Impact of Information and Communication Technologies on Research and Development: A Case of University of the Punjab-Pakistan

Nosheen Fatima Warriach
Department of Information Management, University of the Punjab, Lahore, Pakistan.
Email: nosheen.im@pu.edu.pk

Muzamil Tahira
Universiti Teknologi Malaysia. Johor Barhu, Malaysia
Email: mufals@yahoo.com

This study explores the research trends at Pakistani universities by highlighting the use of Information and Communication Technologies (ICTs) in the research process and its productivity. It also investigates the impact of Higher Education Commission (HEC) initiatives for research output in Pakistani universities in general and PU, in particular. It explores the essential ICT skills to increase research productivity as perceived by researchers from the Faculty of Social and Behavioral Sciences through structured interviews. An analysis of HEC of Pakistan and PU websites is carried out. The statistics of these websites shows that there is an increase in the number of research articles and PhDs produced every year. Data show that the respondents are not fully utilizing the pricey electronic sources provided by the HEC, yet there is a yearly increase in a number of PhDs produced and published research. The relative growth rate of research productivity and doubling time were not constant. It is also observed that doubling time has increased while the relative growth rate is going to decrease.

Keywords: Information Communication Technologies; Research Productivity; HEC-Pakistan; E-databases; Research Repository: University of the Punjab.

1. Introduction

The use of information and communication technologies (ICTs) in knowledge production has a role in research and academic performance. It has developed a network in which scholars around the world consider themselves as a part of an echo system resulting in quantitative and qualitative research and development. For the last two decades, the availability of full-text journals, books, and other e-sources through subscribed and open access have fostered the research and academic activities in developing countries (Bakri, 2010; Zainab et.al., 2012). The digital initiatives of Higher Education Commission (HEC) have influenced higher education landscape in Pakistan also. Due to the subscription of e-databases and IT facilities by Higher Education Commission (HEC), there is a significant change in the academic and research scenario in the country along with increased research productivity. HEC digital library has been facilitating Higher Education Insitutions (HEI's) research community through access to thousands of peer reviewed scholarly journals in all disciplines since 2004 (Said, 2006; Warraich & Ameen, 2010).

Ndahi (2003) emphasized, "today information that can benefit students is available in virtually all fields of study but only if they can use the technology well" (p.24). ICT technologies and effective usage of information positively link with each other only if students possess the essential skills required for ICTs (Newhouse, 2002), known as ICTs literacy. Arunachalam (2003) advocates the disadvantage of ICTs for research productivity. He discussed that the inception of online journals; online submission and review has made it tougher for a developing country researcher to get published who didn't have access to entire IT infrastructure. He criticized the situation and

stated, "irony is that some highly qualified scholars do not referee merely because they are technology deprived!" They became ''excluded''.

Socio-cultural factors such as appreciation and perception of ICT; attitude of the scientific research community; demographic issues such as age, level of qualification, gender, poverty and literacy level, communication networks and traditional cultural values affect the adoption of ICTs for scientific research communication (Nzwilli, 2009). In Pakistan, HEC has worked on improvement of the quality and quantity of higher education, resulting in a growing number of universities and research. HEC established IT infrastructure including HEC National Digital Library; a project of HEC to provide access to peer-reviewed research literature including the key journals of international repute in all subject areas, Pakistan Research Repository; provides 3600 doctoral theses using the e-print software, and E-library; free Internet access and computers, etc. in public and private sector universities and degree awarding institutions. These IT initiatives of HEC have a key role to develop digital research culture in Pakistani universities to facilitate researchers and students through free access to subscribed databases and research repository as an open source. It has made an impact on, the scholarly communication system and academic environment in Pakistan resulting in increased volume of research in the form of dissertations and articles. However, a number of research studies have been conducted in Pakistan about the use of electronic resources and services in the university libraries (Ameen & Gorman, 2009; Malik, 2010; Tahira, Alinda & Ameen, 2012; Warraich & Ameen, 2010; Tahira, 2008). These studies have established that the usage of electronic resources and databases are not adequate in the institute of higher learning, and researchers are not aware of the available sources. Researchers are not fully utilizing these sources to fulfill their academic and research needs. Our interest in this study lies in understanding the impact of ICTs on research and development activities at organization level. Research and development refers to research output and Ph.D. degrees produced. It also throws light on the steps needed to explore the HEC databases extensively.

2. Objectives of the Study

This study aims to:

1. Analyze the doctoral degrees awarded and published research output by Pakistani universities in general and PU in particular

2. Explore the perception of researchers about the impact of ICT on their research

3. Research Design

In the first section of the study, the available data from HEC and PU websites were analyzed for research output statistics. In the second section of the study, perceptions of researchers (MPhil/Ph.D. scholars) from the Department of Political Science, University of the Punjab were chosen purposively on a convenient basis. A qualitative approach was used to explore the phenomenon. Its "bottom-up" approach to local problems and issues allows complexities to be elucidated by those who are directly involved, rather than studied from a distance by remote researchers (Gorman, Clayton, Shep, & Clayton, 2005). These perceptions are based on twenty research students' structured interviews. The principal author personally contacted the twenty-five researchers. Out of them, twenty volunteered themselves for interview. The interview data were transcribed, content analyzed and tabulated using frequencies.

3.1 Data Analysis and Discussion

Information was collected on the number of Ph.D degrees awarded by Pakistani universities, research output in terms of published articles in international journals, relative growth rate and doubling time (it is the period required for a quantity to double in size or value) of PU research output, and perception of researchers about ICTs skills in the research process are tabulated and described in the relevant sections. To meet the objectives of the study, data about Ph.D. degrees awarded and research articles published in scholarly journals by Pakistani Universities in general and PU in particular were retrieved from PU and HEC websites in the first week of January 2014. Perceptions of researchers about their ICTs skills in the research process were explored through structured interviews.

4. Section one

4.1. Number of Ph.D. degrees awarded by Pakistani universities

A total 3723 PhDs were produced during the last decade (2001-2010). This total (Figure 1) is significantly more than the PhDs produced during the last fifty-three years (1947-2000) i.e. 2803. There was a slow growth in the first five decades, but it got impetus in the last decade due to expansion of higher education sector, growth of ICTs and HEC initiatives to support the research culture in Pakistan. Figure 1 shows the growth rate in Ph.D degrees.

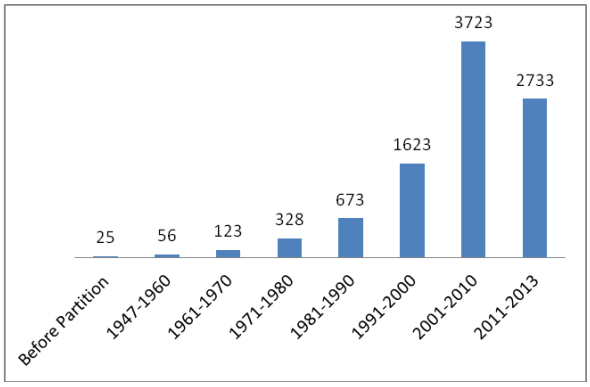

Figure 1: Year wise distribution of the number of PhDs produced in Pakistan (Source: Pakistan, Higher Education Commission)

4.1.1 Ph.D. degrees Produced by PU

Figure 2 shows the number of PhDs produced in PU, one of the oldest and largest universities in the country. It shows that the number is constantly growing, and become almost double from105 to 206 PhDs within five years (2008-2012). This growth has lead to more number of articles published by the researchers in PU.

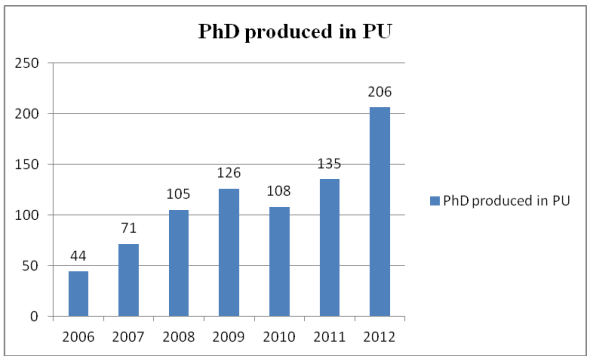

Figure 2: Ph.D degrees produced in PU

4.1.2 Research output in Pakistan

The increase in the number of PhDs has also resulted in a large number of articles published in ISI ranked journal from Pakistani universities. Figure 3 shows an increase in the number of articles published from 2004-2010. The number of articles got published by Pakistani authors/researchers from different Pakistani universities in 2004 was only 1038. The number of published articles by Pakistani universities in international journals shows a significant increase in each year and this figure is three times higher in 2008 i.e. 3639. In 2010, the number of published articles has reached the figure of 4650, which is four times higher to 2004 article count.

This data describe the scholarly communication in reputed journals by Pakistani researchers. The increase in a number of Ph.D. theses produced resulted in publications increase in national and international journals. There is also an obligation to publish at least one article in the journal of repute to get the Ph.D. In addition, few universities give incentives for publication to academic staff including PU.

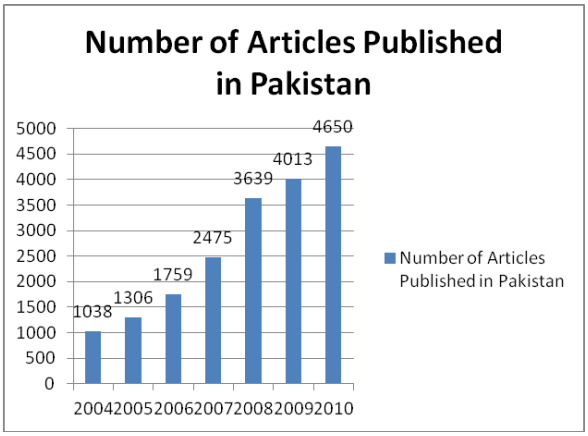

Figure 3: Number of Articles Published in Pakistan

Next, we will review the annual research growth of the University of the Punjab being an oldest and biggest HEI. PU research out-put has been analyzed for the 5 year period (2007-2011) and two-year publications window. HEC research productivity statistics shows that there were only forty-two universities with publications in 2004 while, 95 universities out of 132 were with publications (published paper in national/international journals) in 2010. These figures indicate research growth in a developing country.

There are a number of factors for this gradual increase in research productivity as Said (2006) pointed out that HEC National Digital Library (NDL) program has a role in enhancing the research productivity. The other factors include HEC policies for research students to get published at least one article prior to submitting Ph.D. theses and for teachers' special incentives in Tenure Track System for producing quality research. A healthy competition among universities to improve their ranking might be another strong reason.

4.1.2.1 Number of publications by PU

Figure 4 illustrates number of publications by the researchers of PU in ISI Web of Knowledge. This

data show that the research culture is prospering in the University as teachers are getting published their research i.e. the number of published articles were 162 in 2007-08. It became more than double i.e. 353 in 2010-11.

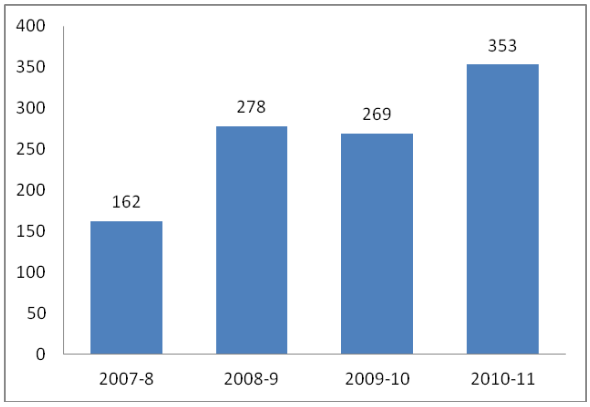

Figure 4: Number of publications by PU (Source: University of the Punjab, Lahore)

PU announced research incentives to motivate all the faculty members to write and to get published. PU gives the financial incentive to the teachers for their research publications in international and national (HEC recognized) journals. PU awarded Rs. 7 million to teachers for their published research in 2011-2012 that is a unique example in Pakistani universities. It also awards travel grants to its teachers for presenting papers at international conferences, and a teacher can avail this opportunity once in a fiscal year. PU teachers also get research project grants from the university and after that they are bound to get published their paper within one year of project submission.

4.1.2.2 Relative Growth Rate and Doubling Time

Relative Growth Rate (RGR) of overall productivity over the 7-year period (Figure 4) and the corresponding doubling time (Dt) are tabulated in Table 1. The corresponding doubling time 'Dt' is the time required to double the publications for a given RGR. "The doubling time of a population is exhibiting exponential growth is the time required for a population to double. Implicit in this definition is the fact that, no matter when you start measuring, the population will always take the same amount of time to double." (http://mathinsight.org/doublingtime). Two related parameters, to find Relative Growth Rate (RGR), is (ln N2- ln N1)/t2- t1. Where N2 and N1 represent the cumulative publications in the years t2 and t1 (Mahapatra, 1985). For the present case, difference between t2 and t1 is one year. Therefore, it is simplified to RGR = ln (N2/N1). The formula for Dt =ln2/RGR.

The value of RGR first decreased exponentially. The RGR value of each year is different and constantly decreasing. However, it is settled down to 0.12. There is a gradual increase in the corresponding Dt required to doubling the productivity record from the previous year except for the year 2007. There is much variation in the Dt value of each year and settled down to 5.59 years for the last two years (2009 and 2010). This implies that the RGR decreases exponentially with constant growth rate of 0.12 and constant Dt of 5.59 years to make the research productivity double in quantity from the previous year. Thus with the decrease in RGR the Dt is increasing.

Table 1. Annual Research output, Relative Growth Rate (RGR) and Doubling Time (Dt)

Year	*Pub*	*Cumulative Publications*	*RGR=Relative Growth Rate*	*D_t=Doubling time=ln2/RGR*
2004	1038	1038		
2005	1306	2344	0.81	0.85
2006	1759	3065	0.32	2.15
2007	2475	4234	0.37	1.89
2008	3639	6114	0.22	3.09
2009	4013	7652	0.12	5.59
2010	4650	8663	0.12	5.59

5. Researchers' Use of ICT skills in Research Process

Researchers were asked about their usage of the computer and the internet, majority of them replied that they used a computer during university timing. They had access to the Internet and online electronic sources. However, the respondents expressed that the age factor played an important role in their computer usage. The respondents with 40 years and above were hesitant to learn new technologies.

They were using a computer and internet, but it was not their preferred way to access information (n=12). They have limited ICT skills and were not able to fully explore new features independently. Even they started to learn these skills after the access of HEC online databases. It was found that researchers in social sciences were either not fully aware or unable to use ICT for research purposes. They were not satisfied with their skills to utilize the available e-

databases for literature survey, software to data analysis (both quantitative & qualitative) and to manage references electronically. Further, they were asked about the purpose of using information and communication technologies and their opinions are presented in Table 2.

Table 2: Purpose of using Information Communication Technologies (ICTs) by Researchers (N=20)

Use of ICTs	*Frequency*
Report writing	20
Email	17
Literature search and review	16
Data collection and analysis	15
Social Networking	10
Preparing bibliography	7
Listserves	6

All the respondents (n=20) use computer for writing their research reports followed by 17 for email. Eighty percent (n=16) use the internet to search the literature on the web. Fifteen respondents use the Internet to collect data by using web surveys and also send their questionnaire through email. They also use it to analyze data. They use different quantitative and qualitative data analysis software to prepare their research reports and articles. Another purpose, to use computers, is to update themselves through social media (n=10) websites i.e. Facebook and Twitter, etc. Only seven respondents utilize the tools to manage their references and bibliographies using Endnote or Zotero. Thirty percent respondents replied that they had joined different professional email groups. Their responses about how did they search literature for their assignments and research work are stated in Table 3.

More than half of the respondents (n=11) visit their departmental libraries to find the relevant literature. Fifty percent (n=10) use Google Scholar to find the needed information followed by 40% (n=8), who use HEC Digital Library. Data show that respondents still visit the library for getting printed material besides the search of e-sources.

The respondents mentioned that Google Scholar serves the purpose of a federated search engine in our local environment. It is a sign that researchers have a tendency to search and use e-sources i.e. Google Scholar, and HEC subscribed sources for their research. "Google deserves credit for making the first step in providing a tool for discovering scholarly information. A big plus is that Google searches the indexes created from the full text or part of the full text of the primary documents" (Jacso, 2006, p.215). There is no federated search available for all the databases in PU. Warraich, Ameen and Tahira (2009) conducted a study on federated search product i.e. ELIN (Electronic Library Information Navigator). It used federated search to provide access to ten databases in different universities, but this service is no more available. The researchers were dependent on Google Scholar to search the subscribed databases.

Table 3. Ways to the search literature (N=20)

Ways to the search literature	*Frequency*
Visit library	11
Google Scholar	10
HEC Digital Library	8
PU library website	7
Consult OPAC	6
Ask librarian	5

Only 35% (n=7) use PU library website to find the appropriate sources for their research and 30% use PU library multilingual web OPAC and union catalogue to know the existence and location of their required information source.

6. Conclusion and Implications

It appears that due to various factors such as digital initiatives, availability of e-sources, HEC policies, University incentives and ICT infrastructure, the growth of research output is quite significant in Pakistan. Furthermore, HEC has taken many initiatives to enhance digital research culture in universities and to improve the quality and volume of research by introducing e-databases and other IT facilities, HEC digital library has been facilitating research community by giving access to thousands of peer reviewed scholarly journals in all disciplines to all universities of Pakistan since 2004. During this period, the production of PhDs' has been increased three times. Research productivity is an important indicator of performance evaluation followed by citations, its subsequent metric and newly introduced h and h-type indices. There is an increase in PhDs and research publications records during 2006-2010. Nonetheless, it is also observed that RGR is not constant and with the decrease in relatively growth rate of research productivity the doubling time is going to be increased. Hence, the pace of R&D activities is not constant and relatively growing to be slow.

The study has several limitations. Notably, for the last four years, HEC website has not been updated in this regard. The publications and Ph.D. data after 2010 were not available. In addition, research output statistics is based on ISI indexed journals only. While one authentic online reference enhanced database Scopus via ScienceVerse and another open access database, Google Scholar research output records are not considered by HEC. Another limitation is to presenting the perceptions of only social science research scholars. The study findings about the awareness and usage of subscribed sources are in line with the previous study by Tahira, Alinda and Ameen (2012). This study is an attempt to understand the impact of ICTs on research and development activities at the organizational level. The study recommends that ICTs workshops should organize at every department level in all universities. Therefore, the scholars have full awareness about the subscription, awareness and utilization of available sources.

To explore extensively the utilization of existing e-sources and its role for the improvement of quality research productivity depends on proper use of pricey databases for the quantity (number of publications) and impact (number of citations). HEC National Digital Library and Pakistan Research Repository are rich with sources in digital forms. Two action plans called Pakistan Education and Research Network (PERN), and PERN2 will interlink all public/private sectors academic and research institutes of the country over an IP based infrastructure through metro fiber ring (www.hec.gov.pk). For Pakistan, where only 2% of total national budget is spent on higher education, establishment of HEC was a spectacular project (Rahman, 2014). Many new interesting avenues of inquiries can be studied in future, based on this study. The study raised two serious concerns that how to drive the HEI's towards improving the quantity and quality and to participating in the world ranking. Several worthwhile research areas have potential for future research. The impact of research initiative given by HEC/universities,on the current scenario of publications and getting citations, the present research performance evaluation system and use of e-sources for the evaluation of the academic and research performance in HEI's can be potential future concerns .

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