rest of the South African research community. The conclusion is however, that local leading researchers are not completely disconnected from upcoming researchers and do in fact work with networks of local partners. Dell[27] points out that 'South Africa's high international collaboration rate persist in spite of the fact that national university funding systems acts as a disincentive to inter-institutional collaboration in the sense that collaborating institutions are required to share the government subsidy that rewards staff members who publish.'

Overall collaboration has had a positive impact on the productivity of South African scientists[28] and scientists prefer international to domestic partnerships. The roots of collaboration date into the past and with time, the country has become a regional hub for collaboration, given its relative strength in higher education, better funding schemes and policy frameworks, well developed research and ICT infrastructures and an attraction to leading African and global scholars. These trends are likely to continue into the future.

Improved visibility is a motive for collaboration.[20] It would stand to reason that examining co-authorship patterns would give one an approximation for visibility (as was undertaken by Sooryamoorthy[29]). While the visibility of African research remains low,[9] the visibility of South African research would have been even lower, had South African researchers not engaged in international collaboration efforts.[24]

Methods

As the South African academic and research landscape moves towards more internationalisation, it is important to begin to analyse the existing collaboration through various research approaches. Pouris and Ho[21] point out that 'scientific co-authorship of African researchers has become a fashionable topic in recent scientometric literature. Researchers are investigating the effects, modes, dynamics and motives of collaboration…' Bibliometric studies, evaluation of author networks and journal impact, are all areas that need a sustained level of evaluation in order to contribute to the global body of knowledge in these fields.

There is a multitude of perspectives that one could take when exploring research patterns. In this study, the perspectives focused on three areas: general growth, visibility and collaboration. Other perspectives, such as research uptake, can be explored in further studies. This study considered the following:

- Has CPUT research output exceeded the growth rate of other Universities of Technology (UoTs) in South Africa? Has it exceeded the growth rate of the other 22 public universities in the country?
- How visible is CPUT research output when compared with the other UoTs and public universities in general?
- What are the patterns of collaboration with regard to degree and type of CPUT research?

Method and data

All data were drawn from Scopus on 3–4 February 2015. The data covered the ten-year period from 2005 to 2014. As Scopus has an export limitation of 2000 records, data were drawn for each institution individually. Sol Plaatje University and the University of Mpumalanga had no records for that time period and were excluded. This left 23 institutions in the sample.

The subject areas were limited to those under the engineering and applied science disciplines and were consistently applied to ensure comparability of the results. The following subject areas were included:

- Agricultural and Biological Sciences
- Chemical Engineering
- Chemistry
- Computer Science
- Materials Science
- Energy
- Engineering
- Environmental Science
- Materials Science
- Mathematics
- Physics and Astronomy
- Earth and Planetary Sciences

The classification of articles into these subject areas was done by Scopus. It is recognised that the selection of these subject areas is subjective and other needs might yield a different selection.

Once the records were found in Scopus, they were exported in comma-delimited format. This allowed for the manipulation of records in Microsoft Excel and VOSViewer.[30] VOSViewer was used to glean the number of authors, the number of unique journal titles and the collaboration details. These were collated in Microsoft Excel.

In all cases, 2005 was used as a base year and growth of any variable reflected the change from the base year. As there were three levels of analysis – the institution, UoTs as a group, and all the public universities in South Africa – using the growth rate for comparison was easier that using the raw figures.

Limitations

This study restricted itself to data available in Scopus. Not all research output was available in Scopus, therefore a larger pool might have yielded more reliable results. However, Scopus is the largest citation database and represents the best data available. Coverage by Scopus of Applied Science and Engineering, the disciplines in question was considered to be better than coverage of the social sciences. By limiting the study to Applied Science and Engineering, the reliability of the results was improved.

Scopus restricts the export of records to an amount of 2000. Without this restriction, the study could have been expanded to include all of African institutions, and possibly institutions on other continents as well.

Results

As indicated by the research questions, the results were discussed in three groupings: growth, visibility and collaboration. For the first two groupings, comparisons were made between CPUT, UoTs and South African public universities. For the third, collaboration, only CPUT was discussed. Motivations for this restriction are given in the section on collaboration.

Growth rate

Figure 1 shows how the number of articles has grown over the ten-year period. From 2008, CPUT has grown its output faster than the national average for public universities, and faster than the UoT average. The dip in 2014 shows that South African research output is not exempt from the publication lag experienced by others. The growth of the number of articles indicates that CPUT has responded well to incentives to increase research output, and has embraced the challenge of joining the research community in South Africa.

Considering the publishing cycle, the initial low output from 2005 to 2008 is not surprising. During this time, inexperienced researchers would be going through a period of revising and resubmitting articles. It would appear that after an initial three years, researchers gained a certain level of experience which allowed publication output to increase rapidly.

According to Kahn, the increase in publications can be attributed in part to the increase in publication subsidy by Department of Higher Education and Training, the increase in South African journals indexed in Web of

Science and a shift in focus to fields with higher publication propensity.[31] Pouris[32] points out that the primary incentive fuelling the recent growth is 'the new funding formula in the country which subsidises the universities by more than ZAR100 000 for each publication; the increase in the number of journals indexed in the ISI Thomson Reuters database and the incorporation of social sciences at the NRF'. All these factors contributed towards the growth of research outputs in South Africa.[32]

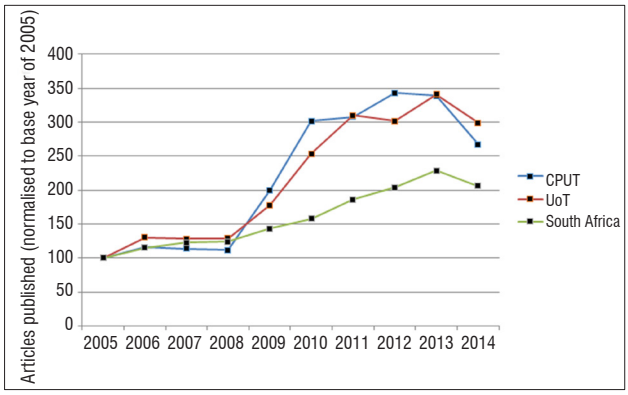

Figure 1: Growth in research output over a ten-year period.

Visibility

Visibility can be considered within the context of three variables: citations, the number of authors and the number of unique journal titles. All three variables show that there is an increasing visibility of CPUT research which conforms or surpasses the rate shown by South African public institutions.

Citations

Citation counting is the most common method of measuring visibility. The shortcomings of this method have been thoroughly explored by others[33] and will not be repeated here. Regardless of such criticism, it remains a simple metric for showing the use of research by other researchers.

The growth rate shown in Figure 2 has been normalised for the year of publication. On the whole, the growth rate of citations of CPUT research has been greater than that of both UoTs and South African public institutions in general. The decrease in recent years could be as a result of the citation lag, despite the attempt to normalise for it. A study covering a longer period would be able to reveal if this is the case.

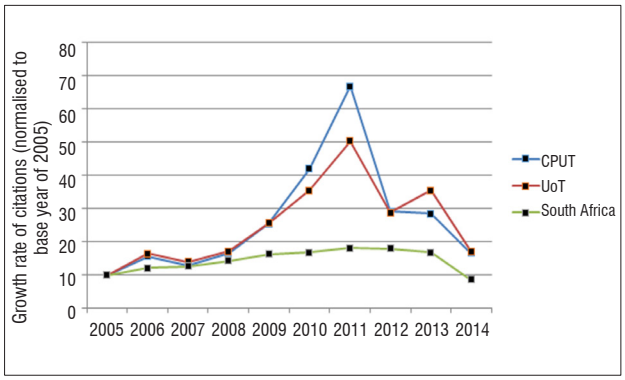

Figure 2: Growth in rate of citations over a 10-year period

Authors

Every researcher has his or her own community, network or audience. By involving more participants in the authoring of research articles, an institution can increase the visibility of its research. Increasing the number of authors could be done through the encouragement of new researchers to publish or by involving authors outside the institution through co-authorship. Figure 3 does not distinguish between these two methods, because from the perspective of growing one's audience, they should not differ.

The growth rate of CPUT authors (and co-authors) has been increasing steadily at a rate similar to that of other UoTs and South African intuitions in general. In 2011, however, there was a marked increase by the latter, while the UoTs, CPUT included, did not follow suit. Whether this is the start of a levelling off, or simply a short slump, is uncertain. What is clear though is that CPUT has increased the number of authors (and co-authors) by more than three times, which is a significant amount.

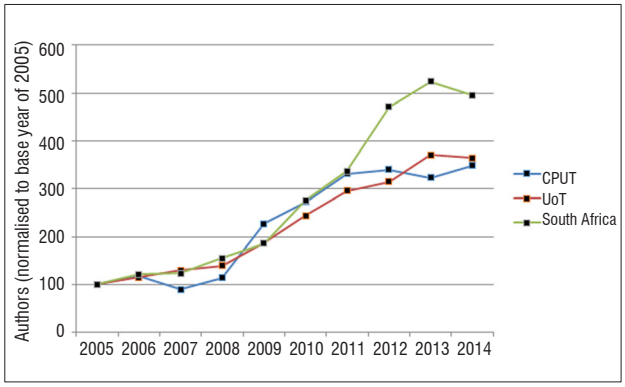

Figure 3: Growth in the number of authors over a 10-year period.

Journal titles

Another way of increasing one's audience is to publish in more journals, as each journal has (assumedly) its own audience. Figure 4 shows how the number of unique journal titles has grown for CPUT, UoTs and South African public institutions. CPUT has been successful in finding new avenues of publication and the growth rate of unique titles CPUT exceeds other UoTs. Other South African researchers have been growing their audience in the same way, but not at the rate of the UoTs.

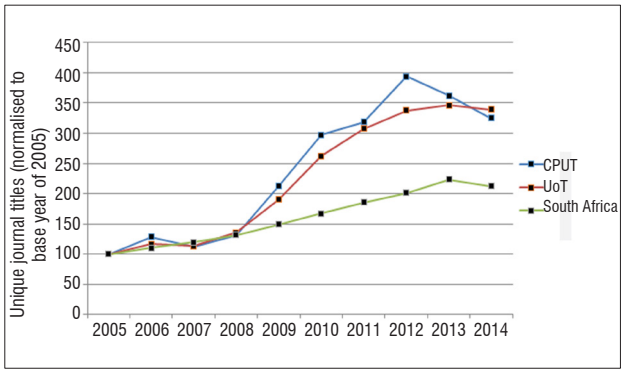

Figure 4: Growth in unique journal titles over a 10-year period.

Collaboration

The final research question was based on the distinction between degree and type of collaboration made by Sooryamoorthy.[25] Degree is the number of collaboration activities, whereas type refers what geographical boundaries the collaboration transverses. For this research question, collaboration was narrowly considered as co-authorship.

Figure 5 displays how the co-authoring relations have changed over the ten-year period of interest. Co-authorships between researchers at CPUT grew dramatically, showing how the internal research community is bonding. Co-authorships with partners in the Western Cape were noticeably more than co-authorships with other South African partners. There was also more engagement with non-African countries than with other African countries. Figure 5 shows that CPUT researchers are not exploiting geographical advantages by partnering with close neighbours. This could indicate a trend towards e-research.

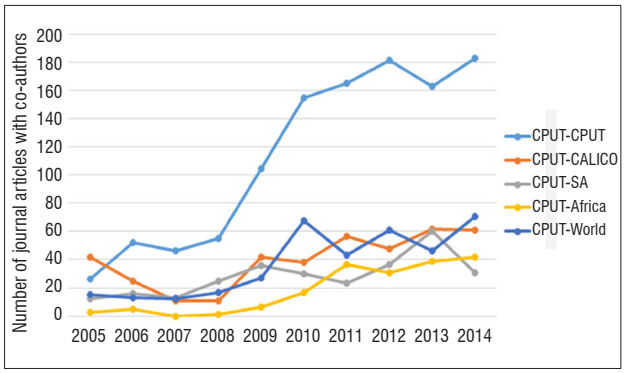

Figure 5: Growth in CPUT collaboration over a 10-year period.

Conclusions

This paper contributes to the literature on publishing patterns of science and technology in developing countries and represents one of the few scientometric studies on a South African institution. The objectives of the paper were to establish the publishing patterns of researchers in the faculties of Applied Science and Engineering at CPUT and the results show a steady growth in research outputs in science and technology at the university. It is clear that researchers in science and technology disciplines at CPUT have taken up the mandate to contribute to scholarly literature since the inception of the institution in 2005. It also shows a continued trend of international collaboration, not only with developed countries, but with African partners too. The increased visibility of the knowledge produced at CPUT creates a virtuous loop of improving the impact of CPUT research. Evidence of this will be seen in citations.

The use of bibliometric data, as provided by Scopus, is just one of the many ways in which researching patterns can be studied. As a UoT, CPUT is also engaged in creating commercially viable knowledge and contributing positively to the community outside of the university. Bibliometric measures, while useful to a degree, do not paint a full picture on the knowledge production and uptake by the institution.

Looking to the future, CPUT is investigating how to continue to increase the experience of researchers and push past the plateau evident in recent years. Engaging in multidisciplinary research is one method as it draws on everyone's strengths. Increased collaboration, particularly with other developing countries could aid, not only CPUT, but their partners as well. The focus on multidisciplinary research areas, growth of specialised research units, appointment of more Research Chairs, unlocking the potential of staff and students, emphasis on research uptake activities as well as the maintenance of excellence in research will all contribute to the growth and development of research outputs within this young university. These measures will work towards increasing the quantity of publications without sacrificing the quality of the research produced.

This paper focused only on three perspectives of research patterns: growth, visibility and collaboration. Other perspectives, such as research uptake, can be explored to supplement the results shown here. It is hoped that this study will be repeated in the future as a way of continuously tracking CPUT research output. The framework presented in this article can be used by other intuitions. Such studies could create a pool of research on publication trends which will be comparable and could be used to benchmark growth.

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Author Contributions

E.C. was the project leader and provided the framework, the content of the introduction and parts of the literature. L.S. provided the initial analyses and interpretations. Both worked on the editing.

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