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ADOPTING A LOGIC FRAMEWORK FOR THE EVALUATION OF THE OPERATIONAL PROCESSES AND OUTCOMES OF KNUSTSpace ON RESEARCH, LEARNING AND TEACHING: A CASE OF EMPIRICAL RESEARCH OUTPUT BY ACADEMIC STAFFS AND STUDENTS

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INTRODUCTION

In recent years, there is an expansive consensus on the significance of openness and dissemination of information resources globally. Information and Communications Technology (ICT) keeps on changing the creation, storage, distribution, preservation and management of empirical scholarly output which has brought numerous products and services to users of this digital resources (Essel, 2010). ICT is changing the face of libraries by making them more competitive to meet the complex and divergent needs of its clients with the introduction of Open Access Institutional Repositories (OA-IRs) with free and unending online access to full content of electronic scholarly outputs of an institution, irrespective of geographical location of users (Osei-Poku & Essel, 2011). Presently, higher education institutions have gradually acknowledged that institutional repositories (IR) are essential and very powerful infrastructure that can serve as an engine of change (Verma and Shukla, 2014; Budu, 2015; Mostofa, Begum and Mezbah-ul-Islam, 2015). The concept of Institutional Repository (IR) has set a new dimension in managing information and intellectual resources which have helped in research, learning and teaching in the Internet era. As research, learning and teaching remain the main ingredients for attaining a higher educational growth and development, there is the need to constantly develop and upgrade digital infrastructure in order to allow scholars gain access to outlets of intellectual resources. Inspired by the open access movement, KNUST has implemented an open access institutional repository called “KNUSTSpace” which store, distribute, preserve and manage KNUST academic scholarly outputs. It was the first open access institutional repository in Ghana and was set up in July 2009 (Lamprey & Corlevey, 2011; Essel, 2010; Essel & Osei-Poku, 2011). According to Oliver and Swain (2006), there are numerous challenges relating to the advent of a new publishing model which IR fall within. Monitoring and supporting the growth of IRs to detect and address significant issues linked to its development is one challenge. Considering the focus on the development and implementation of IRs, little has been done to evaluate them (Davis & Connolly, 2007) of which KNUSTSpace is no exception. Since the inception (9 years ago) of KNUSTSpace, no evaluation has been conducted to assess the inputs and outputs of the repository, and how users (students and lecturers) are benefiting from the IR in terms of research, learning and teaching activities (Lamprey, personal communication, April 20, 2016). Hence, the need to consider the input, output and outcome of KNUSTSpace towards improving its quality and further developments in research, learning and teaching, with respect to KNUST academic user experience and gains. Voorbij and Ongering (2006) opine that only user studies can reveal the reasons, gains, outcomes and problems experienced by IR users.

The study aims at adopting and adapting IR evaluation criteria, a business Logic Model and case studies of other university IR evaluation policies into IR Logic framework, which emphasized operational and outcomes assessments to evaluate the connections among investments (resources and activities) and impact of KNUSTSpace on Research, learning and Teaching in the KNUST academic community. However, the study is also driven by the following research questions:

1. What are the operational processes (inputs and outputs) of KNUSTSpace?
2. What are the outcomes of KNUSTSpace on users' research, learning and teaching?

LITERATURE REVIEW

Evaluation of Institutional Repositories

Evaluation is a systematic gathering of data about the activities, qualities and results of programs to make judgements about the program; enhance program efficacy and inform decisions about future programming (Patton, 1997). Thomas and McDonald (2008), opines that one of the numerous steps required toward the better evaluation of IRs is a collective understanding of how to evaluate them. Institutional repositories are more than just a particular software, contents or policies. Instead, institutional repositories are enterprise-wide programs. Evaluating an IRs impact and progress might be the finest approach to build faculty support for an existing IR if only standardized and significant evaluative metrics were available (Westell, 2006). Proudman (2008) added that a standard evaluative framework would be valuable for boosting other institutions to implement and assess IRs. According to Sivak and Vanderjagt (2013), quantitative statistics data in terms of the rate of participation across the IR by users, frequency of access or number of visits to the IR website, the number of items in the IR are not immediately useful although they are understandable to readers and administrators. They added that the success of IRs involves not only the commitment of the institution in making the essential resources available but also pivots on participation from scholars as to the submitters and users of content. Thomas and McDonald (2008) suggest that integrating quantifiable statistics and users' gains are essential and critical in IRs evaluation and development which goes a bit contrary to what Sivak and Vanderjagt opines. Kim and Kim (2008) state that evaluation can be done on the functionality or usability of an IR which includes the interface, search functions and end-user statistics. Evaluation indicators of IRs are more successful when they include procedural and performance (outcomes/impact) assessment in addition to the operational process (inputs and outputs) measures (Kim and Kim, 2008). Westell (2006) also considered "user acceptance" of IRs as an additional possible category, but on a separate study and also indicated that the ultimate factor of

whether a repository is considered successful or not is based on the amount of content in the IR. Thomas and McDonald (2008) added that one strategy for attaining an effective evaluative framework for IRs is to adopt some of the qualitative criteria discovered by Westell (2006), Kim and Kim (2008) and Proudman (2008), but to supplement them with extensive quantitative measurements of IR contents or participants which are borrowed from other statistics used by university administrators. Franklin, Kyrillidou, and Plum (2009) added that the five topmost assessment techniques currently used by libraries are web usability testing, user interface usability, statistics gathering, a suggestion box and surveys developed outside of the library to determine user gains, satisfaction and experience about IRs.

Evaluation of IRs does not offer a single or clear-cut measure of success or consensus on standard indicators for measuring IR successfully. However, the evaluation criteria approach outlined by the authors were adopted and adapted. These criteria are used in the study as success indicators to assess variables that reflect the realities of KNUSTSpace.

Logic Model Framework

A logic model is a graphical representation of a program displaying the intended connections amongst investments and results (Taylor-Powell & Henert, 2008). This model demonstrates the coherent connections among the resources that are invested in a program, the activities that take place, and the advantages or changes that serve as an outcome. The logic model serves as the basis for program planning, implementation, communication and evaluation. Parsons (1999) states that a poorly planned program hold back good evaluation.

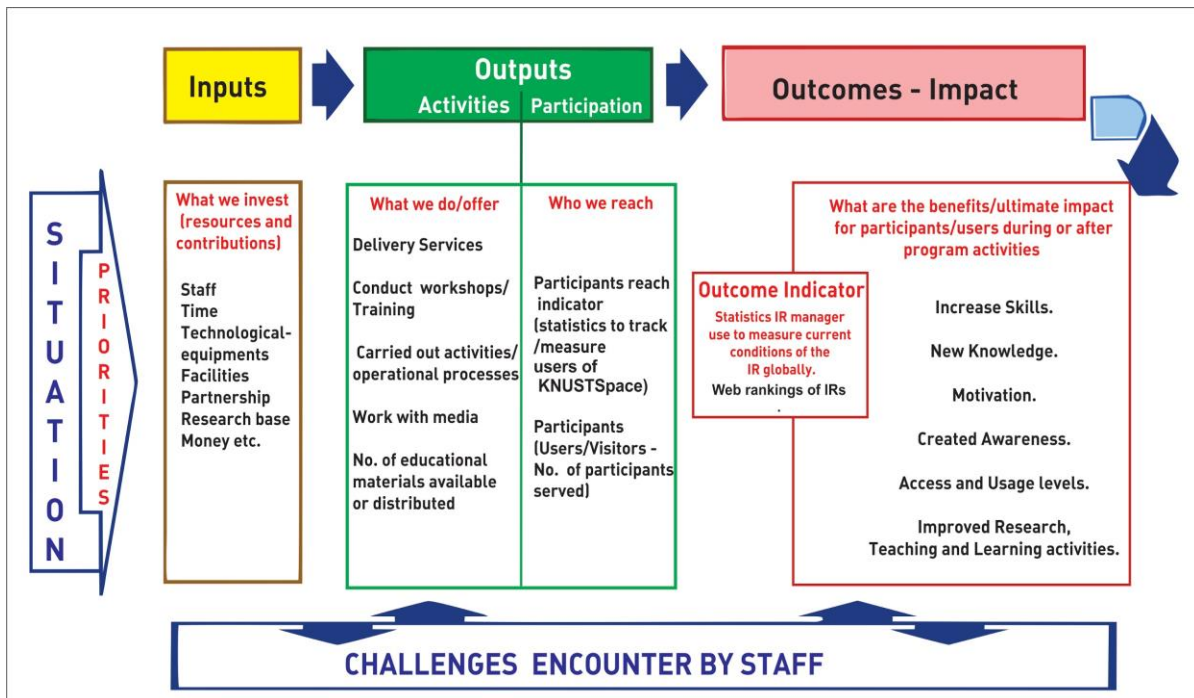


Fig. 1 Logic Model for IRs Evaluation and Development.

Source: Adopted and adapted from Taylor-Powell, Jones and Henert (2003)

Fig. 1 shows the five (5) main components of the logic model that were adopted for the study. These include situation, inputs, outputs, outcomes/impact and challenges encountered by staff which co-exist to help in evaluating KNUSTSpace. The *situation phase* discloses the problem/issue KNUSTSpace address within its institutional settings; *Priorities phase* identify the desired outcomes/intended goals of KNUSTSpace; *Inputs phase* addresses the resources and contribution that go into KNUSTSpace in terms of staff, time, Technological equipment, Research base and money; *Outputs phase* addresses activities (services offered) and reach participants of KNUSTSpace; and, *Outcomes (impact) phase* addresses increase in skill and knowledge, thus, what students and lecturers have benefited/gained from KNUSTSpace scholarly outputs in relation to their research, learning and teaching. It also includes indicators (statistics IR manager uses to measure current conditions of the IR such as rankings and usage metrics) and challenges encountered by staff during operational activities of KNUSTSpace. This model will help document the inputs, outputs and outcomes of KNUSTSpace and help other institutions to also adopt or adapt such initiative to evaluate their IRs for the betterment of distributing and getting access to free scholarly outputs among higher education institutions in

Ghana and worldwide. This model was chosen and modified for its validity and reliability in answering the research questions.

Using Institutional Repository to enhance Research, Learning and Teaching

According to Sarker, Davis and Tiropanis (2010), the need to share research outputs through institutional repositories (IR) have helped to collaborate in research worldwide, to expand research capacity and enhance the value of higher education institutions. IR that contains research outputs is shared within and across institutions so that institutions can know each other's research works and take initiative for an upcoming collaborative project with other institutions. Additionally, to productively bolster critical thinking and argumentation, research outputs need to be made available across institutions to efficiently construct personal and group knowledge by providing relevant information. Institutional repositories containing learning and teaching material, according to West (1999), Biggs and Tang (2007), and Patel and Patel (2013) enhances the quality of learning and teaching in higher education; teachers and students also improve themselves consistently with exposure to these resources. According to Homewood et al (2011), there are two main aspects of research enhancing teaching and learning: First is the way a teacher's use research to enlighten his/her own teaching experience; and secondly, the way the teacher enhances their students learning experience through research-based practice.

METHODS

The study employs descriptive survey methods to gather, analyze and interpret data collected. Indicators from the adapted IR Logic Model was used to measure the operational efficiencies of the KNUSTSpace. Statistics generated from the KNUSTSpace analytic system was also used to test the operational processes. The analytics data used for the study included number and type of resources deposited in the repository, number of visits by the individual, location of visitors, download made within specific periods, and web browser used to access the KNUSTSpace.

Study Participant

The study used simple random, convenience and purposive sampling techniques to sample respondents for data collection. This sample ($n = 179$) included 1 IR Manager, 2 Technical Support Unit (TSU) staff of KNUSTSpace, 35 lecturers and 141 graduate students. The postgraduate students

and lecturers were sampled from the Faculty of Art, KNUST. Postgraduate students sampled for the study were those who had registered for the 2016/2017 academic year.

Survey Instruments

An interview guide was prepared to seek information from the Manager and TSU staff of KNUSTSpace about the inputs (individuals/staff, time, money, technological equipment, partnerships); the outputs (activities/services they offer and participants they reach), resourcefulness in terms of research, learning and teaching materials; intended goals/outcomes; and finally, indicators for analyzing usage statistics and visibility of KNUSTSpace.

Questionnaires were administered to both postgraduate students and lectures. The questionnaires were organized into four sections (A, B, C and D). Section A considered demographic data (the respondent's sex, age range, year of study, degree type pursued and their department of study). Sections B, C and D dealt with users' level of awareness, access and usage; its impacts on research, learning and teaching activities; and, accessibility of scholarly resources, and contributions made by lecturers to KNUSTSpace respectively. The questionnaires were designed using Google Form and administered electronically via SMS texting, emailing and chat platforms (WhatsApp). However, not all the questionnaires were returned; 113 (80.1%) students and 32 (91.4%) lecturers returned their questionnaires.

RESULTS AND DISCUSSIONS

The findings of the study have been organized into five different sections or phases based on the IR Logic Framework and discussed accordingly. These phases include the Situation (Priorities), Inputs, Outputs, Outcomes and Challenges faced by staff of the KNUSTSpace. However, the discussions have been presented based on the research questions.

The Operational Processes (inputs and outputs) of KNUSTSpace

Situation Phase of the IR Logic Framework

Evaluation of IRs is more successful when they include procedural and performance (outcomes/impact) assessment in addition to operational processes (inputs and outputs measures) (Kim & Kim, 2008; Sivak & Vanderjagt, 2013; Thomas and McDonald, 2008). The findings indicate that the situations that necessitated the commencement of KNUSTSpace include:

- addressing plagiarism or academic theft of intellectual properties;

- protection of grey literature (theses and dissertations) from inauspicious environmental conditions (Essel, 2009);
- limited library spaces and shelves for the preservation of books and other resources;
- dissemination, accessibility and global visibility of scholarly outputs produced by members of the KNUST community irrespective of the geographical location of users;
- and finally, enhanced collaboration between members of the KNUST scientific community and other research institutions around the globe.

Per the mandate for the establishment, KNUSTSpace support research, learning and Teaching activities by staff and students in KNUST’s academic community.

Inputs (invested resources and contribution) of KNUSTSpace

The KNUST library has invested adequately into the establishment of the KNUSTSpace by attaining myriad software and hardware logistics (Table 1) that propel the systematic operations of the repository. These software and hardware logistics are specifically responsible for the submission (upload), storage (archiving) and Dissemination of scholarly content in the repository. KNUSTSpace runs on the DSpace Open Source Document Management System. Low-latency and Jitter-free internet connectivity has been provided for the servers that host the databases. The servers are located in a well-furnished room inside the main KNUST library. Extra storage devices have been provided as backups at different locations within and outside the campus for all the files within the main database in the case of contingencies such as file loss on the main servers. For the purpose of visibility and accessibility of the content, the KNUSTSpace has been registered with search engines such as Google, Yahoo, OpenROAR and OpenDOAR to optimize search by researchers from different geographical locations.

Table 1

Software and Hardware logistics used in KNUSTSpace operational processes.

Software	Purpose / Use
<i>DSpace</i>	Open source software which helps preserves and permits access to academic digital content of KNUST in the KNUSTSpace database. The DSpace software is not purchased according to the KNUSTSpace manager.
<i>BookDrive capture software</i>	The application that controls the ATIZ scanner which permits to adjust camera settings from directly within the software and also helps to capture both left and right pages of bound theses by pressing one button to have the images

	rendered on the screen immediately.
<i>XnView software</i>	The application used to organise, view, convert and edit raster images (scanned bound theses). It has brightness level filters and effects (batch processing) that is used to convert blotchy scanned theses image to a highly detailed, sharp and legible text/image effect.
<i>NitroPDF software</i>	An Application used to organise, view, edit and convert scanned bound theses images to Portable Document Format (PDF). It also compresses large file size to smaller size to make it easy to download resources from KNUSTSpace.
<i>Anti-virus software (nod32)</i>	Used to prevent, search for, detect, and remove software viruses, and other malicious software from the computers. This helps computers to run effectively.
Hardware	
<i>Server</i>	Responsible for the central storage and management of KNUSTSpace data files so that other computers on the same network can access them.
<i>Computer</i>	Used to input, store, process and manipulate KNUSTSpace scholarly outputs.
<i>External hard drive</i>	Used to back-up KNUSTSpace data.
<i>Voltage regulators</i>	Used to maintain a constant voltage level when using the mentioned hardware due to unsusceptible electricity/power instability.
<i>Uninterruptible power supply (UPS)</i>	Serves as a battery backup or emergency power supply to computers and the ATIZ scanners. It has a capacity of 1,500 voltages which last for about two (2) hours.
<i>ATIZ Scanner</i>	A book scanner device with a V-Shaped cradle, a transparent platen and two cameras that are used to capture/scan bound theses or books with high-quality images with the help of BookDrive capture software.

Data gathered revealed that KNUSTSpace operations are managed by six (6) permanent staff which include one (1) IT expert; and two (2) service personals whose roles are to scanned retrospective theses/dissertations and convert them into Electronic Theses and Dissertations (ETDs); copying and uploading of ETDs from Compact Disc into KNUSTSpace database; ensure the adherence of quality standards of submitted ETDs and other scholarly outputs by academic staff; and finally, conformance of contents to Open Access policy of KNUSTSpace.

The role of KNUSTSpace staff has assisted the effective and efficient day-to-day operational responsibilities of the repository. However, the library has only one ATIV scanner for scanning all retrospective theses and dissertations. It was evident that the 6-operational staff are sometimes overwhelmed with the workload of converting retrospective theses and dissertations into the database. This account for the low number of retrospective theses and dissertations in the repository.

The operations of KNUSTSpace is financed by KNUST in terms of paying staff salaries, maintenance, repairing and buying of system infrastructures. However, the DSpace is not a payware but open source software downloaded from the Duraspace website. *Time* is invested to help in the productivity of KNUSTSpace; the working hours of staff span between Monday to Friday from 9:00 am to 5:00 pm. Considerable time is also spent by staff on clients/scholars providing support services such as front-desk help.

The study confirmed that KNUSTSpace has a ground *research-based environment* which promotes library resources and enhances other digital research activities. These resources and activities include the effective use of library resources and promotion of open access initiative of members in the KNUST academic community; empowering technology-driven library environment and the advancements of academic libraries through research publications; and, identification of challenges associated with IR's.

Outputs of KNUSTSpace (activities/services they offer and the participants they reach)

Services offered

KNUSTSpace offered services by storing, managing and disseminating academic outputs of KNUST to scholars across the globe. Data gathered established that KNUSTSpace staff organized workshops/training for students and academic staff of KNUST on searching and using the information on KNUSTSpace; research publications; dissemination of research results; citations and references of online sources; plagiarism checkers (Turnitin); and searching scholarly resources to enhanced independent information findings. These workshops are done almost 3-5 times per month in the academic year. Workshops are executed at the E-Resource Centre (Fig. 2) and Research Commons (Fig. 3) all located at the university's library.



Fig. 2 E-Resources Centre for workshops



Fig. 3 Research Commons

Other services rendered by the Centres in supporting research, learning and teaching include the provision of learning environment stocked with computers, access hotspot internet and a spacious discussion lobby. This enabling environment has fostered interdisciplinary connectedness and collaboration among academic staff, as they meet and interact with each other at these centres; besides offering digital literacy skills, the centres also organize clinics for academic staff and students who may walk in and solicit for instant help on retrieving certain information.

Contents of KNUSTSpace databases

There are two forms of ETD's that are deposited/submitted into KNUSTSpace:

- Retrospective theses and dissertations - hard copies of TD that are finally converted to ETDs
- and Self-Archived ETD's that are submitted by academic staff and students to be deposited into KNUSTSpace database.

The study confirmed that only PDF files are uploaded into the KNUST database. Resources that have been archived in KNUSTSpace before 25th March 2017 was estimated over 10,388 (*Table 2*).

ETDs are uploaded by authorized staff with a username and passwords to the KNUSTSpace database. Contents of KNUSTSpace and other services are made know through media channels such University's FM Radio, College or departments' notice boards, university's web portal, and customized SMS to students and academic staffs.

Table 2

Tabulation of types and number of available KNUST scholarly outputs as of 25th March 2017.

Type of Scholarly Outputs	Number of Scholarly Outputs
Conference Proceedings	238
Journal of Science and Technology (JUST)	371
Kumasi Centre for Collaborative Research (KCCR)	70
Research articles	1198
Speeches	338
Theses/Dissertations	8173
Total	10,388

KNUSTSpace also share links and resources with other established repositories such as Networked Digital Library of Theses and Dissertations (NDLTD), DART-Europe E-theses Portal (DEEP), British Library: Electronic online theses services (EThOS), National ETD Portal (South African Theses and Dissertations) and DiVA (Digitala Vetenskapliga Arkivet). These repositories serve as a search tools for scholars to get easy and free access to other institutions scholarly outputs around the globe (see Fig. 5).



Fig. 5 KNUSTSpace user interface showing top repositories linked to KNUST IR.

Source: KNUSTSpace Website.

Google Analytics was used by staff to track statistical data on the activities of researchers of KNUSTSpace. Analytics of KNUSTSpace revealed that there were 5,204 researchers who visited web portal; new researchers comprised 4345 and 859 were returning researchers. The analytics recorded 5,975 interactions by researchers and 8,617 pages views as of 16th December 2016. The global usage metrics revealed that Ghanaian researchers (62.68%) were the heavy users of KNUSTSpace followed by countries such as India (8.81%), Nigeria (7.7%), United States (6.01%), Philippines (3.9%), Kenya (3.31%), Russia (2.43%), United Kingdom (2.18%), Malaysia (2.05%) and Germany (0.93%). In-built analytic features of KNUSTSpace did not give similar metrics as the Google analytics and was described as ineffective by the IR manager. However, the study realized researchers who deposited their research output did not have the privileges of viewing statistics about their research output. Global visibility, impact factor and web presence of KNUSTSpace are measured using webometrics ranking system. This ranking system is released twice each year, thus, January and July of every year. Data gathered for 2017 rankings revealed that KNUSTSpace was 616th in the world (Fig. 8), 11th in Africa, 1st in West Africa and in Ghana; comparatively, in 2014, KNUSTSpace was ranked 38th in Africa and 1,260 in the world (Ibinaiye et al, 2015).

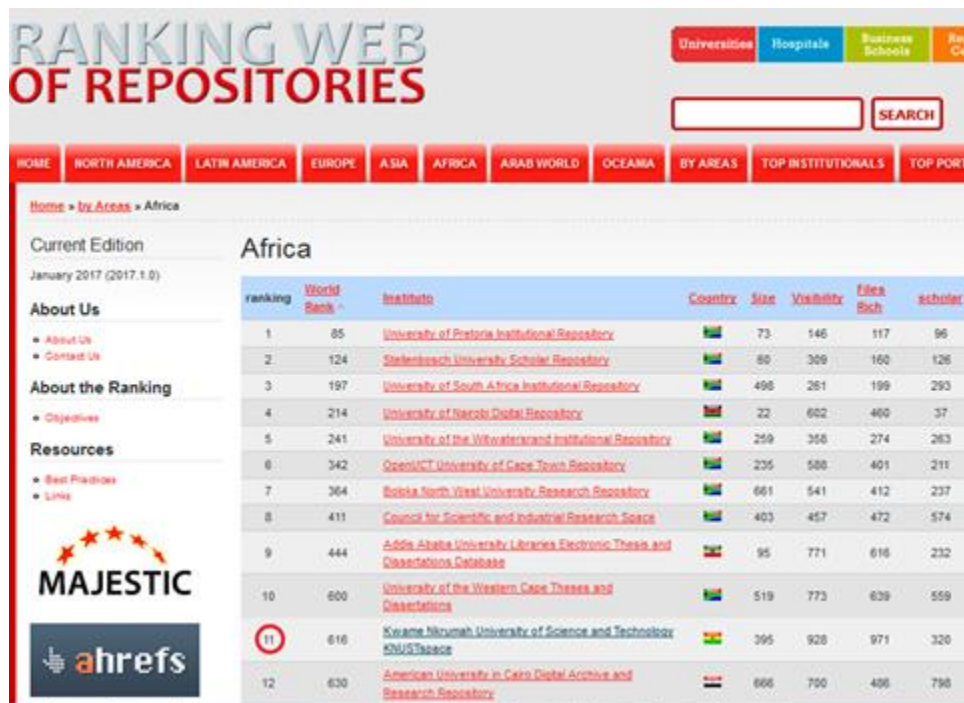


Fig. 8 Webometrics ranking for January 2017.

Source: http://repositories.webometrics.info/en/ranking_africa

The comparison of the datasets evident that there has been a significant improvement in the ranking of KNUSTSpace; this, in turn, has had a positive global impact on empirical research output by staff and students of the KNUST academic community. However, assessment of KNUSTSpace on research, learning and teaching cannot be fully justified based on tracking and reporting on quantifiable statistics data through web ranking systems and user metrics but users' gains, satisfaction or experience in using IRs (Sivak & Vanderjagt, 2013). Voorbij and Ongering (2006) added that users' studies on IRs should also be researched as users can reveal the reasons, views and problems they experienced. Thomas and McDonald (2008) indicate that integrating web ranking systems, user metrics and users' gains are essential and critical in IRs progress. These statements motivated the researcher to research about KNUSTSpace users' gains and experience.

The input process Challenges of KNUSTSpace

The challenges that confront the effective and efficient administration and management of KNUSTSpace include:

- Server instability due to unstable power (electricity) supply at the Network Operating Centre, KNUST.
- There are program hackers who hack into KNUSTSpace database system since KNUSTSpace do not have strong firewall/anti-hackers software. This has created an avenue where KNUSTSpace system slows down or go offline intermittently.
- The number of staff responsible for the operations of KNUSTSpace are inadequate.
- ETDs on CDRoms submitted by Graduate School (KNUST) to be deposited into KNUSTSpace database are usually blank; this creates challenges for staff in depositing postgraduate's theses into the IR.
- Academic staff and students also find it difficult to self-archive their research outputs into KNUSTSpace.

Outcomes of the content of KNUSTSpace on Research, Learning and Teaching

Influences of KNUSTSpace on Research

The contents of KNUSTSpace and its influence on academic activities are pivotal in this study. Hence, students and lecturers were asked to emphasize the extent of influence of KNUSTSpace on research, learning and teaching.

Table 3 the extent at which KNUSTSpace has helped students and lecturers in their research.

Level of Agreement	Students	Lecturers
<i>Extremely Well</i>	12(14.1%)	-
<i>Very Well</i>	38(44.7%)	17(54.8%)
<i>Somewhat Well</i>	28(32.9%)	12(38.7%)
<i>Not So Well</i>	7(8.2%)	1(3.2%)
<i>Not at All Well</i>	-	1(3.2%)

It is realized from the data (table 3) that 38(32.9) of students in the Faculty of Art asserted that KNUSTSpace has helped them “Very well” in conducting research. A minority of the students (8.2%) believed that the KNUSTSpace was not helpful in conducting their research activities. Majority of the Lecturers (54.8%) responded that KNUSTSpace has been helpful to their research activities while 1 (3.2%) responded it did not assist at all. The data suggest that the majority of lectures and students have realized the benefits of KNUSTSpace in term of research.

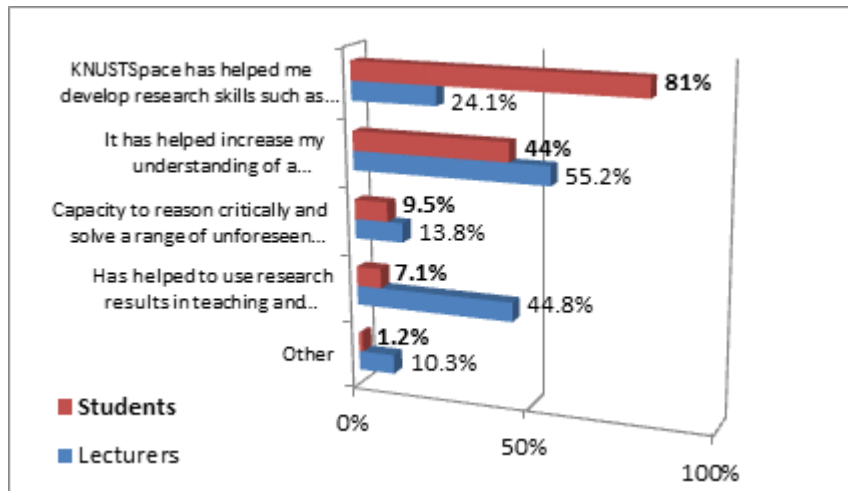


Fig. 9 Ways KNUSTSpace has helped students and lecturers in their research activities.

The respondents were further examined on how KNUSTSpace has helped in their research (Fig. 9). Majority of students (81%) indicated that KNUSTSpace scholarly outputs have helped them develop research skills such as outlining and structuring of research objectives and questions, organization of information, investigational skills, selecting appropriate research methodology, interpretation and analysis of data. Lecturers (44.8%) indicated that it has helped them in using research results in

teaching and learning and also develop their own research capabilities and creativity. These confirm studies by Homewood et al (2011) which revealed scholars getting access to diverse research outputs gains such skills aforementioned.

Both students (44%) and lecturers (55.2%) revealed that KNUSTSpace scholarly outputs have helped increase their understanding of a phenomenon of creating new knowledge. Leedy and Ormrod (2005) revealed that gathering, analyzing and interpreting research findings help scholars to understand diverse situational problems and helps create new knowledge through research.

Influences of KNUSTSpace on Teaching

With regards to the extent of influence of KNUSTSpace on teaching, majority of lecturers 16(51.6%) indicated KNUSTSpace has helped them somewhat well in the teaching processes while 2(6.5) believed KNUSTSpace has not had any impact on their teaching (Table 4). However, 1 lecturer did not respond to the question.

Table 4 the extent KNUSTSpace has helped lecturers in their teaching.

Level of Agreement	Lecturers
Extremely Well	2(6.5%)
Very Well	11(35.5%)
Somewhat Well	16(51.6%)
Not So Well	2(6.5%)
Not At All Well	-

Lecturers were further questioned on how KNUSTSpace has helped their teaching process. In response, the lecturers (33.3%) indicated that KNUSTSpace scholarly outputs have helped them to have loads of information on different subject areas; and understanding them broadens their knowledge. The Lecturers (33.3%) revealed that KNUSTSpace scholarly outputs have empowered their access to teaching materials and research outputs in KNUST; and, has positively enhanced the quality of teaching methods. This finding is in consonance with a number of findings that revealed positive results on how IRs has helped scholars to get access to teaching and research resources;

enhanced the quality of teaching methods; and broaden researchers' knowledge (West, 1999, Biggs and Tang, 2007 and Patel and Patel, 2013). The lecturers (33.3%) also indicated KNUSTSpace has helped them to enhance their students learning experience through research-based practice.

Lecturers were questioned if they use scholarly resources in KNUSTSpace to enhance their teaching practices (using ideas and examples from their own or other research works in KNUSTSpace). Majority of the lecturers (84.4%) indicated "Yes" while 15.6% indicated "No" (Fig. 11). These findings are in agreement with Homewood et al (2011) which identified two aspects of research-enhanced teaching which emphasize teachers using concepts from their own scholarly research or others to enhance students' understanding of a phenomenon, and enhancing students' learning experience through research-based practice by engaging them in various research activities.

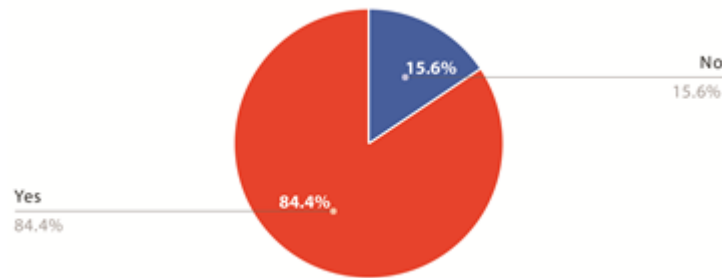


Fig. 11 Lecturers use of KNUSTSpace resources to enhance teaching practices

Learning

On learning, respondents were asked to what extent has KNUSTSpace helped in their learning processes. 85 students and 31 lecturers answered this question. Table 5 reveals that the majority of students 50(58.8%) and lecturers 19(61.3%) indicated KNUSTSpace has helped them very well in the learning processes

Table 5 the extent KNUSTSpace has helped students and lecturers in their learning.

Level of Agreement	Students	Lecturers
Extremely Well	15(17.6%)	-
Very Well	50(58.8%)	19(61.3%)

Somewhat Well	15(17.6%)	15(35.5%)
Not So Well	5(5.9%)	1(3.2%)
Not At All Well	-	-

Respondents were further questioned on how KNUSTSpace has helped them in their learning activities. Figure. 12 shows that majority of students (94%) and lecturers (63%) indicated KNUSTSpace scholarly outputs have helped empowered their access to learning materials (research outputs) across KNUST, which has positively enhanced the quality of their learning by gaining new knowledge. Furthermore, the lecturers (40.7%) revealed it has boosted their perception of the teaching and learning process. This finding is in line with a number of empirical studies (West, 1999, Biggs and Tang, 2007 and Patel and Patel, 2013).

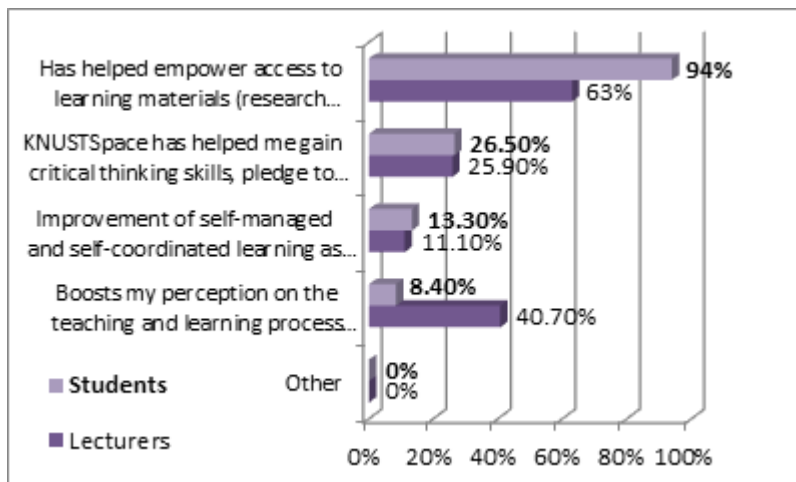


Fig. 12 Ways KNUSTSpace has helped students and lecturers in their learning activities.

Students were questioned if lecturers enhanced their learning experience by engaging them to access and use scholarly resources in KNUSTSpace to enhance their learning and research activities during lectures. Majority of students (67%) revealed that lecturers enhanced their learning experience by engaging them to access and use scholarly resources in KNUSTSpace to enhance their learning and research activities during lectures (Fig. 13). The implications of lecturers engaging students to deeply use resources in KNUSTSpace such as journals, articles and other resources during lectures are to encourage them positively to keep them up-to-date with current happenings

and also to gains broader knowledge about their field of study suitable for the period (Homewood et al, 2011).

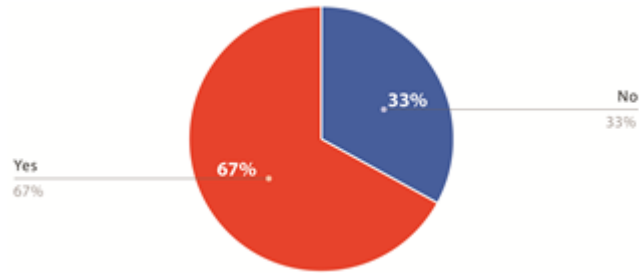


Fig. 13 Lecturers engaging students to access KNUSTSpace during lectures.

Respondents were further questioned on what they have gained in accessing KNUSTSpace. Figure 14 reveals that the majority of students (81.2%) and lecturers (80.6%) indicated that KNUSTSpace has increased their access to loads of research, learning and teaching materials accessible across KNUST. Majority of students (71.8%) and lecturers (48.4%) indicated that KNUSTSpace has increased their access to scholarly outputs from other institutional repositories. This implies that KNUSTSpace has empowered scholars to get vast scholarly resources to improve their learning and research activities not only from KNUSTSpace but from various OA-IRs globally (West, 1999; Biggs & Tang, 2007; Patel & Patel, 2013).

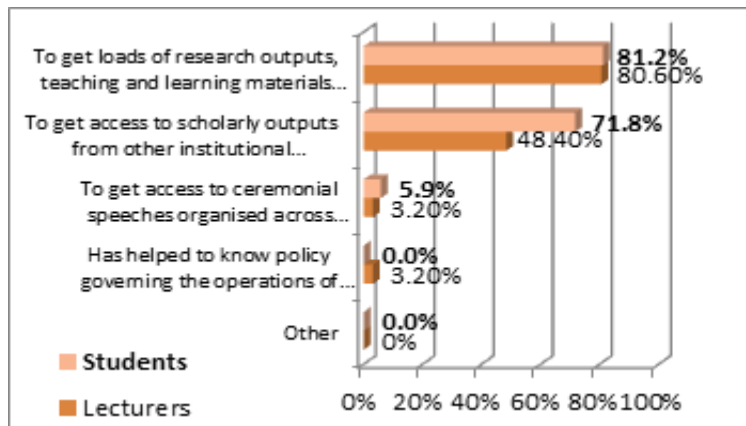


Fig. 14 Students and lecturers gain in accessing KNUSTSpace.

Figure 15 reveals a summary of the investments connections amongst investments and results of KNUSTSpace comprising of the research findings for this study.

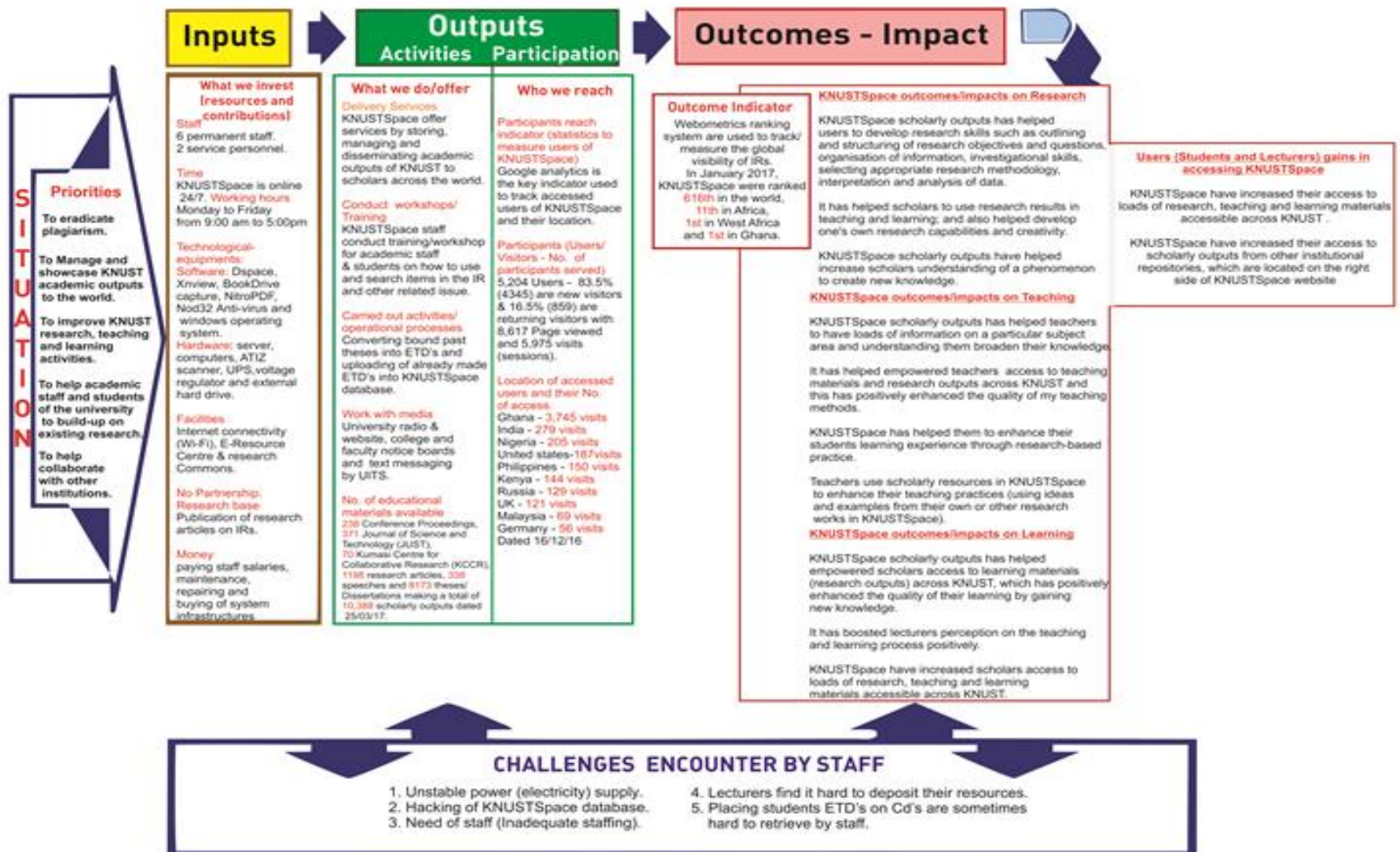


Fig. 15 Logic Model for KNUSTSpace.

Source: Developed by the Researchers

CONCLUSION

This study aims to build a model for IR evaluation which focuses on criteria for procedural evaluation to develop more efficient operational processes by IR staff, unveil challenges staff encounters and uncover users' reasons, gains, outcomes/impact, benefits (Voorbij & Ongerling, 2006) in using the repository in relation to their research, teaching and learning. A conceptual framework with five (5) components was adopted. Based on this framework, an evaluation model is built by utilizing two methods: an interview with expert IR staff about the operational processes (inputs and outputs) and challenges of KNUSTSpace; testing the model on students and lecturers through a questionnaire about the impact/gains of KNUSTSpace on their research, learning and teaching activities.

KNUSTSpace Staff helped with the effective and efficient day to day operational running of the repository. Time invested (work hours) into the operational processes of KNUSTSpace created room for staff to deliver in-depth support services to clients/scholars; clients were also educated on how to access the IR and use scholarly outputs. Myriad software, hardware, training/workshop centre and internet facilities were available for productive storage, management, dissemination and access of quality KNUST scholarly outputs. The software was functional and easily manipulated by staff; hardware brands were robust, effective and durable. KNUSTSpace were financed by the university in terms of paying staff salaries, maintenance, repairing and buying of system infrastructures. Publicities are carried out to educate students and lecturers towards maximization of the use of the libraries and IR resources.

KNUSTSpace offered services on academic outputs of KNUST to scholars globally. The library organized workshops/training for students and academic staff of KNUST to educate them on web search, especially, KNUSTSpace using the E-Resource Centre and Research Commons, all located at the university's library. Conversion of theses into ETDs and upload of the ETDs into the KNUSTSpace were done by staff. KNUSTSpace information schedules are disseminated by the university radio, university website, college and faculty notice boards and UITS.

KNUSTSpace is connected to other OA-IRs such as NDLTD, EThOS, DiVA, and DEEP. Google Analytics is used as a key indicator for tracking users' visits and location. In-built statistics count for KNUSTSpace was ineffective. KNUSTSpace encounters challenges of unstable power (electricity) supply, hacking activities, malfunction CDRoms submitted by School of Graduate Studies for upload, inadequate staffing, and restrictions by the system disallowing self-archiving by students and lecturers. The global visibility of KNUSTSpace was measured using webometrics ranking system.

KNUSTSpace scholarly outputs have helped students and lecturers very well in their research processes. The scholarly outputs facilitated research skill development such as outlining and structuring of research objectives and questions, information organization, investigational skills, selecting appropriate research methodology, interpretation and analysis of data; using research results in teaching and learning; developing research capabilities and creativity; and increasing understanding of the phenomenon to create new knowledge.

Not all the lecturers agree to the fact that KNUSTSpace has assisted them well in their pedagogical practices. However, those who have benefited from KNUSTSpace iterated it has helped them access loads of information and broadened their knowledge on particular subject areas; empowered their access to teaching materials and research outputs across KNUST positively enhancing the quality of their teaching methods; and enhancing students learning experience through research-based practice.

lecturers use scholarly resources in KNUSTSpace to enhance their teaching practices.

Students' learning experience was enhanced as lecturers engaged them to access and use scholarly resources in KNUSTSpace for their learning and other activities during lectures. In addition, KNUSTSpace has increased students' and lecturers' access to myriad educational resources accessible across KNUST. It has also increased access to scholarly outputs from other institutional repositories, provided as links to these institutions.

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