

The Impact of Improved Access and Connectivity on Intellectual Property Output: Baseline Report

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1. Introduction

“...when countries lose their base for academic excellence – throughout-dated policies, neglected institutions, the exodus of their best graduates or woefully inadequate investment in research – their competitiveness in the global knowledge society will dwindle and eventually disappear”⁵.

We open with this quote because it paints a stark but correct picture of what is happening in many African countries, providing a starting point for this discussion.

The intellectual property output of African universities and research institutions and their contribution to national human development is not commensurate with their human resource. The institutions also have very limited visibility at the global level, leading to loss of competitiveness of the institutions, and consequently the competitiveness of their home countries. While this is the result of many factors, ***we posit that the current isolation of Africa-based researchers from the global information infrastructure (GII) is a major contributing factor, and that the reduction of such isolation will lead to increased intellectual property output.***

During 2009, the UbuntuNet Alliance initiated research aimed at examining this hypothesis by tracking researcher behaviour over a period of at least five years. The actual baseline data collection started during 2010, running into mid 2011. In this paper we report on this baseline study that was designed to benchmark the status of access and connectivity as well as intellectual property output, all measured at the institutional level. Based on the findings of the baseline research, we also make action recommendations to universities that are aimed at creating the kind of research environment where improved access and connectivity would boost research output.

We start with a background section that provides the context for this on-going research, specifically discussing what makes up the research environment in a university, in recognition of the fact that there are several other elements that will influence the quality and quantity of intellectual property output. We then describe and explain the research design, followed by a

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⁵ Kearney, M.L., “Charting the Course of the Changing Dynamics of the Knowledge Society”, page 14 in “Higher Education, Research, and Innovation: Changing Dynamics” edited by Meek, V.L, Teichler, U., and Kearney, M.L. International Centre for Higher Education Research Kassel, 2009

per Mbps per month for most universities in the region, the prices are still very high compared to the rest of the academic and research world.

It must be pointed out that access is not simply about Internet connectivity. It also includes campus readiness to connect to the Internet and provide sufficient access devices to faculty and students. The Kenyan NREN—Kenya Education Network (KENET) has conducted two studies, the E-readiness survey in 2006 and the East African Accession Project in between 2008 and 2010.

KENET used the E-readiness survey (2006)⁸ that covered 25 member institutions (17 universities and 8 tertiary institutions) to assess the level of preparedness of member institutions to use ICT for teaching, learning, research, and management. Although it included both a hard-facts questionnaire for institutional data and a perceptions questionnaire for students and staff, the main goal was to influence institutional ICT strategy development through providing a diagnostic e-readiness framework that enables an institution to work through a four-stage process towards better e-readiness. To assess e-readiness, the survey used 17 indicators grouped into five categories—network access, networked campus, networked learning, networked society and institutional ICT strategy.

In the East African Accession survey⁹, KENET went beyond its borders to include universities in Burundi (5), Kenya (17), Rwanda (7), Tanzania (9) and Uganda (10) by working with NRENs in those countries.

A major finding in both studies was that the overwhelming majority of academic institutions at tertiary and university level were not ready to participate in the GII, even if cheap high capacity connectivity was to be provided to them. An internal survey¹⁰ by the Research and Education Network of Uganda, RENU, conducted three years later also revealed that only one institution, Makerere University, was ready (*at the time*) to take in 100Mbps of Internet connectivity.

The UbuntuNet Alliance, working with NRENs, focuses on the removal of isolation of the Africa-based researcher by creating and enabling easy access to both online resources (materials) and online collaboration opportunities (people). The Alliance and almost all NRENs in Africa are still at a formative stage, and require both government and development partner support to get them to the same level of service delivery as NRENs around the more developed countries. There are however competing demands on both these sources of funding, and the Alliance therefore set out to make an evidence-based case for investment by African governments into NRENs and the required connectivity by demonstrating the impact of increased access and connectivity on intellectual property output.

⁷ Tsubira, F.F., Adams, L., Butcher, N., Claire, S., “e-Transform Africa, Education Sector Report”, <http://www.etransformafrica.org/study/final-report-and-executive-summary-education>

⁸ E-Readiness Survey of Higher Education Institutions in Kenya, http://kenet.or.ke/eready/staging/E-readiness_survey_of_Kenyan_HigherEducation_June2007.pdf. Kashorda, M. and Waema, T, led the study.

⁹ EA Accession Project findings on E-Readiness of Higher Education Institutions in East Africa, <http://kenet.or.ke/eready/index.php>

¹⁰ RENU Internal documents

2.2 Intellectual Property Output and the Research Environment

We use the phrase “*intellectual property output*” in this paper to include all scholarly publications and patents. Scholarly communication includes peer reviewed journal papers, conference paper, and non-peer reviewed academic publications. Several authors have highlighted the challenge of limited intellectual output from African universities, in most cases with specific reference to scholarly publications, which manifests itself in the triple challenges of quality, quantity, and visibility. For example, in their paper, Adams *et al*¹¹, using data from the Thomson Reuters Web of Science¹², show that from 1999 to 2008, the entire African continent had 27,600 scientific papers published, while the Netherlands alone had 27,000 during the same period. When one factors out countries in North Africa along with the Republic of South Africa, the number drops to less than 8,000.

The challenges of quantity and quality are compounded by poor visibility. Non profit initiatives like African Journals Online¹³ were set up to ensure the greater visibility and easier accessibility of African scholarly output to both Africa and the rest of the world. The Scholarly Communication in Africa Programme, SCAP¹⁴, is one of the responses to the challenge of visibility. SCAP is “*aimed at increasing the visibility and developmental impact of a spectrum of research outputs from universities in Southern Africa*”. Despite being region specific, the online discussions, findings, and recommendations have relevance to the rest of Africa.

On a global scale, patents registered by African countries are almost insignificant. The 2011 statistics from the World Intellectual Property Organisation¹⁵, WIPO, show that out of 1,414 (2008 data) patents in force as registered by the African Regional Intellectual Property Office, only 113 were from African countries, the bulk of these (98) being from South Africa. The same report has South Africa (2010 data) with 6,530 reported patents in force, including 820 from South Africa and only 8 from the rest of Africa. To provide a sense of the current imbalance, of the 6,530 patents cited above, 1,939; 702; and 493 patents were from the USA, Germany, and UK respectively. Continental statistics have been used to make the point: global statistics push Africa below the significant level.

The national research system of any country, as well as specific institutional organisational factors of say a university, have a direct and high impact on intellectual property output¹⁶. Based on an analysis of 63 agricultural research organisations in Ghana and Nigeria, Ragasa¹⁷, makes the clear case that organisational factors impact the productivity of scientists, while at the same time giving a comprehensive review of papers that have looked at factors that impact on

¹¹ Adams, J., King, C., Hook, D., “Global Research Report Africa”, 2010

¹² http://thomsonreuters.com/products_services/science/science_products/a-z/web_of_science/

¹³ <http://www.ajol.info/>

¹⁴ <http://www.scaprogramme.org.za/>

¹⁵ World Intellectual Property Indicators 2011, <http://www.wipo.int/ipstats/en/wipi/index.html>

¹⁶ Two key references, both books containing related articles from various authors are noted here. One is “Higher Education, Research, and Innovation: Changing Dynamics” edited by V. Lynn Meek, Ulrich Teichler, and Mary-Louise Kearney. International Centre for Higher Education Research Kassel, 2009; and the other is “The Road to Academic Excellence: *The Making of World-Class Research Universities*”, edited by Altbach, P.G. and Jamil Salmi, J. The World Bank, 2011.

¹⁷ Ragasa, C., “Do Organizational Factors Affect Individual Scientist’s Productivity? A Comparative and Multilevel Analysis of Nigeria and Ghana Agricultural Research Systems”, International Food Policy Research Institute, 2010

researcher output. Our focus in this discussion is the institutional research environment. The objective is not to carry out an analysis of the environment, but rather to place access and connectivity as one of the elements within the larger context of the research environment. It also provides an important starting point for tracing the thread of impact of access and connectivity. We recognise the fact that if the other factors in the research environment are not right, connectivity and access alone would still make some difference, but the synergy would be lost as would be the real value of such access.

Figure 2 illustrates the theoretical concept used in this paper in this paper. A researcher, with a given set of attributes (level of qualification, discipline, research competence, ICT literacy, information literacy, teaching competence, gender) gets immersed in the research environment of a university. This environment will then shape the researcher’s behaviour, stimulating them to conduct research and generate intellectual property output. Conversely, the environment, if not conducive to research, can instead discourage a researcher from conducting research.

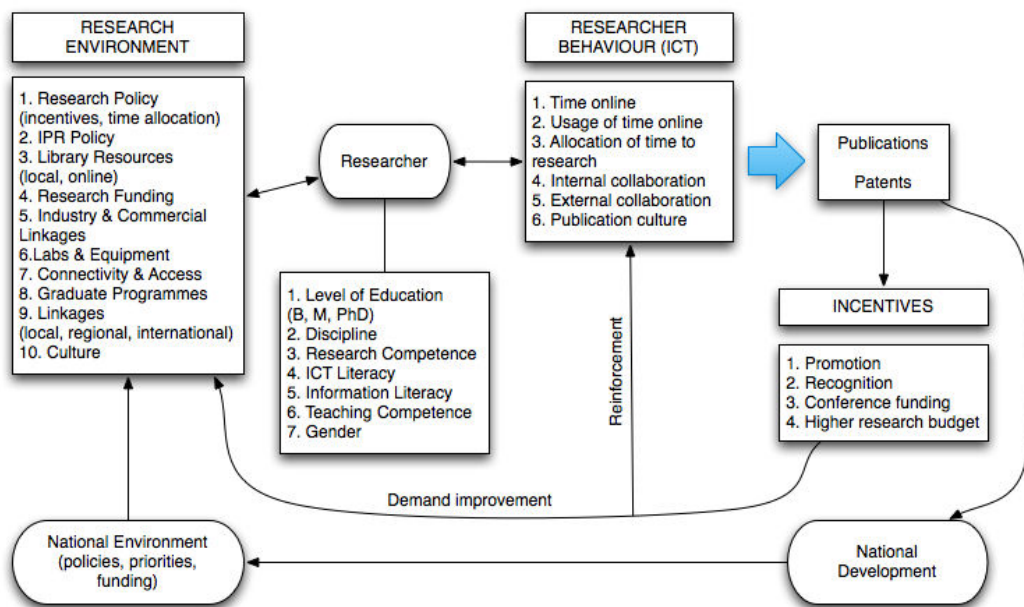


Figure 2: Concept of the relationship between the researcher, researcher behaviour (ICT specific) and the research environment

In the university environment, we note the following key organisational factors that define the research environment:

- i. Research Policy—spelling out the policy objectives and strategy. The policy should cover the organisational positioning and governance of research within the university; principles and methods/processes for identification of research priorities; research capacity development; research funding targets; incentives to promote research (such as research-related promotion; output oriented research funding; recognitions; etc.);

- research dissemination and exploitation; balancing time allocation between teaching and research; etc.
- ii. Intellectual Property Policy—addressing approaches to ownership and rights of the institutions vis-à-vis the researchers; and types of copyright that will apply and how; etc.
- iii. Library Resources—supporting the teaching and research processes, especially those accessible online;
- iv. Research Funding (within the broader context of institutional budget guidelines);
- v. Industry and Commercial linkages (also relates to the level of maturity within the industrial and commercial enterprises);
- vi. Laboratories and Equipment;
- vii. Connectivity and Access;
- viii. Graduate Programmes;
- ix. Linkages (institutional, national, regional, global)
- x. Institutional Research Culture.

This illustration focuses on the specific behaviour we have assumed would be shaped by access and broadband connectivity to the global research and education environment, namely:

- i. Time spent online
- ii. How the time online is used
- iii. The relative amount of time spent on research
- iv. Active involvement in collaborative activities (internal and external)
- v. Publication culture

This behaviour leads to two specific outputs: publications, and patents. What happens next will then condition the researcher in a way that either reinforces or weakens positive aspects of researcher behaviour. If the incentives (as captured in the research policy) reinforce the positive behaviour, the researcher becomes more conscious of the shortcomings in the research environment and will push for improvement. Where the environment is responsive to such pushing, a virtuous cycle will be created and overall research output will be increased.

The following suppositions, not illustrated in Figure 2 (and not addressed in this research) need to be noted:

- i. The actual fact of publication reinforces a good research culture because it leads to satisfaction and a feeling of confidence.
- ii. Where there is positive reinforcement, the researcher will work on improving their attributes especially where the environment supports or enables this: holders of master's degrees will join PhD research programmes, and PhD holders will seek post-doctoral research opportunities as well as other ways of improving their research capacity.
- iii. Experienced researchers, if immersed in a poor research environment, will immediately start to push for improvement. If they fail, they will either leave or degrade.

It should also be noted that while we have included National Development in our model, the real connection is not as simplistic as it appears: there are many other factors not discussed in this paper that will determine whether or not intellectual output will positively impact on national development. This aspect will be expanded on and examined during the next round of data collection.

2.3 The Specific Role of Access and Connectivity

We submit that access and connectivity boost a good research environment in various ways. The first one that has been very important to universities in developing countries is access to online resources, both the scholarly databases and the more general online publications. The second one is enabling collaboration – within the university and nationally, regionally, and globally. This permits the researcher to join (or re-join) the global discourse in their areas of specialisation, to stay up to date, and be challenged by the work and progress of peers. A very important aspect of this is direct inclusion and access to the dedicated resources in the global research and education community, achieved when national research and education networks (NRENs) are established. Thirdly, it enables access to and use of advanced applications, including direct learning and research tools (for example grid computing; online labs or i-labs) and tools that support effective interaction (for example video-conferencing applications). Finally, access and connectivity enable the institution to have online visibility for its programmes, and its intellectual property output, increasing the chances of attracting good students as well as high calibre researchers.

Looking at all the factors that define the research environment, and taking into account the typical pace of change of major policies in universities, it is reasonable to expect that access and connectivity is the only one that will change rapidly over the five year period starting 2010 because it is strongly driven by external factors, providing a window of opportunity for monitoring impact while the other factors remain on a path of gradual change.

3. Methodology

Our methodology is based on the UbuntuNet Alliance Monitoring and Evaluation Strategy¹⁸. During this exercise, the team identified the basic elements of a program theory, which included both an action and a change theory to help facilitate their work.¹⁹ The action theory captures the efforts of the Alliance and key partners in translating available resources to produce the programme deliverables, while the change theory captures the anticipated changes in the target audience as a consequence of these deliverables. The target beneficiaries are Africa-based researchers in this scenario; the leverage mechanism is the presence of reliable, efficient, affordable and sufficient Internet bandwidth on the continent that is likely to contribute towards a positive outcome—their improved intellectual property output at the global level along with its resulting benefits. All of this takes into account the ecological context bound to influence the outcome, of which higher education institutions where these researchers are based is just a part.

¹⁸ UbuntuNet Alliance. Consolidating Research and Education Networking in Africa (CORENA) Monitoring and Evaluation Strategy. UbuntuNet Alliance, 2009, can be obtained on request from info@ubuntunet.net

¹⁹ Huey-Tsyh Chen. "Practical Program Evaluation: Assessing and Improving Planning, Implementation and Effectiveness" Sage Publications, 2005

Others include the national telecoms policy and regulatory regimes, national and regional fibre rollouts, research funding initiatives, etc.

Using a multi-stage process, we created two survey instruments for the baseline study. The institutional tool collected various types of data about higher education institutions that were NREN members in participating countries, aimed at capturing data about the research environment. Multiple administrative personnel (ICT Support; Library; Research Divisions; Administration) at each institution completed this instrument. The individual tool collected individual researcher perceptions about how their institutional environment supported or stifled their research activities, and also solicited data based on which the researcher behaviour could be inferred.

The resulting instruments were structured and included either single-option or multi-option variables. A 5-point Likert scale was used for responses, and an “other” option provided wherever necessary to capture responses that did not match the structured options. The instruments were self-administered, under the management of a researcher or the NREN CEO in each of the countries that participated.

By the deadline, UA had received returns from five member NRENs out of the eight that had agreed to participate in the survey: the challenge in all cases was the lack of response from both institutions and researchers. Only Ethiopia, Malawi, and Uganda returned sufficient numbers of the individual questionnaires from a sufficient number of universities to assure statistical representation. These three countries were therefore carried forward for the current focus of baseline analysis, with the plan to add more countries during the second round of surveys. All institutional questionnaires from all the countries (Ethiopia, Malawi, Rwanda, Uganda, and Zambia) were however carried into the institutional analysis.

3.1 Individual returns

Valid returns were obtained from 271 academic staff of universities: Malawi (66), Ethiopia (140), and Uganda (65). The following major categories, each broken down into sub-categories, were examined through this instrument:

- i. Demographic characteristics: gender, age, academic rank; qualification; duration of employment by current institution; main employment assignments;
- ii. Research policy: existence and satisfaction;
- iii. Sources of research funds;
- iv. Library: resources and satisfaction;
- v. Laboratories and equipment: sufficiency and satisfaction;
- vi. Computers: access, ownership, usage, and applications used;
- vii. Internet: access, quality, utilisation;
- viii. Conduct of research: individual leadership, volume, time allocation, collaboration;
- ix. Research output: type, where published, attitude to creative commons;
- x. Barriers to, and motivation for research

3.2 Institutional returns

Returns were received from a total of 16 institutions: Malawi (3), Ethiopia (5), Uganda (2), Rwanda (3) and Zambia (3). The institutional returns covered the following major categories:

- i. ICT in the Institution: ICT support unit, Internet and email access, ICT in education functions, ICT in research, ICT curricula, data and network security
- ii. Library: Automation, access to online resources, user training (information literacy);
- iii. Research and intellectual property: documentation, dissemination, commercialisation;
- iv. Research support services.

4. Analysis of Survey Returns and Findings

In this section, we present the analysis of the returns as well as the findings. The individual and institutional surveys are separately treated in two parts, and the third part examines the cross-relationships.

4.1 Analysis of Individual Returns

4.1.1 Demographic characteristics

The demographic characteristics of the sample for the individual survey are summarised in Table 1.

Table 1: Demographic characteristics of respondents

| Rank | Attribute | Frequency | %-share |
|--|----------------------|-----------|---------|
| Gender | Female | 53 | 19.6% |
| | Male | 214 | 79.0% |
| | Missing data | 4 | 1.5% |
| Cumulatively | | 271 | 100.0% |
| Age | Younger than 22 | 6 | 2.2% |
| | 22-32 | 82 | 30.3% |
| | 33-43 | 109 | 40.2% |
| | 44-54 | 51 | 18.8% |
| | 55-65 | 19 | 7.0% |
| | Older than 65 | 3 | 1.1% |
| Missing data | | 1 | 0.4% |
| Cumulatively | | 270 | 100.0% |
| Highest degree attained | Bachelors | 34 | 12.5% |
| | Masters | 166 | 61.3% |
| | PhD | 70 | 25.8% |
| Missing data | | 1 | 0.4% |
| Cumulatively | | 270 | 100.0% |
| Academic rank | Professor | 7 | 2.6% |
| | Ass. Professor | 48 | 17.7% |
| | Senior Lecturer | 38 | 14.0% |
| | Lecturer | 130 | 48.0% |
| | Assistant Lecturer | 18 | 6.6% |
| | Tutor | 6 | 2.2% |
| | Research Associate | 2 | 0.7% |
| | Other | 12 | 4.4% |
| Missing data | | 10 | 3.7% |
| Cumulatively | | 271 | 100.0% |
| Duration at current academic rank | Less than 1 year ago | 45 | 16.6% |
| | 1-5 years ago | 155 | 57.2% |

| | | | |
|---------------------|------------------------|-----|--------|
| (years) | 6-10 years ago | 41 | 15.1% |
| | 11-15 years ago | 9 | 3.3% |
| | More than 15 years ago | 13 | 4.8% |
| Missing data | | 8 | 3.0% |
| Cumulatively | | 271 | 100.0% |

The sample had 271 respondents, 79% of whom were male, a very typical situation. More than 72% were below 44 years of age and only 8% were above 55 years. While this could mean that the more senior members could have been reluctant to complete the questionnaire, direct knowledge of the situation in countries like Uganda points to the reality that senior academics, who are normally experienced in research and the research leaders, are leaving the universities earlier in life. These do not necessarily leave the countries but are absorbed into high-level jobs within government, governmental agencies, and the private sector.

61% of the respondents had a Masters qualification and only 26% a PhD qualification, another challenge to research capacity. The main assignments of almost all respondents were teaching and research.

4.1.2 Research policy: existence and satisfaction

While we did not specifically look into the content of research policies, 84% of the respondents confirmed that their institutions had research and publication policies. However, of these, 49% indicated that they were not satisfied with their institutional research and publication policies. The actual content of research policies will be examined in some depth during the next round of surveys in order to get better insights into the internal institutional arrangements.

4.1.3 Sources of research funding

Typically, most respondents (54%) got their research funding from their institutions as indicated in Figure 3. While this would normally be a positive indicator, it should be noted that research budgets in these institutions are meagre. International development agencies and charitable foundations, from which a total of 48% get their funding, spend much more in real terms than the local institutions. The result is that the local research agendas are often driven by considerations that are not cognisant of the needs of African countries, are largely managed outside of the developing countries and lack sustainability beyond the foreign support.²⁰ A rather high proportion of research funding seemed to come from the personal resources of researchers (23%), raising the question of how academics in African universities, who are widely reported as severely underpaid, are able to fund their own research. This will be also examined in the next round of inquiry as this research progresses.

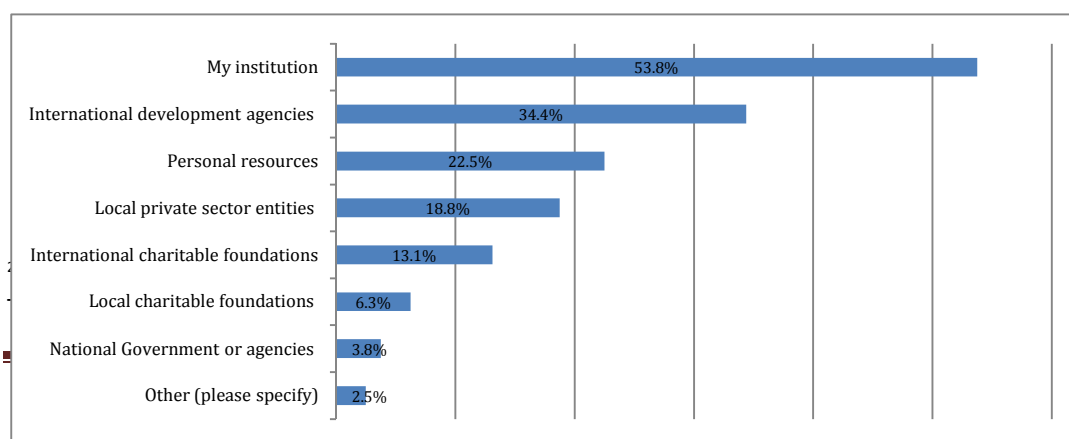


Figure 3: Typical sources of funding for research projects amongst respondents

4.1.4 Library: resources and satisfaction

It emerged that the heavy users of the library resources – using them on a daily basis – use mainly electronic access, pointing to the importance of e-services in libraries. The majority of those who visit the libraries physically tend to do so only once a month (very likely linked to the lending period and number of allowed items). Usage of e-access is still very limited, which is consistent with some of the observations by both Afeworki²¹ and Harle²². On the other hand there are very few users satisfied with the quality of library e-services as can be seen in Figure 4. In many of the universities, the services were reported not to be available.

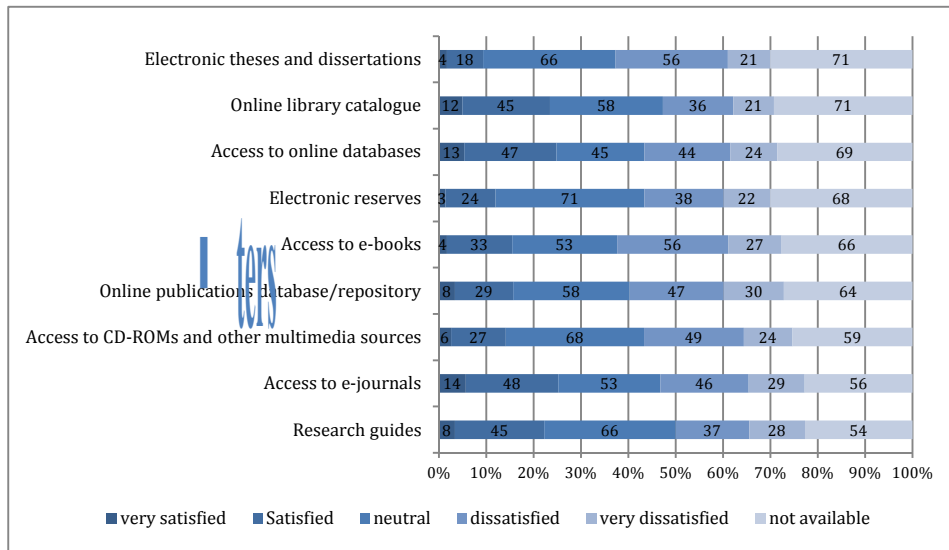


Figure 4: Level of satisfaction with library e-services

4.1.5 Laboratories and equipment

The majority of the respondents pointed to insufficiency or lack of laboratories and equipment as one of the two biggest barriers to research. This is a challenge that would hit especially the science-based disciplines, keeping researchers out of a lot of the front line research.

4.1.6 Computers

Almost 96% of the respondents confirmed having access to a computer/laptop at work. Institutions owned 89% of these computers, pointing to the very low level of ownership of computers. Computers are primarily used for research and teaching, both taking up 62% in almost equal measure as highlighted in Figure 5.

²¹ Afeworki P. "Library resources, knowledge production, and Africa in the 21st century." *The International Information & Library Review*, vol. 40, issue 4, December 2008, Pages 251-256, ISSN 1057-2317, 10.1016/j.iilr.2008.09.006.

²² Harle, J., "Digital resources for research: a review of access and use in African universities". Issues paper prepared as part of an ACU study of Arcadia, June 2009. www.acu.ac.uk/publication/download?id=173

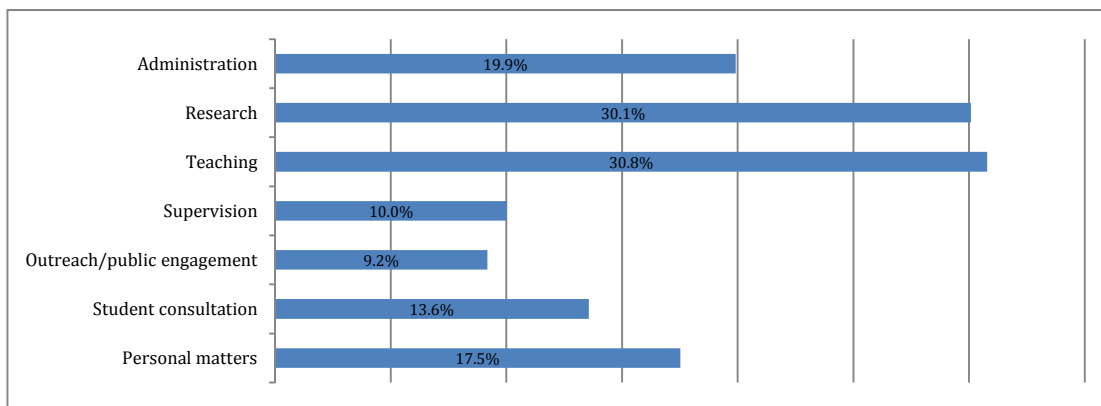


Figure 5: Use of computers/laptops for various functions

Respondents use different software applications to support their research activities (Figure 6). Word processing, presentation and spreadsheet applications dominate. However, at the time of data collection, none of the institutions had any form of educational volume licensing with vendors as a way to help bring down the cost of accessing software, although they reportedly provided most of the software (73%). This was a rather surprising finding, considering the increasingly high penetration of computers, the high cost of software, and funding challenges of universities in the region.

Surprisingly, the majority do not use modelling and simulation applications, both important to advanced research. This in itself points to the level of most of the research currently conducted.

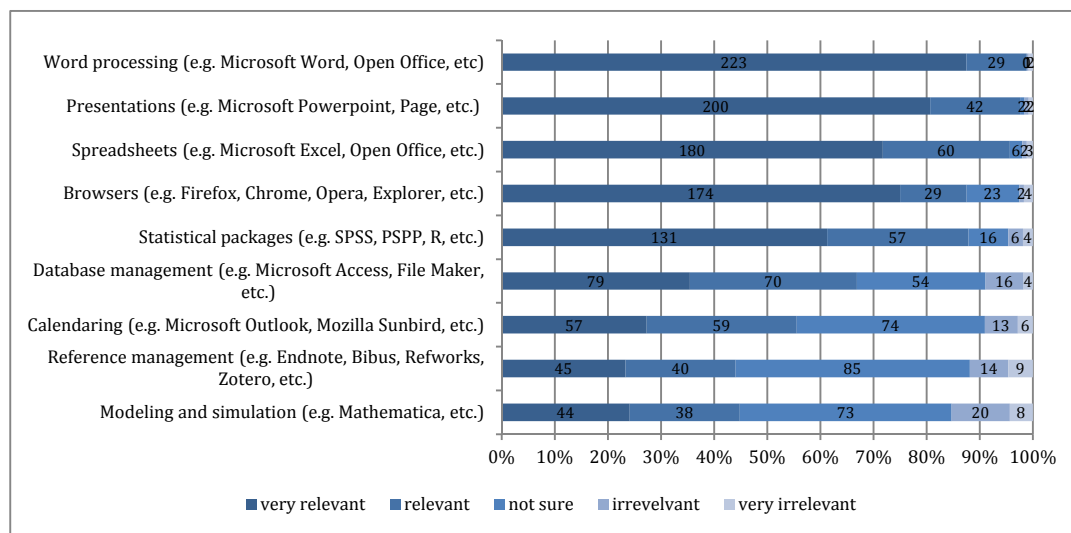


Figure 6: Relevance of different software to research (ranked)

4.1.7 Internet: access, quality, utilisation

Most respondents (77%) indicated that their institutions had a campus network, which they used to access the Internet. Among those with access, 73% access the Internet using a

computer/laptop in their office, and 20% shared a computer in a lab or Internet café at the institution. Only 36% of respondents had Internet access at home.

Despite the clearly limited bandwidth available to universities and the generally poor quality of service, only 46% rated the speed of Internet access as slow or very slow; and only 37% had concerns about reliability. This could be because most respondents have not experienced faster speeds or better quality of service, or because they do not use any bandwidth-intensive application or downloads. As can be seen in Figure 7, use of the Internet is still dominated by non-research activities.

Lack of internet access at home combined with limited ownership of computers discussed earlier will limit the amount of time academics can use to access online resources, especially taking into account time demands by other assignments during office hours.

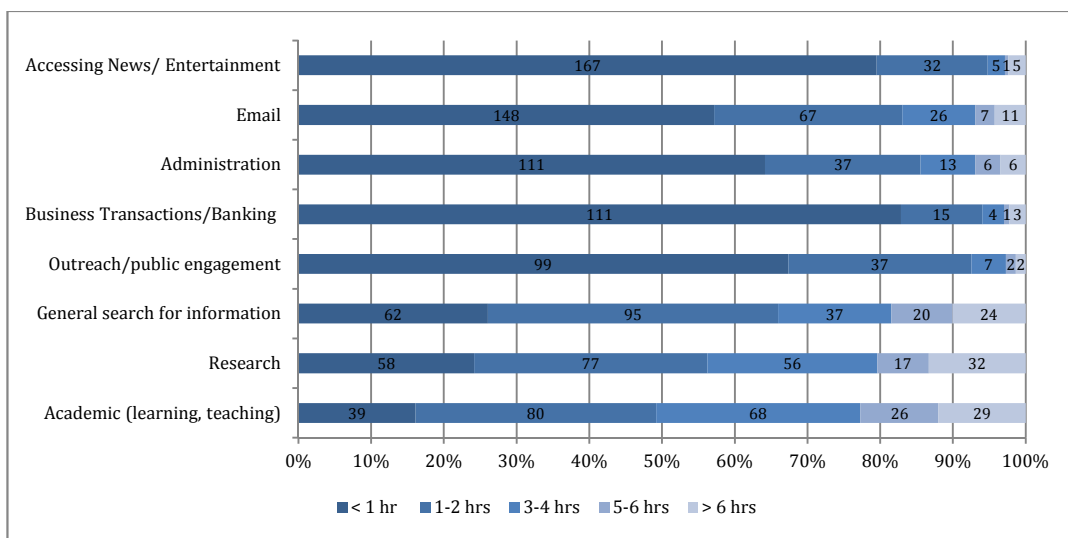


Figure 7: Use of Internet for different activities at educational institutions amongst respondents

4.1.8 Conduct of research

Figure 8 summarises the percentage time spent by respondents on different activities. It is evident that teaching related activities take up most of the time, with only 18.7% of the time allocated to research. While 90% of the respondents felt they were giving enough time to teaching, 70% felt they were not giving enough time to research. This challenge has also been noted by Sawyerr²³.

About 50% of the respondents only handle one project at a time, which they also lead. A decreasingly smaller percentage handles up to five projects and beyond: these would be the more senior members of staff (professorial levels) who normally have other academic staff reporting to them.

²³ Sawyerr, A., (2004). "African Universities and the Challenge of Research Capacity Development." Journal of Higher Education in Africa, vol. 2 no1, pp 213-242. ISSN: 0851-7762

The majority of collaboration activities involve research projects that also lead to joint authoring. Collaboration networks however tend to be generally local, with most researchers focusing on others in their specialisation, in their discipline, in their faculty/school/college, in their institution or in their country. Only 33% of the responds had collaboration beyond national borders. Cross-disciplinary research, one of the hallmarks of the knowledge society, still remains very limited, with only 24% of the respondents working with researchers from other disciplines.

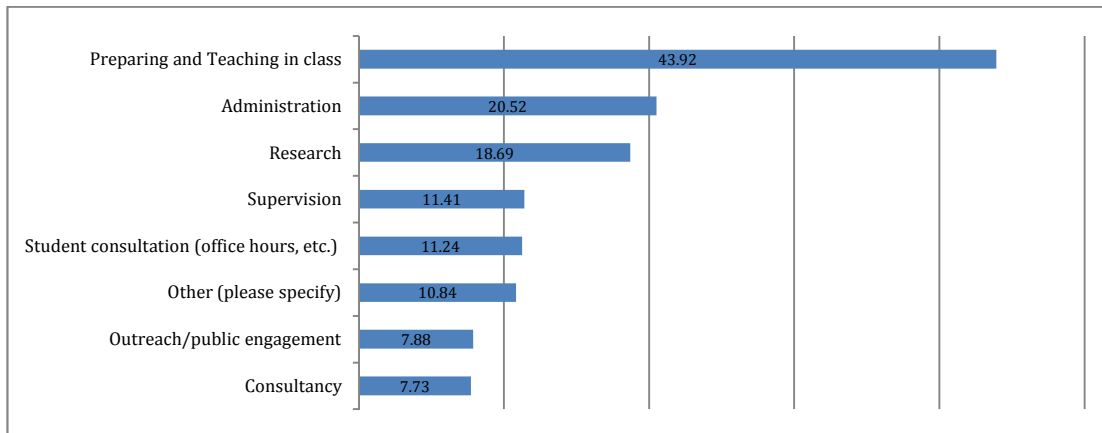


Figure 8: Percentage of respondent time spent on different activities (ranked, weekly)

In their analysis of research within the University of Stellenbosch, Pauw and Imbayarwo²⁴ highlight the importance of networks to research output, and illustrate the extensive collaborative networks of this university.

Responses indicated that where there is collaboration, the commonest tools are either mailing lists or various online platforms. This underscores the importance of access and connectivity to research collaboration.

4.1.9 Research output

The commonest form of research output is a journal article, closely followed by a conference publication. Books, chapters in books, and technical reports are also at a significant level. What is however especially worrying was the number of respondents who reported no output at all. Figure 9, showing the number of respondents (out of the 271) who had not generated any item of research output in the different categories during the previous year, underline this major challenge. There was only one patent during a period of five years among all the institutions surveyed.

Ordinarily, an institution should have more conference publications as researchers share their findings in more timely and regular conferences compared to journals that should have longer peer reviews and lead times. The fact that more researchers had journal publications compared to conference proceedings during the year might be an indication of researchers responding to institutional promotion policies as opposed to nurturing their research ideas into agendas.

²⁴ Pauw, C., and Imbayarwo, T., "Tracking Research Collaboration and Research Output in Africa: A Case Study of Stellenbosch University". African Science Trackers & Stellenbosch University, 2010

The choice of publication channel is heavily dominated by funding limitations, visibility within the discipline, promotion policies, and ease and clarity of the submission process. Electronic publishing, which would be comparatively cheap²⁵ is very limited. Outside other barriers to this, it is very easy to link it to the promotion policies in universities that do not recognise such publications as significant. Most respondents (88%) support open access repositories and 90% would be happy to share their publications free of charge.

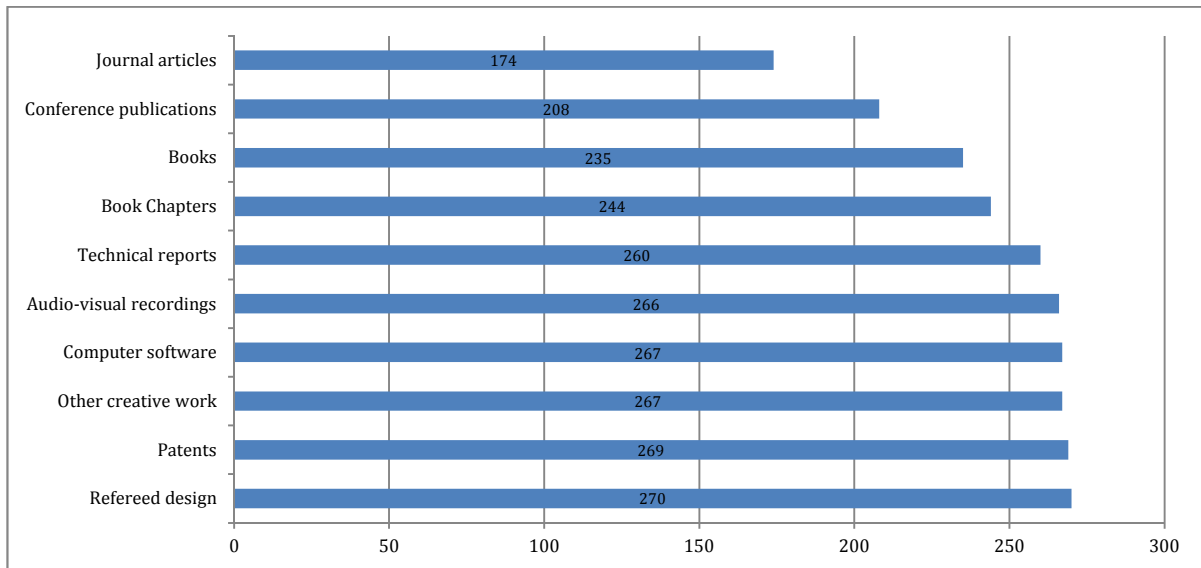


Figure 9: Number of respondents without any output in the indicated categories during the previous year

4.1.10 Barriers to, and motivation for research

The majority of respondents (70%) ranked both lack of sufficient time for research and inadequate research facilities/laboratories as the major barriers to research, followed by a heavy teaching load, lack of incentives, and inadequate remuneration (Figure 10). It is clear, considering this finding alongside how respondents spend their time (See Figure 8) that institutions need to critically rethink how best to allocate time for research activities amongst staff expected to both teach and undertake research.

²⁵ The reference to lower cost does not ignore the reality of cost and the other challenges around electronic publishing. See e.g. Crampton, M. and Hulley, F., "Online Access to the Research Output from and about Africa through Database Aggregation and Full Text Linking", 2004, *NISC Pty Ltd, Grahamstown, South Africa*.

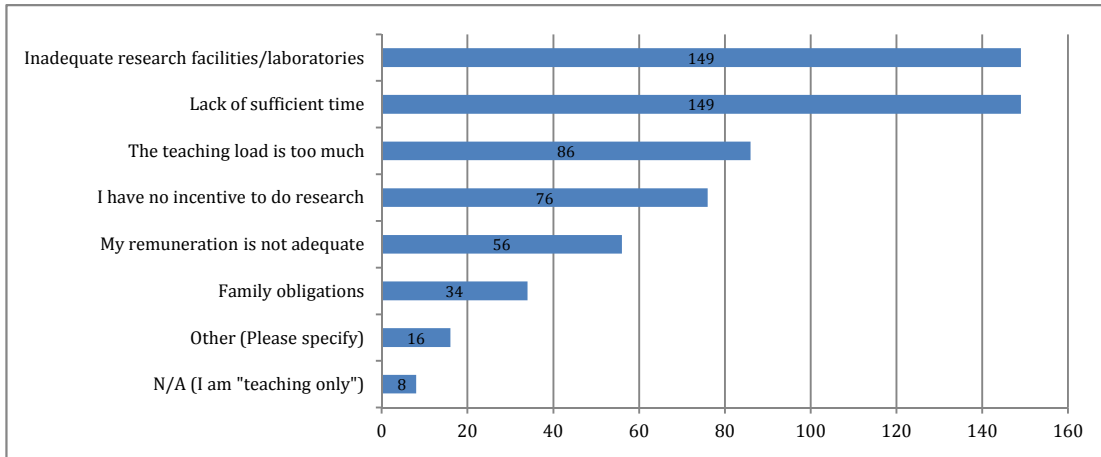


Figure 10: Biggest obstacles to undertaking research (multiple selections, ranked, no. of respondents)

When it comes to motivation for research, figuring out ways to recognize research output (promotions, awards, research funding that is not tied to specific areas, etc.) seems more important than increased remuneration to incentivize research activity as revealed in Figure 11. This echoes findings by Ragasa²⁶ in the study of research organisations in Ghana and Nigeria.

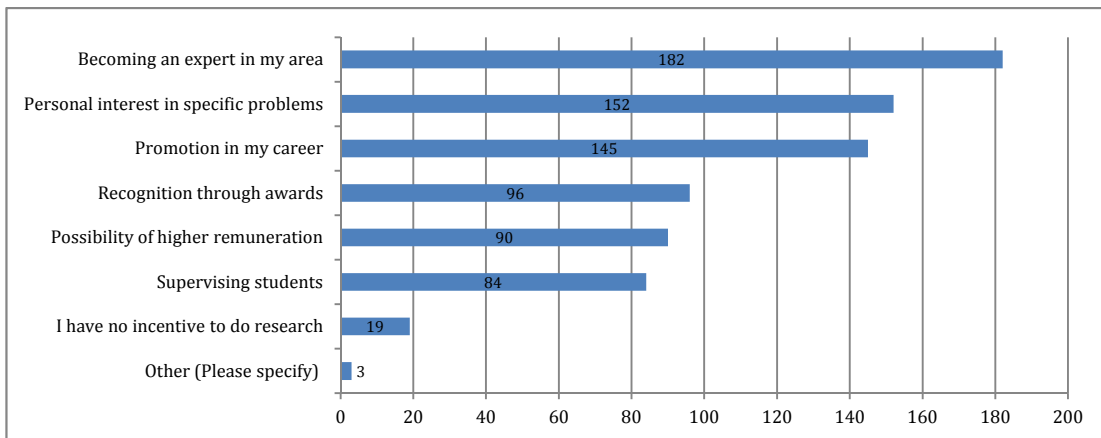


Figure 11: Motivations for research (multiple selections, ranked, no. of respondents)

4.2 Institutional survey

4.2.1 ICT in the Institution

Higher education institutions play a critical role in the life of researchers by providing the first-level of support in an enabling environment. In all but 4 of the 16 institutions surveyed, there were more non-academic than academic staff, perhaps indicating a lack of focus on their core mission, and limited or ineffective computerisation in the administrative aspects of universities. This is not what would be expected in a situation where 15 institutions reported integrating ICT within their educational functions and 12 within research as highlighted in Figure 12.

²⁶ Ragasa, C., *op cit*

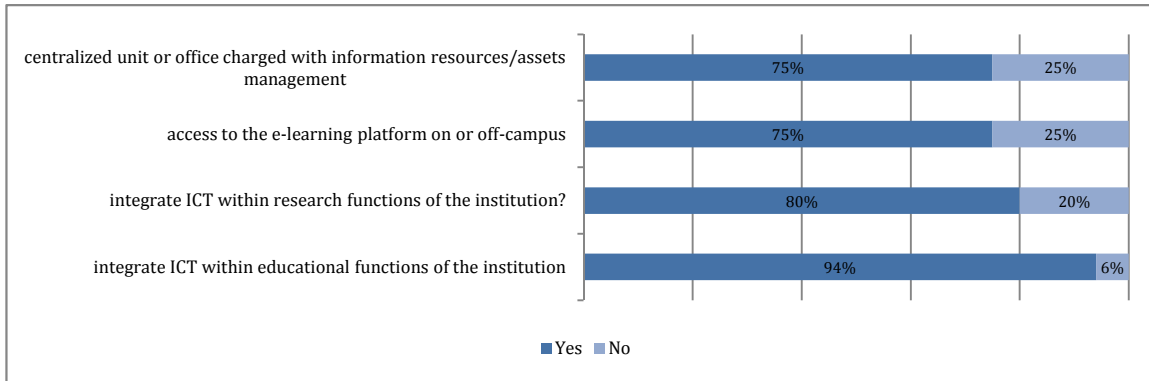


Figure 12: Integration of ICT within institutional core functions

More institutions (12) are adopting a centralised method of information resources/assets management as they increasingly rely on ICT by setting up a unit solely charged with this responsibility. The institutional policy environments however still have to catch up as summarised in Figure 13. Institutions are still struggling to develop and implement good and responsive ICT policies and many are yet to think beyond the now and start planning for the inevitable disasters that can occur within the digital realm.

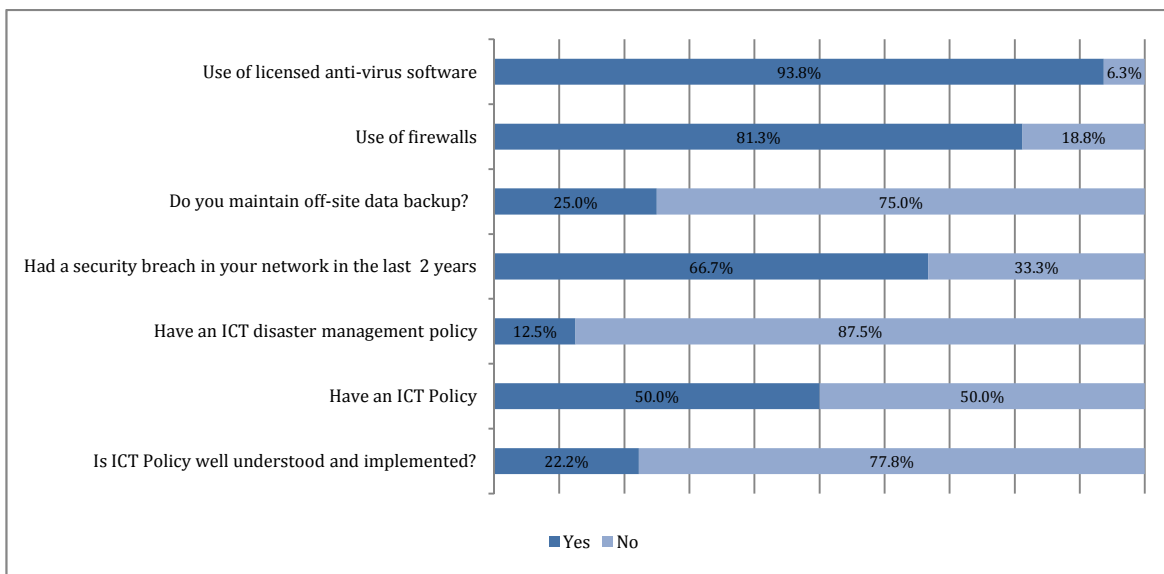


Figure 13: Overview of ICT policy and management practices adopted across institutional respondents

Internet access is still limited, with only seven of the institutions reporting access through fibre networks. Download capacities ranged from 512kbps to 40 Mbps, and upload capacities from 512kbps to 10 Mbps. Downlink/uplink asymmetry that characterises most Africa institutions is a reflection of the imbalance in intellectual property, with Africa running a very large deficit. All institutions reported having an institutional website, with 10 of these locally hosted within institutional networks and 6 with local ISPs. Local hosting within institution, while it appears good, has serious drawbacks in a situation where bandwidth is constrained (in this compounded by the smaller uplink pipe). First, all who want to access the website and related resources share the limited expensive bandwidth, constraining it further. Second slow access speed means that

the institution is invisible to the world and loses competitiveness. Third is the reality that most of the campuses do not have 24x7 data centres.

To support education, 12 institutions reported using Moodle as their eLearning platform of choice. In addition to the advantages of being an open source platform, it provides an opportunity to share digital content at an institutional level and a potential collaboration area around which NREN activity could be structured.

4.2.2 Library

All institutions have institutional libraries, but with varying capacity to deliver on their mandate. The first challenge for many libraries is competent leadership - one library reported that they do not have a head. The second challenge is limited computerisation: only 4 libraries reported having an ICT budget and if it was not donor-funded, then it was really low. Despite the poor funding, libraries have moved to automate key core functions like the OPAC and issue desk as indicated in Figure 14.

Information literacy is a challenge that can slow down researchers, and libraries in Africa normally take a lead in developing this among researchers. 5 institutions reported offering no training whatsoever, 8 reported offering in-class training, but in a sporadic manner and only one institution reported taking advantage of the internet to offer such training to researchers using online techniques.

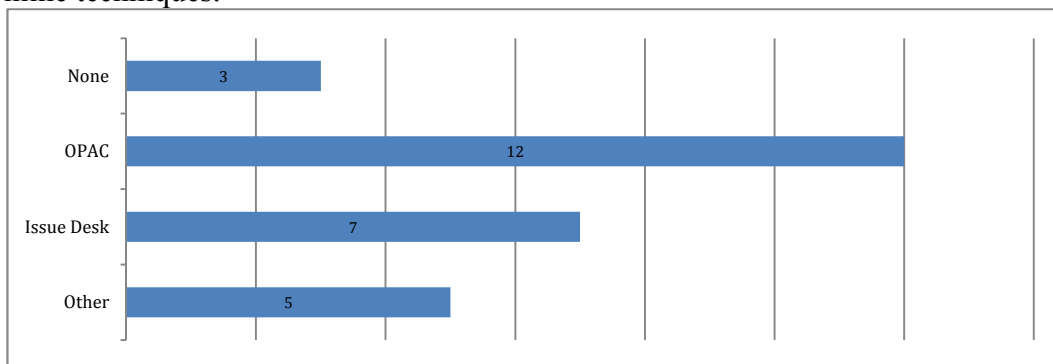


Figure 14: Selection of core library functions that have been automated

While libraries reported using email to provide regular updates and library information to researchers, their adoption of technology appears to be greatly driven by the large global suppliers and publishers that they interact with through the adoption of electronic processes, rather than by internal strategies and plans.

4.2.3 Research and intellectual property

Documentation of research outputs and dissemination across participating institutions is still very poor. 12 institutions did not have adequate knowledge about recent publications by their own staff, 10 institutions did not know of any recent research recognitions and 5 reported neither. In such an environment, where keeping track of research activity is still a challenge, one can argue that commercialization of any research outputs must still be far off. As such, it is not surprising that only one institution reported a patent being filed by a researcher during the last 5 years.

Having a good and up to date research database is absolutely crucial in the current environment if universities are to track research, collaboration, and take informed policy and strategic decisions about research: Most universities in the region appear to be steering research totally blindly. The kind of information-rich analysis conducted for example by Pauw and Imbayarwo²⁷ should be routine for universities in the region.

4.2.4 Research support services

While research support facilities across institutions are improving as indicated in Figure 15, the lack of research funding is still a big hurdle. Institutions seem to lack the necessary funding to nurture and reward research activity. Instead, research is primarily funded by international entities.

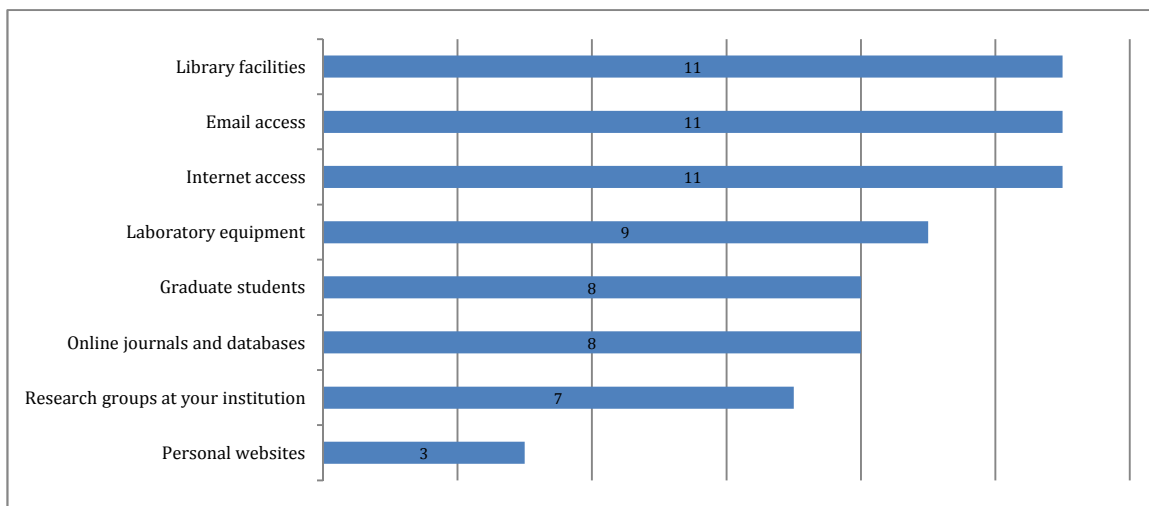


Figure 15: Access to different research support services across participating institutions

4.3 Impact of access and connectivity on intellectual property output

While this paper primarily presents the baseline study that was aimed at establishing the current status of the research environment, researcher behaviour, and researcher output, we have included this section as a preliminary examination of the relationship between connectivity and intellectual property output. In doing so, we underscore the fact that since there are many other factors that are components of the overall research environment (see Section 2.2), what is presented here should not be interpreted as conclusive findings: the research environment varies widely from institution to institution, making the interpretation of statistical correlation of impact of connectivity on research output with only one set of data both difficult and inaccurate. This will however be possible for each institution when a time series (surveys over the planned five years) of the data sets is generated, and some of the issues that have emerged from this study are examined further.

4.3.1 Comparison of connectivity

²⁷ Pauw, C., and Imbayarwo, T., *op cit*

We need to reduce the varying levels of external bandwidth delivered to institutions to a common denominator before examining the relationship between connectivity and per capita intellectual property output. Possibilities include bandwidth per connected computer or number of network points; bandwidth per member of staff or per student, and bandwidth per user (staff plus students).

Bandwidth per connected computer and bandwidth per network point is illustrated in Figure 16 for the institutions surveyed. The former is higher in institutions where the number of computers is still limited (many unused network points), and the latter higher where there is comparatively high usage of wireless access. Institutions 4 and 12 are EthERNet members that had just upgraded their bandwidth but were yet to acquire sufficient computers to support their user base (staff and students). Makerere University in Uganda (16), which had the highest bandwidth also had the highest number of computers.

It should be noted from Figure 16 that all the respondent institutions have a bandwidth per connected computer that is less than 25kbps. Many have only about 10kbps per connected computer. Even if one takes into account diversity (not every user demanding bandwidth at the same time), this is extremely low by international standards and emphasizes the continuing challenge of insufficient bandwidth.

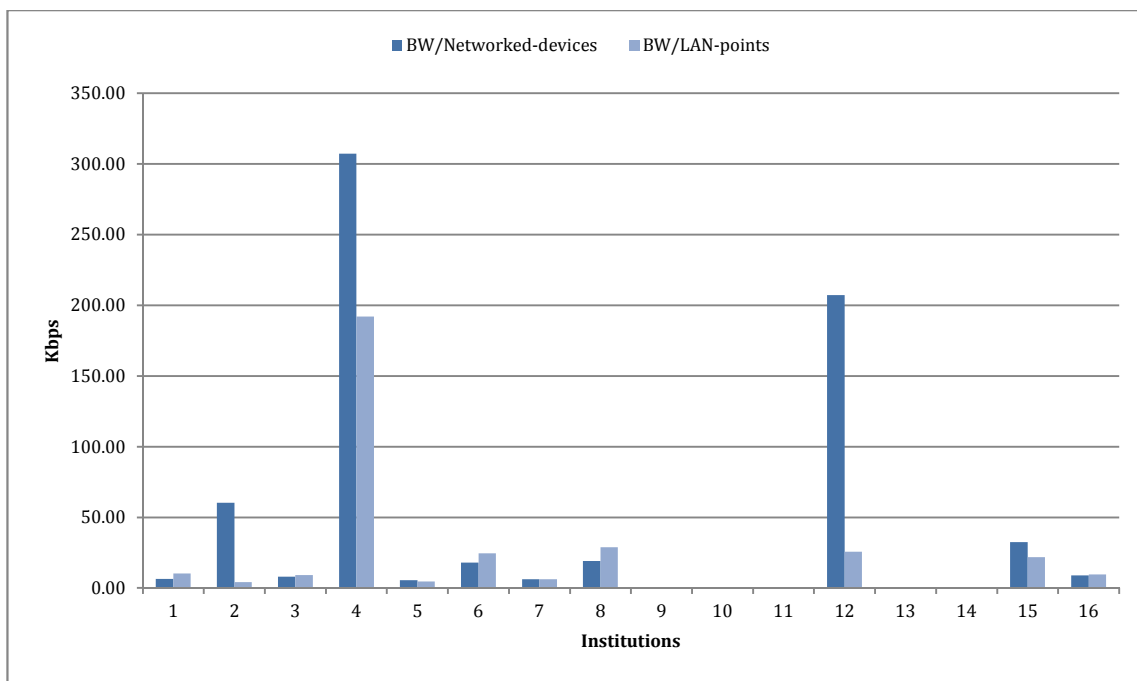


Figure 16: Bandwidth versus networked-devices and LAN-points across participating institutions

In situations where there is a very high user to available computers ratio, the bandwidth per networked computer might be high, but sharing of access means that actual time online for each user is constrained. It therefore provides a more balanced view of access if the comparator is bandwidth per user, enabling comparison across institutions of varying sizes with varying levels of connectivity. This is illustrated in Figure 17. From this, the institutions with the highest connectivity are respondent 6, the Kigali Institute of Science and Technology (KIST) with 28 Mbps for 233 Academic staff and 3000 students; and respondent 15, Uganda Christian University (UCU) with 32 Mbps for 166 staff and 7800 students.

4.3.2 Linking per capita intellectual property output to bandwidth

Intellectual property output per capita (publications in the last five years) is still very low amongst participating institutions as summarised in Figure 18: on average, none of the institutions has produced at least one publication per staff member over the last five years, underscoring the poor research performance of African researchers and institutions.

The highest per capita output is from respondents 6, 12 and 16. This is consistent with Figure 17, with the exception of responded 15, the Kigali Institute of Science and Technology that has the highest connectivity but no research output. This is not really surprising: KIST was established as a technical institute, not as a university. While it is apparent that institutions that have the highest connectivity also have the highest research output, we emphasize that this does not validate our claim at this point: it only gives an indication that there is a relationship between the two.

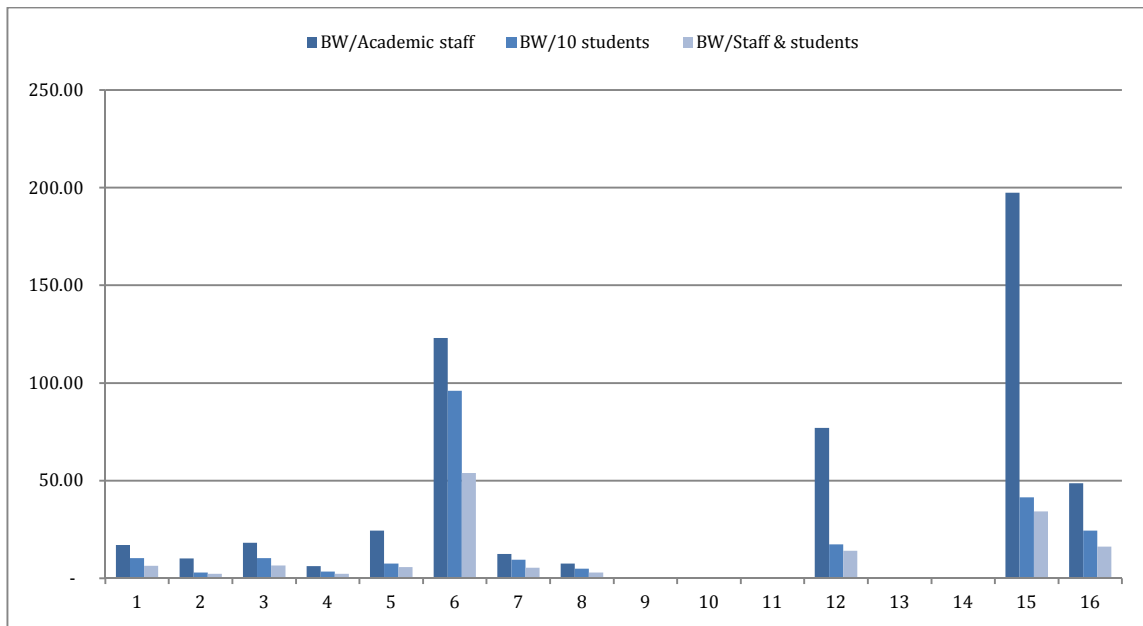


Figure 17: Bandwidth versus number of academic staff and students across participating institutions

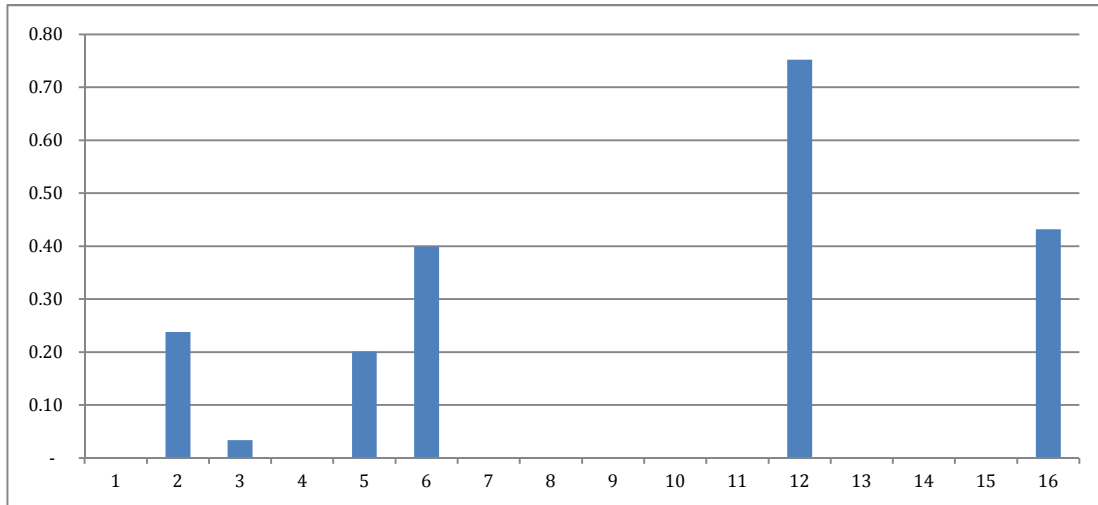


Figure 18: Research per capita (ratio of academic staff to research output) across institutions

5. Summary: Challenges and Opportunities

We recognise that improving connectivity and access will not have the expected level of impact on research output unless some of the key challenges identified by this baseline survey are addressed. In this section that is aimed primarily at African institutions, we highlight what we consider key challenges as identified in the findings, and make some suggestions about how these can be converted to opportunities for improving the quantity and quality of research.

Applicability needs to be qualified: we have not, at this point in time, carried out tests of statistical validity, or indeed the level of depth of statistical analysis that would be required for conclusive and generalisable findings. These challenges and opportunities are therefore specific to the institutions and to some extent the countries examined, but they do provide lessons for other institutions and countries.

- i. The departure of experienced researchers from universities into the public and private sector reduces research leadership as well as the opportunities for developing research capacity. The limited number of PhDs among the remaining young population of lecturers compounds the situation. On the other hand, the young population of lecturers can be an opportunity for the universities if it is properly channelled, especially when combined with steps to improve the overall research environment as discussed further below.
- ii. There are very limited local budgets for research, a finding that echoes results from other sources. Some of the sources cited in this paper state that this results in research and research agendas that are driven from outside the countries, and not necessarily aligned to the research priorities of these countries. The opportunity for universities facing this challenge is making convincing cases about institutional and national priorities so that funding can be re-focused by development partners to these priorities; and making evidence based arguments (based on survey findings that are more country specific) to national funding sources so that research funding can be increased. Universities must learn to research their research environment, activities, and outputs.

- iii. Online library services and resources have become increasingly available to African universities. There is however dissatisfaction among the majority of users regarding the quality of e-services provided by libraries. Leadership is still a challenge for many libraries. It is within the institutional capacity of universities to address these challenges, based on recognition of the importance of online services and competent library staff to the growth of research. The second aspect is objectively examining causes of user dissatisfaction (as opposed to a typical defensive reaction) so that users can increasingly drive services delivery (pull) rather than librarians (push). This should go hand in hand with concerted training for researchers in information literacy so that online research time is more productive.
- iv. Laboratories that can support research are insufficient and lack equipment. This is a challenge especially for science-based disciplines. Realism must recognise the fact that advanced research equipment, along with the capacity to maintain and sustain it, can only come in the medium to long term. Connectivity however introduces the opportunity of accessing remote laboratories, especially taking into account the fact that modern research equipment is largely computer driven. This should be combined with specific training in modelling and simulation; an area, which will reinforce advanced research.
- v. Access by academic staff to computers, more than 90% of them owned by the institutions, is close to 100%. Internet penetration in universities in our sample has also increased, even if tends to be generally low speed with most universities providing less than 10kilobits per second per capita. Internet access is however heavily dominated by non-research activities. This increasingly high penetration of access and connectivity is an opportunity that still has to be harnessed for productive research. A key factor in doing this will be the incentives tied to research. As noted, the survey revealed that 49% of the researchers are not satisfied with the research and publication policies of their institutions, pointing to an area where changes are likely to have significant impact.
- vi. Where there is a strong research culture that needs to be nurtured, the ability to access the Internet for research related purposes has to be a daily 24-hour reality for academic staff. The finding that most researchers have access at their places of work but do not own computers is a gap that needs to be addressed. The approaches used by countries like South Africa and Kenya to provide laptops for teachers²⁸ can be easily replicated at university level, the driving requirement in this case being increased research output.
- vii. Research in the knowledge economy is increasingly defined by inter-disciplinary research as well as research collaboration beyond departmental, institutional, and national borders. The survey findings have revealed that this is still very limited. Research incentives targeted at stimulating interdisciplinary research and collaboration could have a positive impact on this.
- viii. Research output, currently, largely journal papers, is still very limited. Universities need to seize on the willingness of researchers to share their research outputs freely as

²⁸ Teacher Laptop Initiative: <http://www.teacher-laptop.co.za/#>; Department of Education, (2009). *Teacher Laptop Initiative Policy*. Government Gazette No 32007, 8 May 2009; 'Teachers to get laptops with financing under new PPP', CIO East Africa, August 2010, <http://www.cio.co.ke/Main-Stories/teachers-to-get-laptops-with-financing-under-new-ppp.html>

- established by this survey to exploit online publishing where the ground is more level for institutions from developing countries. It should be especially noted that cost related to publishing was established as a barrier.
- ix. The majority of staff devotes almost all their time to teaching, mainly due to teaching overload. Until institutions achieve a proper balance between time allocation for teaching and research, research output will remain limited. In Norway, for example, the general guideline is that staff should spend 50% of their time on research and 50% on teaching²⁹. In many cases, this could be just a case of diverting budgets from bloated administration (as established, 75% of the institutions surveyed have more non-academic than academic staff) to support to the core missions of the universities, enabling the hiring of more academics. Limited computerisation of administrative functions could be one of the factors leading to the staff being dominated by non-core functions: This needs to be addressed hand in hand with effective business-process re-design that would lead to a reduction in the number of administrative and support staff.
 - x. The failure to track research and research data is a major challenge across all the institutions surveyed. Most institutions do not have data about themselves, and where efforts have been made to collect the data, it is not well managed, severely reducing its utility. In addition to this, failure to put any such data online reduces visibility. The implication of this is that the institutions cannot make evidence-based policy and strategy decisions aimed at increasing research output. This is an area of action that should be an easy win for any institution.
 - xi. While the extent of data, and the ability to which it can be used to give meaningful correlations is still limited, it has emerged in this baseline survey that there might be a correlation between per capita internet bandwidth and per capita research output. In depth statistical analysis as a time-series of data is collected will examine this.

6. Conclusion

This paper has established the baseline for the periodic surveys that will be carried out as we establish our main hypothesis, and has also identified the necessary areas of interventions by the majority of African institutions if access and connectivity are to have the expected high impact on intellectual property output. The baseline analysis has also identified gaps and limitations in the instruments used that will be addressed in subsequent surveys.

While we underscore the fact that it is a preliminary finding, the analysis of the baseline data has also shown that those institutions in our sample that have higher per capita connectivity also have higher per capita intellectual property output, pointing to a possible correlation. In-depth statistical analysis based on future surveys will examine this further as we build up the evidence-based case for improving the connectivity of universities and research institutions.

²⁹<http://www.eui.eu/ProgrammesAndFellowships/AcademicCareersObservatory/AcademicCareersbyCountry/Norway.aspx>