A Comparative Analysis of Innovation Support Models at Higher Education Institutions in South Africa

Silvester Oluput
Manoj S. Maharaj

Abstract
In this paper insights on how innovation support models at universities in South Africa can best be structured to achieve success. Some of the factors that effect innovation at higher education institutions include the institutional arrangements for the management of intellectual property and technology transfer capacity. A case study approach was adopted to examine innovation. The interview analysis revealed that Higher Education Institutions use more than one indicator to measure their performance. While there are several good innovation performance indicators, this study preferred the patent system as a good yardstick.

Keywords: Innovation, Technology Management, Patents

Introduction
This study analyses the innovation support models at South African Higher Education Institutions (HEIs). The study provides some useful insights on the extent to which patenting affects publication, with particular emphasis on the 'Big Five' research universities in South Africa. The study reviews the institutional arrangements for the management of intellectual property and technology transfer at the institutions and various policy initiatives by the Department of Science and Technology (DST) of South Africa (Sibanda 2008).

Below is a summary of analysis of provisional and complete patent applications filed by these institutions at the South African Companies and Intellectual Property Registration Office (CIPRO), and patents granted to the institutions for the period 2001 to 2007.

Table 1. Patent Applications Filed and Granted to the 'Big Five' at CIPRO (2001- 2007)

Name of HEI	Research publication output ranking	Number of provisional applications	Number of complete applications	Number of granted patents
UP	1st	41	22	28
UKZN	2nd	2	0	0
US	3rd	85	23	19
UCT	4th	49	23	14
WITS	5th	69	11	3

Source: Sibanda (2008)

Table 1 shows an anomaly in respect of the UKZN, where patenting activity is negligible as compared to its peers. Other factors held constant, UKZN should have had between 20 and 27 patents granted within the same period in order to achieve the second position in patenting. Sibanda (2008) attributed the anomaly at UKZN to a lack of policy in respect to IP management, as the individual researchers retained ownership of IP generated from their research.

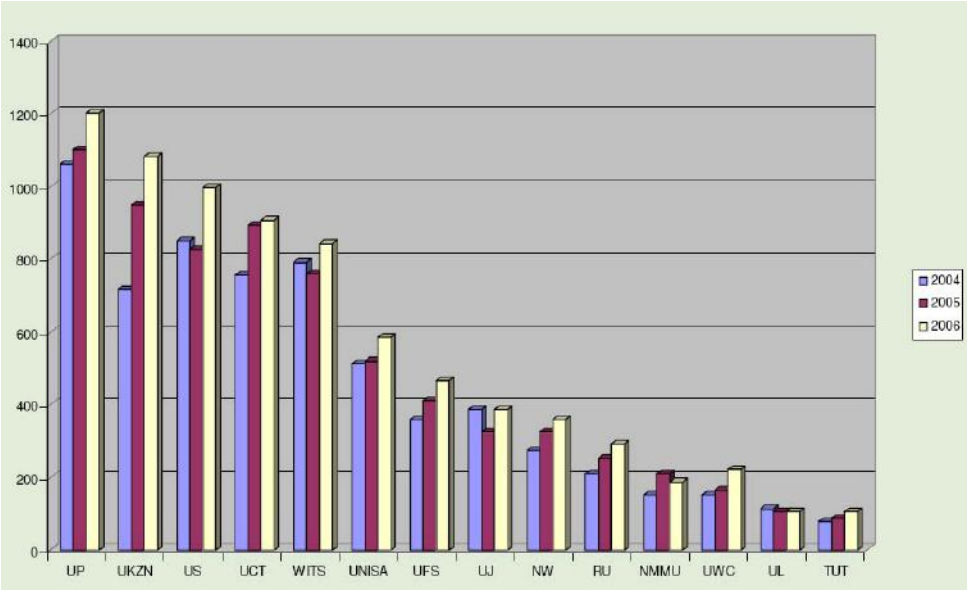
Problem Statement

Research universities broadly have integrated scientific research as a core component of their teaching and mission. They are frequently the source of

technological innovation, which is usually measured by use of patents data (Garduno 2004). Patents data are the only manifestation of innovation activity covering virtually every field of innovation worldwide and over long periods of time. Patents counts are highly correlated with contemporaneous research and development (Trajtenberg 1990). However, despite UKZN's high research publication output as shown in Figure 1, there seems to be no patenting activity at UKZN as shown in Table 1.

This study seeks to investigate why there is an anomaly by critically analyzing innovation support models at HEIs in South Africa, and make recommendations for possible success of technology transfer of UKZN's research output.

Figure 1. The Publication Output of 14 Selected HEIs in South Africa



Source: Eloff (2008)

Research Questions

The research was carried out to be able to address the following major questions from empirical studies:

- To what extent does innovation integrate into the academic research? A case of the top five research institutions in South Africa.

- What is the measure of successful innovation at HEIs in general?

The underlying sub-questions adopted from the study of Sibanda (2008) and addressed by this research include the following:

i. What is the extent of innovation by the institutions both at the local and international offices?
ii. What are the factors perceived by the institutions as affecting innovation?
iii. To what extent are the institutions commercialising their research?
iv. What is the mode of commercialisation of innovation by the institutions?
v. Are the institutions' commercialisation activities based solely on patents or other forms of intellectual property?
vi. Is patenting hindering scientific development by reducing publication rate?
vii. To what extent is the existence of technology transfer offices and IP policies influencing patenting and commercialisation of research results at HEIs?

Case Study Findings and Recommendations

General

The case study suggests that UKZN is indeed one of the top five leading research institutions in South Africa. However, despite the high research output, UKZN does not have the stature that it should have as being a superb research institution that creates economic activity and social benefits through technology transfer of its inventions and research ideas. No patent has been granted to UKZN in recent years, yet patents are technological indicators worldwide and used by DST in South Africa to monitor performance. Similarly other HEIs, though better than UKZN in the area of patenting, performed poorly as compared to their peers internationally.

This study recommends that UKZN should work towards achieving an alignment between research excellence and commercialisation efforts and

attitudes of its staff. This will ensure that research output is an integral and prominent part of UKZN's aspiration to be one of the superb research universities in South Africa that creates economic and social value out of its research. This can be achieved through fostering a clear goal of maximizing disclosures of research discoveries, which is hard to recognize in the early stages. Through disclosures, the private sector and industry will see a large throughput of ideas with commercial potential thus developing as many valid candidates as possible (Manley 2004). Likewise, other HEIs should make their goals of maximising disclosures very clear. Lack of clarity in areas such as revenue sharing ratios may send mixed messages to researchers, hence encountering resistance to technology transfer activity.

Intellectual Property and Management Policies

Existence of IP management policies at HEIs and patenting activity appears to be correlated. HEIs with established IP policies and structures performed better in terms of patenting. This study agrees with findings by Garduno (2004) and Sibanda (2008), which argued that there is no Intellectual Property management policy operational at UKZN. However, a framework for IP commercialisation is stipulated in the Commercial Initiative Policy that was approved by UKZN senate in 2008. Lack of IP Policy has contributed to negligible patenting activity at UKZN compared to its peers. It is also important to note that the number of patents completed and granted to the HEIs in South Africa was lower than the provisional patent applications made by the institutions. A good example of such a scenario is WITS (as shown in Table 1.1), out of 69 provisional applications, only 3 patents were granted. Nevertheless, Moore (2009) argued that filing of provisional patent applications is a common phenomenon, which is quick, and a relatively cheap way of securing a priority date and starting the patenting process so that publication can take place.

This study recommends that UKZN should introduce and implement IP management policies that comply with the IPR Act 2008. Other HEIs that already have IP policies should consider revising their policies to comply with IPR Act 2008. This study cautions the HEIs not to go on a patenting spree just for the sake of patenting and end up with a large number of non-commercial, archaic and expensive patents. It is therefore necessary to involve qualified staff with both science and commercial skills, who should

be able to advise whether a particular invention is novel with commercial value. Generally, patent attorneys recommend filing of provisional patent application within two weeks of disclosure without necessarily carrying out due diligence process that is costly and leads to delays in publications. Due diligence can then be carried out before the PCT application is filed. The PCT application leads to International Search Report that is very useful in assessment of patentability and value of an invention (Mulder 2008; Venter 2008; Moore 2009). This study therefore recommends such a procedure to be carried out before committing significant resources to patenting.

Resources

Successful IP management is a prerequisite for successful commercialisation, thus technology transfer activity is a complex process, which requires funding and a right mix of skills, performance, motivation and cooperation between researchers and TTO staff. However most HEIs indicated that there were challenges in the area of funding to finance the patenting costs and a lack of the right mix of staff with science and business backgrounds. The root cause of insufficient funding stems from lack of entrepreneurial abilities by the universities, whose core objectives are teaching, research and outreach.

This study recommends the HEIs to implement strategies adopted from Manley (2004) as follows:

- Develop in-depth knowledge on what research is being done and assess its commercial potential before patenting.
- Educate researchers on how to protect their ideas, build trust and comfort with the idea of commercialisation.
- Try to attract private sector interest for both licensing technologies and creating start-up companies.
- Promote linkages with other functions such as contracting basic research with the aim of enhancing value of the original research idea.
- Introduce Bachelor of Innovation in Business Administration (BIBA) in South African HEIs to provide students with both business and science skills. The curriculum should be tailored such that graduates of BIBA will develop the critical thinking skills, multi-faceted team oriented skills and basic innovation background to ensure that they

can effectively compete in the changing career landscape in areas driven by innovation. Short courses in the similar field could also be introduced and administered by Innovation Support Models at HEIs to generate third stream income. A range of Bachelor of Innovation (BI) programmes should be considered in South Africa to meet the skills shortage. BI programmes are already offered in other international institutions such as University of Colorado at Colorado Springs (UCCS).

- The above are long-term strategies, however, in the short term the HEIs should look for funding from the DST to support innovation activities. Transaction fees as well as revenue from licenses, contracts and other transfer activities could be a source of revenue to develop and maintain the critical mass needed internally to provide service levels and the expertise needed to carry out technology transfer and commercialisation. UKZN Innovation currently uses this approach and has not yet benefited from Innovation Fund financial resources (Govender 2008).

Support Structures

The Innovation support models at South African HEIs are in three forms:

a. Integrated within the university environment as a department or a division within the Research Office, as is the case with UCT and NMMU.
b. Autonomous separate entities independent from university administration structures but owned by the university as in the case of Wits Enterprises and now InnovUS which initially operated within the university environment.
c. Mixture (Hybrid) of the two above as is the case with UKZN and UP.

Each type of structure has its own unique challenges and has implications in areas such as financial resources, infrastructure and expertise, IP protection, rate of decision making process, to mention but a few. This study recommends the position argued by Burton (1998) that, whatever the local configuration, to be successful, an innovation model should make reference to an entrepreneurial culture.

Governance, Leadership and External Relationships

Governance and leadership of innovation support model depends entirely on the structure as summarised above. Getting the institutional leaders to embrace technology transfer activity is a challenge for most HEIs interviewed. Other interviewees described the governance and leadership in the institutions as bureaucratic with 'too many university chiefs'; others paid just lip service, while members of some governing boards kept the academics out of their boardrooms.

However, it is essential that the board members of the support structure act as true partners to build a collaborative environment. They need to understand and balance both the needs of researchers and those of the business world. The ability to draw on the insights of experienced and skilled people in the private sector (with the right mix of business and science backgrounds) and from other parts of the research community would also be hugely beneficial. The creation of an Advisory Board with involvement of members outside the university community would provide valued advice to the leadership of the innovation support model and would represent a keen interest in the social and economic benefits of research to the community. There should be a need for serious engagement by the most senior officials of the HEIs including the Vice Chancellors and Deputy Vice Chancellors in charge of Research and Innovation. Regular review of the success of the commercialisation effort should be accepted as an important element of the Vice Chancellor's activities (Manley 2004).

Culture

The HEIs surveyed, especially the 'Big Five', have a reputation of being the top research institutions in the country and in the continent of Africa. The entrepreneurial drive is often secondary. Some of the HEIs such as UKZN have a culture that does not support technology transfer as portrayed by lack of IP policies and delays in implementing decisions. Others regard TTO as an irritation rather than a need. In some HEIs, there is a lot of freedom while in others 50% of the professors were not involved in research.

This study recommends that HEIs should adopt a culture in which technology transfer and commercialisation are encouraged, respected and rewarded for the economic and societal benefit. This is in line with the IPR

Act 2008 that calls for establishment of TTOs at HEIs and stipulates the functions of TTOs. The government of South Africa through DST expects returns from public funds invested in HEIs, not necessarily in financial terms, but in terms of new technologies, new treatments and medications, thus benefiting the society. For the case of UKZN, cultural issues are part of the reasons that have led the country's second largest research output producer to under-perform in the area of patenting. With these recommendations, this study argues that the leadership of the UKZN needs to take all necessary steps needed to make positive attitudes to technology transfer and commercialisation central elements of its culture.

Comparative Performance

Analysis of interviews showed that there is low rate of patenting by South African HEIs at both local and international level. Existence of IP management policies at HEIs and patenting activity appears to be correlated in that the HEIs with established IP policies and structures like UP, SU, UCT and NWU performed better in terms of patenting. Furthermore, the bulk of research from the 'Big Five' is skewed towards basic research as per UKZN's research output analysis by faculties. However, NWU appears to focus mainly on applied research with commercial value as per its vision and goals. In general, despite low patenting activity coupled with low conversion of these patents into commercial ventures, there is progress by the HEIs in terms of setting up the IP policies, TTOs and structures that favour technology transfer and commercialisation.

This study recommends that HEIs improve on infrastructure and develop world-class facilities and equipment so as to attract skilled and creative research leaders. Moving an idea from the laboratory to commercial application involves providing a service to the inventor and success is commensurate with the quality of that service. The officials responsible for technology transfer and commercialisation must be skilled at finding and packaging technologies inside the HEIs and introducing the technologies to the best private-sector matches for further commercialisation. Furthermore, the service providers must build a climate of trust and innovation culture through having closer, active ties with the researchers while focusing on their needs.

Performance Indicators

The interview analysis showed that HEIs used more than one indicator to measure their performance. These include: Number of disclosures, number of patents, number of breakthroughs to industry, number of projects managed within the Innovation Portfolio, the level of efficiency of innovation systems and tools. Other indicators include financial viability of research projects through the successful commercialization of projects and income generated.

While all the mentioned variables are good indicators to measure the success of an innovation support model, patent system is accepted internationally as a good yardstick. Patents can be used to analyze the technological activities of inventors, firms, regions and countries. They are valuable because they provide the researcher with a coherent set of data across countries and specific technological fields for long time series. Moreover, patents show a high level of correlation with R&D at the firm level and this suggests using patents as an 'input' indicator that measures the technological effort of companies and non-firm organizations to create new products and process (Montobbio 2007). In South Africa, patents are one of the technological indicators monitored by the Department of Science and Technology (Pouris 2005). This study therefore recommends patents as a yardstick for measuring innovation in general. This is due to the fact that proper use of the patent system could result in additional publications to the researchers and could facilitate the transfer of new technology to industry as indicated in the next sub-section.

Publishing, Patenting and Commercialisation

There is evidence that high quality research and high quality researchers tend to go together with patenting. The Murray and Stern (2007a) paper as cited by Montobbio (2007), shows that patented research is on average more cited and keeps on being cited even if at a lower rate. Case study evidence suggests that patenting is becoming important for having bargaining power to exchange and share protected tools and materials. However, the relationship between patenting and publishing may be negative at the individual level mainly due to a 'publication delay' effect and /or a 'basic-applied trade-off.

Despite delays in obtaining patents, the patent system has the benefit of securing the researchers a far earlier date for their research work, namely

the 'priority date' on which the first patent application (for example a provisional patent application) is filed, (Hurlin 1985; Sibanda 2008; Moore 2009).

Regarding the commercialisation of research, some lessons can be drawn from the literature surveyed. For example, companies' absorptive capacity is extremely important and companies in various industries have to be 'connected' with the HEIs in order to be able to absorb new ideas and discoveries. Montobbio (2007), argued that knowledge transfer between university and industry is based on a lot of different forms of interaction. Most of the research has focused on life sciences and biotechnology where basic research is very close to commercial applications. In these fields, there has been an impressive growth of university patents. However, technology transfer mechanisms vary considerably according to the scientific field, to the stage of development of the invention and across regions because they adapted to different institutional setting and research systems. Reamer, Icerman and Yantie (2003), Mowery and Sampat (2005) and Montobbio (2007), point out that the explosion of university patenting in the US is to great extent related to the biotechnology revolution that in turn has is roots in the considerable amount of federal funds dedicated to medical research.

This study therefore, recommends that technology transfer professionals in the HEIs should be in close contact with both the researchers and the industries with the aim of commercialising the research from the HEIs. Without any bias to other fields, emphasis on life science, biotechnology and basic research with commercial applications should be exploited and commercialised. The government of South Africa should follow the example of US federal government by increasing research funding in general, with emphasis on life science, biotechnology, biomedical and any basic research with commercial applications.

Other Factors

Apart from the above factors, this study established that, there are other challenges that the TTOs in South Africa are faced with. These include: loss of IP due to lack of awareness by researchers; not enough visits to the relevant units around the country; lack of funding for product development and commercialisation; difficulty in market penetration (both local and

international markets). Other factors include: the stage of development of the technology, the extent to which the patent addresses a large potential market, lack of systems that support venture creation, dearth of venture capital investors who really understand the technology offering and lack of seed funding for preliminary proof of concept work to increase success of licensing and technology transfer activities.

Recommendations based on the TTOs experiences include: Use of awareness raising to solicit invention disclosures, establish audit units to identify inventions, give due attention to all invention disclosures; evaluation based not only on commercial potential but also social benefit; licensing out for further development and Spin-outs where appropriate. The study by Sibanda (2008) suggests that successful technology transfer requires a regulatory and institutional support framework that must include policies regarding ownership, protection and transfer of new technology. The transfer of technology to industry is a complex function requiring diverse skills some of which may have to be outsourced from outside HEIs. The technology transfer process takes time and requires patience; undue pressure should not be placed on technology transfer professionals based on unrealistic monetary expectations. With the technology transfer concept being new in South Africa, researchers in HEIs have tended to focus on other mechanisms such as secrecy, publications and contract research. However the HEIs now have the support from the government of South Africa through the IPR Act 2008. All the researchers using public funds need to comply with the IPR Act.

Conclusion

This study addresses the extent to which innovation integrates into academic research. The possible yardsticks for measuring innovation are summarised in the sections above. However, comparative analysis of innovation can be hampered by scarcity of appropriate data and lack of good indicators with a wide coverage. Patents counts, weighted by citations are regarded in South Africa as good indicators for measuring and assessing the value of innovations.

This study therefore, recognizes that the path to achieving research and innovation excellence in South African HEIs, especially UKZN, will not be an easy task. It will involve breaking down existing barriers within and

outside the institutions, place building links, trust and a collaborative spirit. Successful innovation at HEIs rests largely on quality infrastructure and availability of highly skilled and creative researchers and technology transfer professionals, thus reflecting a truly entrepreneurial and innovation culture.

References

Burton RC 1998. *Creating Entrepreneurial Universities: Organisational Path-way of Transformation.* Oxford: International Association of Universities and Elsevier Science Ltd. (Issues in Higher Education Series.)

IPR Act 2008. Department of Science and Technology (DST) 2008. Intellectual Rights from Publicly Financed Research Act. Pretoria.

TIA 2008. Department of Science and Technology (DST). Technology Innovation Agency Act. Pretoria.

Eloff T 2008. Research and Innovation as a Differentiating Factor in Higher Education. HESA Presentation by HESA Chair to the SARIMA Conference, Stellenbosch, 4 June 2008.

Garduno E 2004. *South African Technology Transfer: A Comparative Analysis.* International Intellectual Property Institute Report. 906 Pennsylvania Avenue, SE Washington, DC 20003. Available at: 202-544-6610 www.iipi.org. (Accessed in November 2008.)

Govender R 2008. Interview with Govender R, CEO of UKZN Innovation (Pty) Ltd.

Hurlin DCR 1985. *The Management of Technology Developed at South African Universities.* Pretoria: University of Pretoria.

Manley J 2004. Report of the Manley Panel on Commercialisation and Technology Transfer at the University of Toronto. November 16, 2004.

Montobbio F 2007. *Intellectual Property Rights and Knowledge Transfer from Public Research to Industry in US and Europe: Which Lessons for Innovation Systems in Developing Countries?* Varese: Insubria University, Italy CESPRI – Bocconi University, Italy.

Moore R 2009. Interview and Comments from Mr. Rory Moore: Director of IPMO, UKZN.

Mowery DC & BN Sampat 2004. Universities in National Innovation Systems. Haas School of Business and School of Public Policy, Georgia:

Institute of Technology.
Mulder S 2008. Technology Transfer at the Medical Research Council: SARIMA TTO Workshop in October 2008.
Pouris A 2005. Technology Performance Judged by American Patents Awarded to South African Inventors. *South African Journal of Science* 101, May / June.
Reamer A, L Icerman & J Yantie 2003. *Technology Transfer and Commercialisation: Their Role in Economic Development*. Economic Development Administration, US Department of Commerce.
Sibanda M 2008. *Intellectual Property, Commercialisation and Institutional Arrangements at South African Publicly Financed Institutions. Innovation Fund.* Pretoria: National Research Foundation.
Sibanda M 2008. Presentation paper at SARIMA Conference (Oct 2008) and Presentation paper at a workshop to Researchers at UKZN.
CIP 2008. University of KwaZulu-Natal Proposed Commercial Initiatives Policy (UKZN PCIP) 2008.
Venter P 2008. Commercialisation of Intellectual Property in Research and Teaching Institutions: Presentation Paper. Hahn & Hahn IP Practitioners RSA.
UCCS 2009. Available online at: www.vast.uccs.edu/~tboult/BI/survey-results.html. (Accessed in January 2009.)

Silvester Olupot
Graduate School of Business,
University of Kwazulu-Natal
Durban, South Africa
Olupot@ukzn.ac.za

Manoj S Maharaj
School of Management, IT & Governance
University of KwaZulu-Natal
Durban, South Africa
Maharajms@ukzn.ac.za