

The Role of ICT in Appreciating Tri-Axis Efforts of Research, Publications and Library Services in Higher Education

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Abstract: Information and Communication Technology (ICT) is a principal enabler to nearly all functional efforts including quality assurance sustenance in higher education. Studies have revealed that research has a feeder effect on the quality of knowledge that fulcrums higher education principles thence it attracts significant investments. These research efforts are captured and documented in publishable context for availability to knowledge consumers under a more structured system, the library. Our study focused on unearthing the phenomenal role of ICT on the three principal foci; Research, Publications and Library services in relation to Higher Education. However, despite higher education traditional definitive texture, its universal agenda is to discover, avail and preserve consumable knowledge, which in principle rhythms with our study focus, ICT being the facilitation operand. This paper approached the significant role played by ICT's functional support to the three focal areas. We appreciated the collaborative existence of research, publications and library services towards actualizing Higher Education fundamental goals. This was achieved through critical review of existing literature. We were able to establish ICT role in activating the tri-axis connection between research, publications and library services within higher education. We eventually proposed a functional framework that appreciated the role of ICT in promoting Higher Education as underpinned with ICT at its bedrock.

Keywords: ICT, Research, Publications, Library, Higher Education

1. Introduction

Philip Zimbaro, a renowned scholar, once captured it well by saying that *academic success depends on research and publication*, and by this he qualified their significant role in higher education. In July 2011 at the European Council for Students Affairs conference where the Berlin Declaration on the Social Dimension was launched, research was identified as one of the central pillars of well-performing higher education system. Libraries on the other hand have been for a long time the legal deposits of scholarly researched publications [1]. The main aim of research is completed through publications. The library complements it by systematically storing such research publications for ease of access. Information and Communication Technology (ICT) with its technological aspect, improves the traditional avenues towards availing research publications for ease in retrieval and management [2]. Fundamentally, developments in ICT have made significant contributions to all spheres of human life. The contributions have been rather prominent in case of service activities such as banking, health, transportation, education and libraries. ICT efforts in

these services can be broadly explained in terms of economy, ease, extension and efficiency. Library is thus a major component of any education system [3] [4].

The magnetic term ICT has visibility in all corners of the global arena and has been incorporated in organizational, managerial, developmental and marketing sectors. The services rendered with the help of ICT are faster and more effective [8]. ICT and digital revolution has taken on the world of publishing through paperless or electronic publishing. ICT has brought the world closer together by improving the dissemination of knowledge, acceleration of research, stimulation of innovation and facilitation of collaboration [6]. Besides research and publications, ICT has considerably facilitated higher education in other facets like teaching, content development, knowledge dissemination options and as a feedback mechanism to curriculum engineers [9] [10]. This has made major positive contributions in education sectors for the benefit of both students' and scholars' community.

2. Study objectives

The research objectives of this paper were;

- To review existing literature and the related research studies to bring clear understanding of the intended research study.
- To identify and explore respective roles of ICT in Research, Publications and Library in Higher Education.
- To co-relate Research, Publications and Library as underpinned by ICT as applies to Higher Education.
- To establish existing connection between Research, Publications and Library as underpinned by ICT in Higher Education.
- To propose a framework for ICT Impacts on Research, Publications and Library in Higher Education.

3. Literature Review and Related Work

Several studies have been conducted to unveil the role of ICT in Higher Education. While casing the Canadian scenario, Kamal and Thahira [9] concentrated on studying ICT roles on teaching, learning and assessments using CAI package. Their work was more inclined towards seeing ICT as an agent of educational change especially concentrating on the facets of teaching, learning and assessments. Similar study was conducted by Ron Oliver [10] in Perth, Western Australia where he explored the roles of ICT in relation to *what is learned, how student learn, when and where student learn* and *emerging issues* like expansion of teaching and learning constituencies. In assessing the roles of ICT on higher education in Southern Africa, Cheryl et al concentrated on impacts of ICT infrastructure [11] where the results showed that despite infrastructural constraints and organizational challenges, considerable improvements were evident on higher education, varied institutional contexts notwithstanding. More evident, was on enjoining collaborative efforts towards research projects and sharing good practices as an optimization option for the benefits of ICT in higher education. Maureen Jackson [12] on her work weighted impacts of ICT on *further education (FE)* as a superset of higher education where despite little coherent strategy in FE, majority of students experience difficulties in locating, accessing, evaluating and using information effectively.

Evidently, most research studies lack comprehensive exploration on roles of ICT on research, publications and library. Research is treated in regards to finding information by use of ICT resources like educational tools and online services for teaching and learning purposes, publication is viewed as use of ICT to broadcast or advertise contents like in web

advertisements and library is more towards online repository at the expense of the traditional library premised on physical infrastructure.

3.1 *Research: Knowledge Discovery in Higher Education*

Research is understood to mean conducting systematic investigation in an existing or new knowledge. ZoraNeale Hurston, an American Folklorist once described research as formalized curiosity and that it is about poking and prying with a purpose. Research in Higher Education can be categorized using the following considerations; Forms of Research, Methods of Research and Design of Research.

ICT is a significant enabler of research in Higher Education, mainly to support research initiatives and also to expand research dimensions within ICT itself. According to Luckson et al [13], ICT as domain of knowledge, media and resource tools for communication potentially fulcrums functional networks among academics within Higher Education. Their findings scored the relevance of knowledge dissemination as a meaningful component of research hence appreciating the significant connections between research, publications and library in Higher Education.

Research in ICT is both multimodal and multidisciplinary process as it hinges different research fields. Dirk Schneckenberg [14] in his research paper views ICT potential as the centre piece to eCompetence Development Process, an innovative angle to post-industrial Europe and places universities as key actors towards its realizations. In Balasubramanian et al [15] paper, four important contributions of ICT in research for Higher Education are identified as; Increase Bandwidth and Computing Power, Communication Links, Combination of Communication Links and Libraries and ICT Policies in Higher Education.

ICT therefore plays significant role in enhancing research activities since it is an activator of knowledge management [16] in Higher Education. Knowledge management encompasses knowledge growth, knowledge communication and knowledge preservation. Research is a structural process phasing through significant steps towards solutions, and ICT integration through research layers. The table below shows this.

Research Layers	Descriptions& Expectations	ICT Role Integration
Observations and Descriptions	To observe and ask	Data Capture tools & techniques
Predictions	Take Statement of Intent, developing strong hypothesis	Prediction Models (Algorithms, Tools)
Determination of Causes	Statistical procedures to disapprove hypotheses	Analysis Tools, Simulators
Explanation	Possible explanations of happenings	Computational Models, Theories
New Directions	Validity of results, new research areas	Data Validation Tools, Testing Models

Table 1: Showing ICT Integration in Research Layers and Their Impacts

3.2 *Publications: Knowledge Broadcasting in Higher Education*

Publication, in the legal perspective, is attached to distribution of copies with express consent of the author. In the context of Higher Education, it leans towards scholarly publications [17] as opposed to commercial publications. In scholarly publications e.g. as in scientific journals, the authors unlike their counterparts in commercial publications do not necessarily depend on revenues generated from their work but are motivated by the desire to share discovered knowledge to academic communities.

Use of ICT in publications can be viewed in two ways; using ICT tools in completing the productions process, and also using ICT infrastructure and systems to avail published materials for consumptions.

These can be summarized as below;

- (i) Publication being a step by step process; ICT integration in every step of production can be summarized in the table below. The summary is retrieved from [19] [20].

Process Level	Descriptions	ICT Role Integration
Idea	Topic (raw)	Abstraction Tools and Techniques
Research	Information gathering	Online libraries, digital archives, ICT
Informal Communication	Communication with no structural agenda	ICT communication systems
Idea Protection	Patents, copyrights, trademarks, etc	ICT Equipment and Applications e.g.
Report findings	Lab Reports	ICT Systems, Applications
Productions	Books, Journals, Online (Blogs, Forums, E-books, Websites, Tutorials	Contents productions and Online publications

Table 2: Showing ICT Role Integration in Publication Process and Corresponding Impacts

- (ii) Use of ICT Infrastructure and Systems in Publications: As much as it might be interpreted as more to do with electronic publishing [22] [23], more focus here is about use of ICT infrastructure and systems to support publications with biasness towards publications relevant to Higher Education.

Publishing Models	Presentation Modes	ICT Role Integration
E-Books	Static, Read Only	Quick publishing and dissemination of information. Use SGML software for production in consumable format.
E-Periodicals	Static, Read Only	Includes e-journals, newsletters, magazines and discussions lists.
E-Databases	Deductive, Archiving	Academic library database online e.g. OPAC for universal access
E-Publishing on CD-ROMs	Static, Read Only	Research materials stored on movable media to allow capacity and convenience access for offline audience.
Print-On-Demand	Hard Copy Medium	Mix of Electronic and Print Publishing where hard copies are obtained on order.
Digital Content		Delivered to consumers through downloads to handheld and other wireless devices. Always in Adobe PDF, XML, WAP etc
Electronic Ink	Dynamic,	Used in creating publications that updates themselves e.g. evident on billboards that changes contents by itself
Email Publishing	Asynchronous,	Delivery of regular content-based email messages e.g. for newsletters, online journals, mailing lists and discussion lists.
Web Publishing	Interactive, Dynamic	With introduction of new development languages like XML, publishers are able to make contents that are viewable on portable devices.

Table 3 : Showing ICT Role Integration in Publications

3.3 Library: Knowledge Reservoir in Higher Education

Library holds a definitive position depending on its application e.g. in computing or operating systems for that matter, the term library or libraries refer to a folder or folders with sub-folders inside. By design, this enables users to control contents (document library)

folder structure stored in a system. On the same note, a library is reference term appended to a building or room that is used to keep collection of books, periodicals, films, music etc for people to access, borrow and use. In the context of Higher Education, a library is collection of researched academic publications organized in a retrieval structure for readership population. The most applicable type of library in Higher Education context is academic one.

ICT infrastructure and mountable technologies like the Internet have revolutionary effect on the functional life of libraries because it spans beyond the fundamental organization and activation of retrieval criteria. Table 4 below summarizes roles of ICT on different types of libraries in use.

Library Types	Descriptions	ICT Role Integration
National	National repository of information with right of legal deposits	Securely configured access functions e.g. IP sub-netting, User Policies etc
Research	Contains in-depth collections of material in one or more subject area	Superior storage and retrieval functions for collaborative and concurrent access
Reference	Contain materials that are not lent but for on-site reading purposes	Authorization, Access Facilities and Authentication systems
Public Lending	Serves the public, borrowing section is activated; non-restrictive	Managed consumers' database and controlled access functionality
Academic	Provide resources and research support to academic community	Available, Scalable, Portable and Secure applications and services
Children's	Special collections of materials intended for juvenile readers	User interface (graphical, interactive) consumable to by juvenile readers
Special	Contains specialized research materials for employees e.g. hospitals, museums etc	Improved access infrastructure with in-built secure retrieval functionalities

Table 4: Showing Different Types of Libraries and Impact of ICT Integration

Libraries have been considered as the storehouses of books but with the intervention of ICT, their organization, administration and other technical processing have become easier and more quantity of work are done in a more relaxed mood [4]. While general ICT application tools and Integrated Library Management Systems are largely used in housekeeping operations, like acquisition, cataloguing, circulation control, serials control etc; the Internet has been used extensively as a resource as well as a tool to deliver the Library and Information Services (LIS) [1].

Digital library services have evolved after the implementation of ICT in the library and information centers. ICT enabled services can be viewed in two ways; either ICT enabled conventional LIS that can be delivered more efficiently through use of ICT infrastructure, systems and applications, or New Services, which have been made possible due to developments in ICT [8]. ICT Enabled Conventional LIS can further be divided into Online Public Access Catalogue and User Services that handles organization of contents and Information Services that handles service formats.

4. Methodological Approach

In this section, we explored the three research foci areas; research, publications and library in relations to integration of ICT. Research was viewed as more of discovery of knowledge as its systematic functional approach relies on phase by phase flow. Publications were understood here as more of compacting discovered knowledge in a format that can be consumable. The library was considered to be a functional reservoir in regards to consumers' convenience and satisfaction. In all these key foci, ICT was agreed to be the core principal driver towards realizations of their goals. A co-relationship that joins the three research concentrations was also arrived at.

5. Discussions and Results

5.1 Connector Role of ICT in Higher Education

Our study observed that ICT has significant role in promoting relevance of research, publications and library services in Higher Education i.e. it has relationship to improve on the foci areas of our research. Below is a figure demonstrating the connector role of ICT in the three areas i.e. Research, Publications and Library.

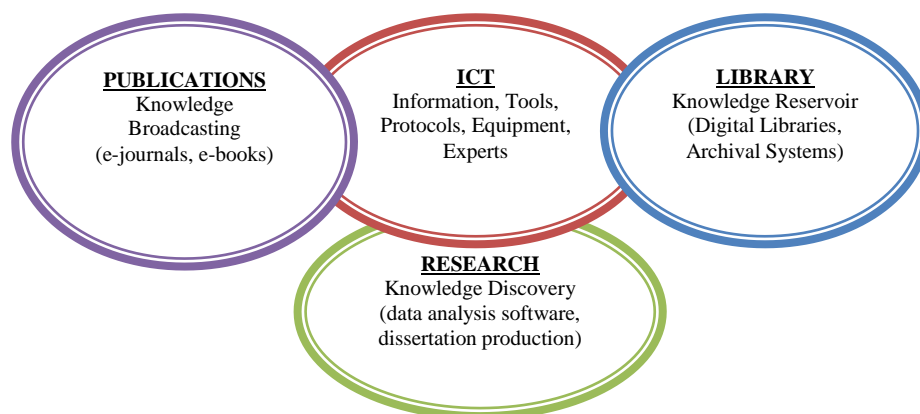


Figure 1: Showing ICT as a Driver to Research, Publications and Library in Higher Education

Figure 1 above graphically demonstrates that ICT has relationship with the three research foci; Research, Publications and Library by involving its tools and technology. Research, benefit from involving ICT asynchronously or synchronously when researchers collaborate through the aid of connected processors that host and exchange digital information. Digital networks are securely integrated in the research efforts to accommodate and authorize participations i.e. use of subscriptions and access policies enforcement ensure privacy compliance. Productions of these research efforts, publications, are aided by use of ICT hardware and software applications e.g. application software, input/output hardware etc and thus availed to knowledge consumers either through hard copy output or presented in a soft copy format. ICT tools and techniques are relied on to store the researched and published products in a more retrievable manner, either for online consumption or offline usage. This is a reliable demonstration that ICT constructively connects research, publications and library services in higher education space. It achieves the objective of our paper that ICT is a connector between the studied areas.

5.2 Tripartite Inter-dependence Relationship in Higher Education Environment

From previous subsection 5.1, we learnt that research, publications and library benefit from ICT as it aids in integrating one another. Knowledge discovery, broadcasting and warehousing is achieved by involvement of ICT.

Below is a diagram demonstrating that among the three study foci; they have inter-dependence relationship with ICT playing a pivotal role.

Figure 2 above demonstrate how research is supported by library services through availability of literature for establishing fundamental understanding of the researched area. Conversely, research equally supports library services by adding newly discovered knowledge, stocked for consumer constituency. On the other hand, publications support research efforts by availing the researched work ready to be merchandised for user needs. Publications are supported by library services as they store already published materials ready for consumptions; this it does by cataloguing these publications for ease of access and availability for contents consumers. ICT is visible in all these; as through its infrastructure,

researchers access library contents faster. Through digital access functionalities and communication medium, publishable contents are made available for consumption. ICT tools are used in Research and faster publishing e.g. online publishing. The objectives of higher education are achieved through integration of ICT. We therefore see research, publications and library services inter-dependending on ICT.

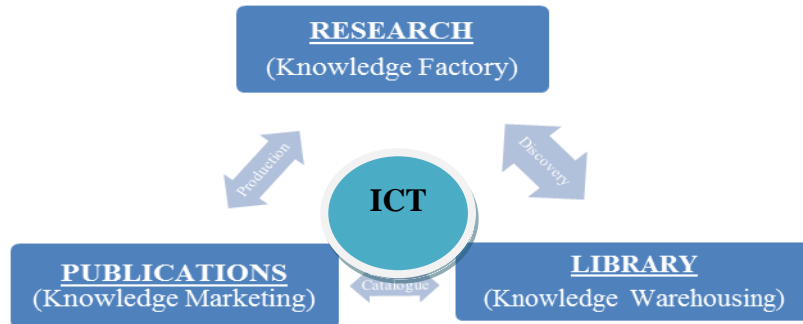


Figure 2: Inter-Dependence between Research, Publications and Library in Higher Education

5.3 Roles of ICT on Research, Publications and Library in Higher Education

In this subsection, we summarized the roles of ICT on Research, Publications and Library as applies to Higher Education. The table below highlight this.

Study Element	ICT Enhancing Roles	ICT Inhibiting Roles
Research	<ul style="list-style-type: none"> - ICT tools for data gathering, observations and analysis - Enhancing collaborative research initiatives through reliable communication links - Advanced data analysis tools - Powerful computing systems that interpret complex research situations - Systems used in data collection in risk points - Online data repository for literature review - Proliferations of cheap portable and wireless hardware ease access burden - Facilitation of multi-disciplinary research initiatives by use of ICT 	<ul style="list-style-type: none"> - Privacy violations as some tools - High bandwidth costs - Associated health hazards with over exposure to such systems - Plagiarism and copyright abuse - Malicious programs glittering as downloadable materials may dismember local PC
Publications	<ul style="list-style-type: none"> - ICT infrastructure and tools for instant publications - Faster production of research materials - Consumable format - Idea protection through digital formulation - Availability of publications at all time - Translation tools allows production in many languages faster 	<ul style="list-style-type: none"> - Reading digital publications for long may cause health complications - Loss of revenues for commercial publications cost of reproduction is relatively affordable
Library Services	<ul style="list-style-type: none"> - Time independent access to library services - Availability of library facilities to physically impaired - Portable and massive contents storage - Configured functionalities allow a single material to be accessed concurrently - Easy content posting and modifications 	<ul style="list-style-type: none"> - Unwarranted downtime transfer costs to access - Online frauds may compromise copyrights - Malicious programs may re-configure retrieval parameters

Table 5: Showing Summary of ICT Impacts on Research, Publications and Library in Higher Education

5. Framework for Roles of ICT in Higher Education

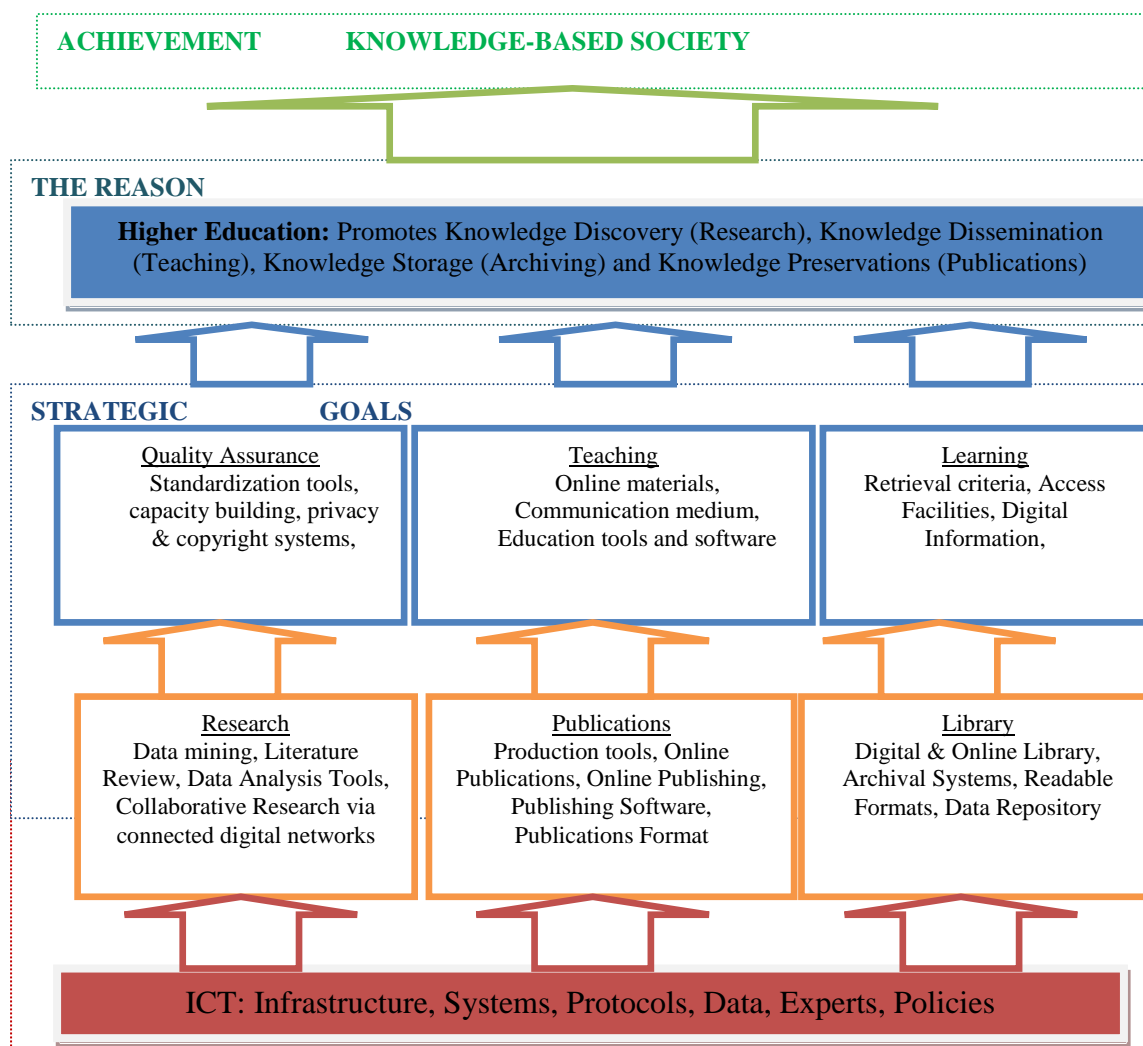


Figure 3: Showing Proposed Conceptual Framework for ICT Roles on Research, Publications and Library in Higher Education as Underpinned by Information and Communication Technology (ICT)

From Figure 3 above, ICT pillars higher education by enhancing research, publications and library services. ICT major contributions range from achievements, reason, strategic goals in areas of research, publication and library in higher education sector. The framework proposed supports the roles played by ICT as shown in above figure.

7. Conclusions and Future Work

Our study succeeded in meeting our research objectives. We clearly illustrate the roles of ICT in research, publications and library services as bedrock pillar and establishing connection existing between the three foci as underpinned by ICT. We managed to propose a framework for ICT roles on research, publications and library services with ICT as the major pillar underpinned in improving the main goal, vision and mission in Higher Education

However, we also identified areas that require further work in order to cover a comprehensive research spectrum. The potential focal areas that shall improve the quality of ICT roles in Higher Education include empirical research approach, to expressively and conclusively explore ICT roles. Another focus should be on integrating measurable ICT indicators in exploring roles of ICT in research, publications and library services in Higher Education. Investigation of ICT contributions on research, publications and library services

in non-academic institutions like research based organizations to provide balanced outcomes. There is need also to relate similar research with contributions towards quality assurance as a principal pillar of Higher Education. This shall also incorporate study on impacts as felt on Teaching, Learning and Assessment in Higher Education.

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