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Internet of Things Affordance for Open Educational Resources in a Comprehensive Open Distance E-learning

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Abstract

The Internet of Things (IoT) space has dual dimensions of affordance to support open educational resources (OER). The duality of affordance has little or not been well articulated in relation to OER, particularly in a Comprehensive open distance e-learning (CODEL) institution. Such an institution is a mega open distance in South Africa and beyond the continent to accommodate students globally and rely on information and communication technology (ICT) in the provision of tuition. In the CODEL institution, there is a recognizable shift as the institution encourages the appropriation of OER and phasing out the prescription of the prescribed textbooks. The research opted for the qualitative approach to establish the role and the causality of IoT affordance in the appropriation of OER. The technology affordance theory has been used as the main theoretical underpinning for this study. The study found that the CODEL institution is IoT driven when handling OER. Furthermore, IoT affordance for OER suggests two propositions as a contribution: CODEL requires to articulate and realignment of its business enterprise system with IoT-driven infrastructure to accommodate tuition using OER; and the IoT-driven context needs to seek possible solutions to adopt artificial intelligence practices for the advancement of OER. In a recommendation for future research, there is a need to investigate the appropriation of OER through IoT affordance in all South African higher education institutions including the contact or traditional universities.

Keywords: Internet of things, open educational resources, comprehensive open distance e-learning (CODEL), affordance theory

1. INTRODUCTION

The Internet of Things (IoT) has recognised in different organizations including the education sector. IoT is the process of enabling different devices to communicate with each other over a network (Ashton, 2009). Once the interaction and interaction of devices and technologies have happened, the systems afford human interaction (Rastegari, Nadi, Lam, Abdullah, Kasan, Rahmat & Mahari, 2023). Most processes and gadgets today use the IoT, a developing technology that has the potential to improve people's quality of life by making it easier to access certain information and services (Villamil, Hernández & Tarazona, 2020). Globally higher education including the education sector has potential growth of IoT. The IoT promote academics and students to use digital technologies to enhance their e-learning, and a variety of tools have been used to integrate formalized learning environments in teaching in higher education. (Alenezi, 2023). The proper implementation of e-learning IoT architecture in universities and colleges can improve their distance learning programs and increase efficiency without affecting their academic activities (Haque, Haque, Zeba, Kumar, Ahmad, Rahman & Ahmed, 2023). Furthermore, IoT has a significant impact on education in a number of ways that allow institutions to make better-informed decisions in an effort to enhance student learning experiences, operational efficiency, campus security, and many other factors (Bekturdiyev, 2023).

IoT affordance in open distance and online learning is advancing for better innovation. Affordance is the process that allows the exploration of IT artifacts in turn facilitates the analysis of interactions between IT and users within the organization and improving the understanding of affordance existence and affordance perception (Kalimullina, Tarman & Stepanova, 2021). In education, IoT affordance is recognised when then there is an interaction of physical and virtual objects embedded with instructional technologies, mobility applications, and cloud computing (Kalimullina, et al., 2021). The instructional technologies include LMS such as Blackboard, Sakai, and Moodle. IoT technologies also enable the integration of mobile learning applications used by learners to manage learning and used by instructors to administer assessments and teach through

simulations and gamification (Tsakeni, 2021). IoT affordance has potential growth because many higher education institutions rely on internet learning where online resources are appropriated for tuition.

The most popular online resource is open education resources (OER). All types of higher education institutions like distance education, open institution, blended learning, and contact institutions appropriate OER for tuition and learning. This artifact emerged during a meeting of the United Nations Educational, Scientific and Cultural Organization (UNESCO) meeting in 2002. OER are resources that encourage open access to information for educational purposes, including whole courses, course materials, modules, textbooks, exams, tools, materials, and approaches (Oelfke, Sadowski, Ramseier, Iremonger, Volkert, Dykman & Baumann, 2021). The Ministerial Statement by UNESCO (2017:301), which was adopted during the Second World OER Congress, held in Slovenia, states that: "*for OER to reach its full transformative potential for supporting the realisation of Sustainable Development Goal 4 (SDG4), OER needs to be more integrally a part of educational policies and practices from early childhood education to post-secondary, technical vocational educational training, higher education, lifelong learning, and teacher training*". OER is kept and processed within the information systems platforms, which are connected to the Internet (Mncube, 2022). OER relates to IoT affordance since are created, retrievable and appropriated online. Yet, there is little knowledge of IoT affordance for OER. The study sought to close such a gap and increase knowledge related to IoT affordance for OER. Therefore, the aim of this study is to investigate how IoT affordance plays a role in the appropriation of OER in a Comprehensive Open Distance e-learning (CODeL) institution. To answer this question, technology affordance theory deems to be relevant for this research.

2. LITERATURE REVIEW

OER acceptance, creation, and dissemination depend on ICT systems. Users can access a variety of information resources through ICT for knowledge sharing, collaboration, and personalization (Xin & He, 2020). ICT are essential to OER's existence. Open education depends on ICT for the distribution of information and resources, and many universities have adopted it for knowledge management and research development (Tudor, 2020). Due to the creation of access to databases, e-journals, e-books, institutional repositories, and OER, this is essential for open access movements (Jain & Behera, 2023). Consequently, it is possible to hypothesize that ICT supports the open access effort by enabling ODeL academic institutions and organisations to adopt, create, access, use, and spread OER and gain access to information at any time and from any location.

Globally, governments must think about building a sufficient ICT infrastructure, including widely available mobile technology, affordable broadband access, and dependable electrical power supply (Kinyua, 2019). Even though ICT appears to be valued for information delivery, the infrastructure presents difficulties in developing nations like Afghanistan and any other African nations, including South Africa (Oates et al., 2017). These infrastructure issues include inadequate electricity and unreliable internet connectivity and many other social factors.

ICT is understudied, and it is necessary to move away from conceptualizing ICT as empowering and toward an empirical understanding of how ICTs are used (Birkland, 2013). This can be a sign that there are different levels and abilities for using ICT in a certain domain. By ensuring that academics have access to devices that can be utilized to access the most recent digital information, ICT assistance should facilitate the mainstreaming of OER (Cai, Dong, Li & Wong, 2023). It is crucial to comprehend the software, applications, and systems employed in an ODeL university if one wants to grasp how academics are utilizing ICTs for OER. This study examines the literature on the connections between and utilization of various ICT at a CODEL institution. Therefore, such ICT infrastructures are devices, software, MOOCs, LMS, and the fourth industrial revolution (4IR).

2.1 Devices as an enabler for OER

The primary factor in the adoption and advancement of OER is ICT device ownership. There is no assurance that an OER will be active in the absence of ICT tools. ICT infrastructure, in particular hardware like computers, workstations, and any other portable devices, is necessary for the usage of OER (Gupta & Gupta, 2020). Hardware devices that can be utilized to carry, process, store, and transfer information have come to light because of the introduction of OER. The gadgets that academics use to access the internet have an impact on how they use open educational resources (Tila & Levy, 2023). However, Musakwa and Petersen (2023) assert that the gadgets used in the Global South are comparable to those used in other nations and do not contribute to utilisation factors. When it comes to context usage, people have different preferences; some choose desktops, laptops, and mobile devices. Through the process of optimizing for the delivery of educational resources, for instance, students choose tablet computers and smartphones to consume OER learning content during class (Zhang, 2022). Both the non-use of

OER by academics and the non-ownership of different gadgets may impede students' ability to complete their academic work. Despite the fact that some people may own a range of devices, these are not employed for education but rather for personal usage (Sheaffer & Vinson, 2023).

Without the required equipment, academics in the contemporary IoT era find it difficult to innovate and conduct research and teaching. Governments all around the world have supported projects to widely deploy computers, such as tablets, in public schools since the start of the twenty-first century (e.g., Thailand, Turkey, India, Singapore, United States of America, and Brazil) (Farias, Ally & Spanhol, 2018). It seems like a terrific idea for students to possess gadgets and use them to interact with digital platforms to access their education. According to Conrads, Rasmussen, Winters, Geniet, Langer, Bacigalupo and Punie (2017), many European national policies introduced between 2010 and 2015 place a strong emphasis on providing portable devices like laptops, netbooks, tablets, or smartphones to all students in a given school, regardless of class or age group. When compared to one-on-one learning efforts, this has a significantly positive impact on creating an environment where students are the focus of attention in the classroom (Balanskat, Bannister, Hertz, Sigill, & Vuorikari, 2013).

Higher education institutions in South Africa may be responsible for providing personal gadgets for their academic staff members. This is done to enable them to carry out their everyday tasks at the specific job. According to the research, many academics at HEI are given tools to use in creating and adopting instructional resources (Okai-Ugbaje, Ardzejewska, & Imran, 2020). The enrollment of students is the issue. The throughput rate and level of academic frustration in higher education will increase if students are given access to all necessary resources, such as devices (Cox & Trotter, 2017). In contrast to the Global North regions, where students are given personal gadgets, pupils in these locations are considered to be a disadvantaged community (Conrads et al., 2017). All enrolled students should receive personal devices from the South African government, especially in rural areas where the majority of residents still struggle with poverty and infrastructure disparities.

2.2 Software role in OER

Every ICT system or device used to handle OER needs a specific piece of operating system or application software. According to Ni., et al. (2023), software is referred to be a command that gives the computer the ability to carry out a specific operation. That makes software eligible to act as an enabler in the delivery of OER. Different operating systems, including Windows, Mac OS X, and Linux, as well as paid and free software programs, can be helpful in the creation of OER (Zhang, Tlili, Nascimbeni, Burgos, Huang, Chang & Khribi, 2020). Therefore, in order to ensure appropriate operation, OER developers must ensure that all computers and other devices utilized in the development of OER, as well as the aforementioned operating systems and applications, are installed before usage. In order to run OER, the Linux operating system, Apache Web server, and OpenOffice desktop application have all been shown to be of the highest quality (Kurshan, 2006). This enables the study to draw the conclusion that there are differences in system software ownership and use around the globe.

The software cannot run in a vacuum or independently from hardware. It is not a stand-alone phenomenon. Additionally, the integration, access, utilization, and diffusion of OER provision are impacted by the interconnection of hardware and software. To facilitate communication and cooperation, it is essential that software be utilized differently while creating and modifying OER (Deng, Mueller, Rogers & Olechowski, 2022). When it comes to software ownership and use, there are regional differences. An integrated set of open-source learning tools known as Sakai was developed by some American universities using collaborative software (Walz, 2015). Sakai is a learning management system.

Similarities in OER dissemination can be seen based on the hardware and software used for distribution. According to Walz (2015), once academics have created OER, they must be shared via the institutional repository of the university or another OER repository, such as MERLOT, OER Commons, Jorum, or any other channels. OER may be distributed in print or digital media, according to Walz (2015). Branca, Resciniti and Loureiro (2023) point out that research reveals differences in consumers' preferences and results when comparing printed text to digital format. To make OER use convenient for learners and to create space for accommodating the most widely used knowledge bases, numerous distribution methods must be used (Dobrowolski, Kobylarczyk, Wagner & Mazur, 2018).

Academics and institutions must choose the hosting platform when OER have been processed, developed, or chosen. Therefore, the platforms that are necessary to host OER for instruction and research are the main emphasis of this section. Learning management systems, MOOC platforms, and educational social media platforms are just a few of the many platforms utilized in higher education institutions to mediate between lecturers and students when developing OER (Halimi, Salzmann, Gillet & Saliah-Hassane, 2018).

2.3 Massive open online courses

Education is gradually moving away from a traditional model and toward an online one. Numerous e-learning platforms are available in academic fields all over the world, which has increased prospects for open education (Alharbi, 2023) and attracted the attention of OER. MOOCs are one of the most popular e-learning platforms in the globe as well as a platform for OER delivery (Hidalgo & Abril, 2020). According to John et al. (2016), the most prestigious colleges in the world, including Harvard University, Stanford University, Massachusetts Institute of Technology (MIT), and the University of California at Berkeley (UCB), have all benefited from MOOCs. This platform is significant as it allows millions of students to make use of free, open online tools and resources for their tuition.

The key reason MOOC is advised when academics are implementing OER globally is that the project is based on well-established web-based technology platforms and has amassed significant amounts of high-quality resources that are being shared openly (John, et al., 2016). However, the authors point out a drawback of MOOCs, namely that certain students frequently struggle to recognize the content that is necessary, helpful, and required at their level. This shows that there is a definite requirement to comprehend the platform and OER to make the offered information relevant to all intended consumers. Dichev and Dicheva (2012) further suggest that it becomes challenging for potential users to locate the content they require in repositories and portals for open content. Pawlowski and Hoel (2012:17) in the Paris OER Declaration underlined the need for greater research in this area and "encourage the development of the user-friendly platform to locate and retrieve OER that are specific and relevant to particular needs" in order to overcome these challenges.

Universities in the Global South have struggled to accommodate more flexible learning models, create online courses, and use open educational resources. Only lately have institutions in the Global South started to use MOOCs. The pedagogical and geopolitical ramifications of developing-nation participants in MOOCs coming only from the rich world are understood (Czerniewicz, Deacon, Small & Walji, 2014). To offer exciting options for educational supply, particularly in developing countries, MOOCs have been demonstrated to be a crucial component of the inclusion of OER (Julia & Marco, 2021). Only a small portion of OER and MOOCs are created by universities in the Global South (Czerniewicz & Naidoo, 2013), which shows that developing nations have more often been recipients and users of OER than producers. According to others, OER and MOOCs would give academics and universities in the Global South the chance to rebalance the uneven global networks (Adam, 2020)

2.4 Learning management systems

Learning management systems (LMS) are widely acknowledged and valued for their contributions to research, instruction, and education. LMS is the system used by many higher education institutions, especially ODeL universities, to provide tuition and conduct research (Cobb, 2020). This has been made possible by the introduction of ICT into the classroom, which is steadily driving institutions in that direction. ICT integration can improve academic or instructional practices while delivering advantages by offering more effective ways to manage lectures, time, and content (Tomé & Coelho, 2023). The adoption of LMS also enables organizations to adhere to e-learning regulations.

To enhance the administration of the teaching and learning process, e-learning has been widely used in the educational setting (Ramadhan, Hidayanto, Salsabila, Wulandari, Jaury & Anjani, 2022). Because it increases enrollment and has the potential to enhance throughput rates, the effort has become crucial for academics, students, and the institution. LMS were only functional or acknowledged in ODeL institutions in the 1980s. The 21st century saw a significant shift as various higher education

institutions began to recognize the blended learning model, in which courses are delivered both traditionally and online and complement one another.

The development of LMS as a component of digital technologies has made them crucial to the future of tertiary education globally (Kaputa, Loučanová & Tejerina-Gaite, 2022). Although there are differences in the appropriation of LMS, both developed and developing nations have LMS subscribers. For instance, developed nations have high levels of involvement since they all need to put in place supportive structures and procedures to keep up with the advancement and use of LMS. Academics and students who utilize the LMS are given the tools they need to interact with it when it first launches (Farias, Ally, & Spanhol, 2018).

South Africa, a developing nation, adopted the LMS efforts but was unable to afford to provide pupils with the necessary equipment. Low maturity characterizes the framework used to facilitate the development of LMS (Zhao, Cao & Liu, 2022). This causes a persistent issue because it is impossible to assume the same performance from pupils raised in developed and developing nations. The issue can be identified by the disparity in who owns the systems and devices that users interact with when using LMS for OER. It is also important to note that universities have a stronger emphasis on supplying devices, helping professors get through tuition hurdles, and resolving technical difficulties with LMS usage (Mncube & Mthethwa, 2022).

2.5 Fourth industrial revolution web technologies for OER

The fourth industrial revolution (4IR) and the Internet of Things (IoT) have caused development and education to advance and move more quickly. Web 2.0 and Web 5.0 have received the most attention in the adoption and development of OER. The educational system and universities stand to benefit from Web 3.0 to Web 5.0 tools and applications (Al-Zoubi, Dmour & Aldmour, 2022). According to Ohei and Brink (2019), these tasks facilitate intellectual development and enhance the acquisition of general intellectual skills required for lifelong learning in the information society. Web 4.0 is too sophisticated, particularly in underdeveloped nations like South Africa. The new 4IR, which was created through digitization and robots, is called Education 4.0. According to da Motta Reis, Costa, Espuny, Batista, Francisco, Gonçalves and de Oliveira (2020) it tends to incorporate information that is available in both the actual world and the virtual one. Particularly in the developing countries, this has not yet been adequately invested in the development of OER in HEI.

Since using Web 3.0 - web 5.0 as part of lectures, academics in higher education institutions, notably in the CODeL setting, have changed the way they instruct and oversee students. Initially, Web 2.1 was designed to foster informal communication and social networking in order to encourage the sharing of social, personal, and individual experiences (Alenezi & Brinthaupt, 2022). When technology began to be utilized for social communication and education, there was a gradual but evident transformation (Halili, 2018). Web 2.0 and 5.0 are popular in the twenty-first century and advancing the goals of tuition provision (Germain, 2020). Colleges and universities have realized the value of these online technologies in supporting their group e-learning projects. Facebook, Twitter, YouTube, blogs, wikis, podcasts, web platforms, cloud storage, and other platforms are the most popular teaching tools (Aljawarneh & Halili, 2018). The utilization of OER cooperation and engagement on digital platforms is shown by the transition in Web 2.0 and 5.0 technologies (Oon, Pegrum, Stevenson & Benson, 2023). Academics may have opportunities to adopt and develop OER as Web 2.0 up to Web 5.0 must be included in CODeL institutions for tuition and research (Mncube, 2022). In the current era, the use of IoT and Web 5.0 apps by academics and students to integrate, access, use, and spread OER is yet unknown.

3. COMPREHENSIVE OPEN DISTANCE E-LEARNING INSTITUTION

The University of South Africa enjoys being one of the biggest comprehensive open distance learning (CODEL) institutions in South Africa and Africa as a whole. In 1946, it became one of the first public universities in the world to teach exclusively by means of distance education (Unisa website, 2023). Unisa is widely recognised as a leading comprehensive, open, distance and e-Learning (CODeL) university. The university has more than 370 000 students and is the largest university in South Africa and on the African continent, and one of the world's mega-universities (Unisa website, 2023). In terms of ODL, UNISA has a similar profile to India's Indira Gandhi National Open University. Due to the university's prominence or international recognition, students from all over the world apply to attend, regardless of their race, gender, ethnicity, age, religion, or political affiliation. The university makes every effort to give its student body opportunities for lifelong learning because admission to UNISA is open to anyone, regardless of age. For obvious reasons, many students prefer attending this university because it gives them a variety of courses and degrees to pick from. Also, there is more flexibility since classes are taken online and afford the opportunity to study from home, work, train, bus, and in any convenient spaces.

CODeL has made a remarkable contribution in allowing students to access tertiary education in developed countries, access remains limited in developing countries (Aruleba, Jere & Matarirano, 2022). Despite being considered a developing nation, South Africa's ODL position is very different from that of other nations. While the university offers a wide range of authorized degrees at all academic levels, from undergraduate to doctorate, it also offers accredited short courses, certificates, and diplomas in all of its colleges and departments. The status of CODeL institution is fully online and rely on ICT infrastructure for teaching and learning. All students and academics engage remotely where tools such as World Wide Web, Email, audio recordings, video recordings, broadband, optic fiber, video conferencing, video calls, internet of things, and cloud computing (Sevnarayan, 2022) are appropriated on a daily bases.

MyUnisa, which has Moodle integrated, is the most popular system in a CODEL institution. The ability to teach and learn is made feasible for both students and lecturers by these online service delivery tools. Students can express their opinions and concerns regarding their education on MyUnisa. Additionally, it gives students a chance to interact with one another through discussion boards. The students can use myUnisa to develop and create study groups by posting their contact information to other students nearby. The academic staff and students can also access announcements, discussion forums, and social conversations on myUnisa (Nsamba, 2019). In the year 2010, It was suggested that the amount of communication between students and instructors by telephone may be significantly reduced (Van der Vyver, 2010). Because Unisa employs an internet platform for tuition and the present Unisa provision is entirely online, this goal is already realised. For easy access by students across the continent and overseas, feedback on assignments and exams can be put on the portal. The portal also gives students the option to submit electronically, which saves them time as they are no longer required to send assignments and exams to the university by postal service or courier service.

4. AFFORDANCE THEORY

This study opted for affordance theory to investigate IoT affordance during the appropriation of OER. According to Volkoff and Strong (2013), the term "affordance" has been used extensively in IS research to assist explain and analyse various artifacts. Affordance theory is "particularly well suited to help Information Systems scholars build theory about ICT use" (Majchrzak, Markus & Wareham, 2016:272). While other researchers have explored the associated affordances with different kinds of IT solutions (Strong et al., 2014), some researchers have constructed theoretical affordance models (Volkoff & Strong, 2013). The study approach for this research focused on the relationship between the infrastructure of information and communication technologies and people's use of those technologies (Gibson, 1977).

To delve into literature and answer the research questions, this study opted for three concepts of affordance by Lanamäki, Thapa and Stendal (2016) such as technology capabilities; human ability; and affordance utilisation capabilities. In the technology capabilities phase, the relationship can be between a class of an artifact and a social convention; among designer, artifact and imagined users; between artifact and actual users; or between an artifact and another artifact (Lanamäki, et al, 2016). On that note, this phase helped to discover the relationship between the artifact and the actual user by investigating IoT for OER appropriated by academics. The affordance capabilities help us create a nuanced picture of how technology affects the human actor and the usage of technology (Lanamäki, et al, 2016). Therefore, the affordance utilisation capabilities deem to be useful in addressing IoT systems and academic capabilities used for OER.

5. METHODOLOGY

This study employed a interpretivism paradigm and a qualitative approach, with the case study (the CODeL institution) as the chosen research design. Because the initial participants were chosen from a diverse institution with eight colleges, 18 schools and 70 departments, snowball sampling was used. A total of 42 lecturers – consisting of Junior Lecturers, Lecturers, Researchers, Senior Lecturers, Associate Professors and full Professors (P) participated in the semi-structured interviews. Due to their flexibility, semi-structured interviews appears to be the most effective method for qualitative research (Gillham, 2005). The interviews lasted for 25–60 minutes. The selection criteria were based on the fact that lecturers are responsible for teaching and rely on OER. One of the ways for collecting data in this study was document analysis. Documents, which included the OER plan, the Open Distance Learning Policy, and the UNISA Annual Reports (2013 and 2019), were analysed as part of the triangulation of the existing data.

The data collection process was followed by the thematic data analysis. NVIVO was used to store and management of collected data. After being made anonymous, the transcripts were coded in NVivo and analysed. After re-reading the interviews and the codes, NVIVO memos were created on various topics by returning to the individual interviews and further analysing the data. At this point, the researcher began to look for themes. The researcher went over all the coding, themes and links between the

primary themes and began to redefine and rename the final themes after identifying or combining concepts, completed the analysis. The ethical clearance letter and the permission to conduct research at Unisa were obtained. Following ethical guidelines is essential, including those relating to informed consent, confidentiality with regard to participants, sponsors and co-workers, the importance of the benefits of study to participants over the hazards involved, and participants' requests that go above and beyond social standards (Lipson, 1994). Therefore, participants' identities were kept private in the presentation and discussion of the findings as all participants were referred to as "academic 1 - 42".

6. FINDINGS

6.1 System affordance utilisation and capabilities

MyUnisa which is embedded with Moodle, institutional repositories, and library guides are the three key systems of a CODeL institution that enable the use of OER. The appropriation of OER in a CODeL university is facilitated by these systems. For using OER, academics rely on the current LMS (myUnisa). Because myUnisa is the official system employed by the CODeL institution, some academics have demonstrated their reliance on it. They decided to continue using the current institutional system since it appeared to meet their goals for tuition and research and because the LMS and library systems were already in place and could handle OER. Some academics admitted that they liked myUnisa because of its straightforward graphical user interface, which allowed for quick engagement and participation. They also praised myUnisa for its versatility and familiarity, allowing for student interaction and the capacity to embed many media modalities that are pertinent to teaching and learning.

> *"I think MyUnisa is key to any academic right and our students have been aligned to MyUnisa so directly so, there are no other systems that I`m using besides MyUnisa"* (Academic 6).

Other academics expressed the opinion that they depend on the current system because of the institutional policy, which both allows for it and is required. This is in addition to the utility, familiarity, and usability of myUnisa. Some claimed that using additional systems is unethical because they are required to adhere to the institutional role policy.

> *"We are not allowed to use other systems such as YouTube and others"* (Academic 15).

On the other hand, some professors concurred that, despite its drawbacks, myUnisa gives them the chance to communicate and teach their students. MyUnisa offers all the necessary teaching aids, but sharing larger files is not possible. MyUnisa has several restrictions because it is only permitted to upload 10 megabytes at a time. The process may take longer to complete if OER audio and video files are uploaded.

OER were created by some professors and kept in the institutional repository. They believed that the library locations were advantageous for promoting OER. The librarian reaffirmed that the academic library served as the administrative hub for their institutional repository, which housed all of the data generated by the institution. The institutional repository's major goal was to disseminate the intellectual output of the institution to the world for the benefit of other academics and learners. Although there is some affordance in the institutional repository, creating resources and getting them saved takes time. The CODeL institution has space designated for OER produced by its professors.

> *"I will probably put it on the OER…UNISA has now got an OER repository through the library so I will put it up there"* (Academic 36).

Some professors said that they use LibGuides in addition to the institutional repository to advertise their OER. LibGuides are online websites that librarians have developed to assist academics in putting their OER. These conclusions appeared to be accurate because the researcher checked the library portals to see if any OER LibGuides had been made, and she discovered that there had been OER LibGuides prepared for OER. The other participants volunteered to demonstrate his LibGuides embedded in an LMS with subject-specific information during interviews.

> *"I would inform them to go through that and then the library guide, so they also have access to a lot of resources"* (Academic 25).

6.2 CODEL IoT Technologies and Capabilities

There are several IoT technologies affordance which played a role during the usage and development of OER. Some of the IoT technologies are as follows:

Table 1: Internet of Things technologies

Category	IoT technologies	Affordance capabilities
Application and innovations	**Custom-made OER systems**	Teaching app Creation or development of OER Usability and convenience
	Common online platforms	Sharing knowledge Collaboration Open access
	artificial intelligence	Efficiency Accuracy data distribution
Social media	**LinkedIn, Facebook, WhatsApp, YouTube, blogs, and ResearchGate**	Information Sharing OER dissemination Online OER storage showcase our tuition
	Google Scholar	Storage Research management Knowledge management
	YouTube	OER retrieval OER storage
	Microsoft Teams and Zoom	Teaching Presentation Administration
Storage devices	**Cloud**	Online storage Adoption and dissemination
	Computers /laptops	Physical storage Appropriation
	Smartphones	Storage Adoption and dissemination Instructions

6.2.1 IoT application affordance

Some professors allegedly go so far as to create unique programs that can be used with the smart devices that many pupils own. They called those gadgets "cell phones" and "tablets." Academics are encouraged to use specialized mobile apps, podcasts, and other venues to make OER easier to access. Since many academics and students' own smartphones, it was noted as a benefit that all of the aforementioned platforms or Apps are easily accessible via smartphones. Since they can be used anywhere—including on trains, in restaurants, and in gyms—these apps and technologies were favoured by academics because they are more convenient for their students. They, therefore, don't always need desktop PCs. They also suggested that file sizes and types should be kept to a minimum and should be more suited for OER. Some academics also favoured employing website builder programs to create distinct web platforms.

> *"I developed a mobile App for practical teaching skills so it`s already there I have the resources on it now*" (Academic 22).

Some academics suggested that organizations build shared platforms with material that is just for OER and is organized by schools, colleges, departments, and subject-specific regions. They recommended the need for relevant or suitable systems and application software that are compatible with OER in addition to the online platforms. OER platforms should, according to academics, also support all OER connected to research and community involvement. Academics suggested that when handling OER, colleges should take artificial intelligence into consideration. Academics believed that one should be strategic due to the introduction of the fourth industrial revolution and advised using machine learning to help with the creation, acceptance, and dissemination of OER. They believed that investing in robotics for OER would assist institutions speed up the process once they started doing so. Academics believe that artificial intelligence is more accurate than human contact sometimes when looking for OER.

"If we integrate the robotics, into the facilitation of OER …I mean robotics can help you, they can talk to you, they can engage with you, they can lead you to the information that you are looking for" (Academic 40).

6.2.2 IoT social media for tuition

Social media was their favoured option due to its usefulness, practicality, features, and accessibility to upload and save content. Academics chose LinkedIn, Facebook, WhatsApp, YouTube, blogs, and ResearchGate. Facebook has become more widely used for open educational resources, as shown by the large number of academics who use it for their work. Because social media is less expensive and more accessible than any other software, academics favoured it to support OER. Others thought of podcasting platforms that permitted the creation of audio lessons pertinent to the subject matter of their modules. They thought that audio podcasts offered students an easy way to acquire OER. Some permitted the creation of numerous brief instructional topics for the modules.

According to academics, the most popular social media platforms are simple to use and accessible to students with smartphones. Some academics agreed that there is no need for social media seminars or training because everyone may just explore and learn for themselves, regardless of educational background. Academics have added that, particularly in the context of South Africa, the aforementioned social media are well-known and fashionable. Due to their easily recognizable interfaces and minimal effort required for posting and downloading OER content, social media is regarded as being crucial in the use, diffusion, and promotion of OER. The CODeL policy also lists social media usage as a prerequisite for teaching and learning under its list of institutional criteria. The institutional policy attests to the official CODeL use of social media.

"ODeL [institution] *will make effective use of educational and social technologies in learning programmes in appropriate and innovative ways that improve the quality of teaching and learning"* (Document 2).

Microsoft Teams has been praised by academics as a fantastic instant chat-based interactive tool that enables document sharing, online meetings, and conducting live lessons with students without any physical interaction. They claimed that Microsoft Teams can create OER that may be shared with students, teachers, and the general public and later reconstructed. Academics mentioned that Microsoft teams really aided them in adhering to social distance since they were able to instruct and manage their students during the challenging moments of COVID-19. They said that by using this platform, you will experience the atmosphere of a real lecture hall while yet being able to conduct meetings in the comfort of your own home, office, street, or any other suitable location. In addition to helping them with their coursework, academics praised Microsoft Teams for making it possible for them to accomplish daily tasks including holding meetings with their organisations, seminars, and academic conferences. Some professors suggested Zoom for OER as an alternative to Microsoft Teams because it also allowed them to join the full class at a predetermined time. This made it possible for academics to encourage involvement among distant learners. They praised it since it made it possible to save meetings and distribute them afterward as payment for the support and tuition of pupils.

"…so I think Zoom and Microsoft Teams currently these platforms can be used to generate OER" (Academic 13).

OER in Google Scholar where they expose their research output. They make the decision to do this in order for other academics to see what they have accomplished in terms of OER and to be able to cite them. Some people are inspired by their work as academics, where they are concerned with spreading ideas and making them accessible to the public.

"Google Scholar in finding your work, people who read journal articles, but out of that, we talked about it with friends with groups without community engagement groups just talk up" (Academic 18).

Academics used YouTube to access and share open educational resources. They added that because to YouTube's usefulness and user-friendliness, students prefer to access OER there. They recommended YouTube because it draws a large audience in addition to their students. YouTube is praised for being a useful platform for OER because it contributes to open access. Academics have also praised YouTube for its OER-related ease because there are no registration or subscription procedures needed. They promoted open access and scholarly research and thought of YouTube as truly open. Although YouTube was

applauded on another occasion, some academics believe that the CODeL institution is opposed to academics uploading instructional content on YouTube since doing so would violate the university's copyrights and intellectual property.

6.2.3 IoT Storage devices

Academics relied on both online and physical storage devices for storing and retrieving OER. Academics have praised these storage devices as trustworthy venues for keeping and disseminating OER in CODeL institutions. Online secondary storage devices such Google Drive, iCloud, OneDrive has been recommended by academics as the greatest online storage platform for sharing all educational resources according to subject or content. Academics said that they could deliver files and documents to their students via online drives regardless of time or place. Others depended on digital storage devices, which gave them the opportunity to instruct pupils as well as a large group of stakeholders. They praised these platforms, particularly in light of COVID-19's global impact.

Besides, the cloud storage devices academics also considered desktops and laptops for string OER. These devices afforded academics a space to retain the data for a longer period. They preferred these devices because even if there is no electricity, they can still use these devices to appropriate OER since the data is kept in the device's hard drive. A storage drive, however, allowed academics to permanently store data, so it Is available each time they turn on the computer. Smartphones were also used as secondary storage devices for OER. Academics needed smartphones to store OER in different formats such as photos, videos, apps, contacts, stream music and films, messages and webpages. Smartphones are considered as equivalent devices to laptop and desktop computers because can store huge OER content.

7. **DISCUSSION**

7.1 Learning Management Systems affordance

IoT affordance it is experienced at Unisa LMS's as having an opportunity to share, create and disseminate OER so that can be appropriated by academics for teaching and learning. This is an indication that the influence of ICTs on teaching and learning methods, approaches and strategies is acknowledged by scholars in a CODEL. The adoption, diffusion and sustained use of ICTs in teaching and learning are largely dependent on the attitudes and positive perceptions of the user (Kalimullina, et al., 2021; Osei, Kwateng & Boateng, 2022). UNISA academics have positive attitude towards teaching using OER with the help of IoT, however, academics cannot physically contact their students for tuition purposes, the university is placing emphasis on technology in an effort to increase its teaching and learning (Sevnarayan, 2022). This university has created a central LMS called myUnisa to bridge the geographical distance between students, lecturers and the university itself (Mncube, Dube & Ngulube, 2017; Nsamba, 2019).

The findings showed that there is a sync between existing institutional LMS such as institutional repository and library guide as they are all embedded to myUnisa. The integration of system and technologies has a potential to enhance e-learning (Azenezi, 2023; Bekturdiyev, 2023). This is an indication that in a CODEL institution IoT affordance in the appropriation of OER is successful. Although, there are some contradictions related to the limitations of data upload to myUnisa. The identification of myUnisa as a standalone system is not the characteristics of IoT. IoT can be used as a greater space for data hosting. In the current context, academics complained about the limited spaces within the institutional LMS. This is an indication that there is a lack integrated system. IoT is better described as integration of devices, cloud storage and LMS technologies for convergence and sharing and storing of resources for better services through the network (Kalimullina, et al., 2021).

In the current different views and opinions, there is a sign that the CODEL has not fully defined the current IoT, OER and LMS integration in alliance to SGD 2030. They posit that the higher education institutions have to strive for advancement of IoT a 4IR for tuition (SGD, 2030). Therefore, the study proposes that CODEL requires the articulation and realignment of business enterprise system which is IoT driven for tuition using OER. This is confirmed by Kouzari, Sotiriadis and Stamelos (2023) that business enterprise systems can help to standardize and improve the internal processes of an organization.

7.2 IoT affordance for OER

IoT affordance for OER has been recognized in a CODEL institution. Academics rely on a variety of IoT technologies and applications when appropriating OER. In teaching and learning, IoT can play a key role in facilitation, assessment and feedback systems, examination, smart teaching environments, and interactive tools for teaching (Haque, et al., 2023). As one of the disruptive technologies, the Internet of Things (IoT) has the potential to significantly improve learning opportunities while also aiding academics' day-to-day work, university administration, and the provision of remote learning (Zeeshan, Hämäläinen & Neittaanmäki, 2022). In a CODEL institution, academics have been relying on IoT devices such as application software, social media, and storage devices. This is in line with Haque, et al (2023) as they postulate that all education systems need to be IoT-based and IoT architecture so they can improve their distance learning programs and increase efficiency without affecting their academic activities.

This is an indication that the current context is advancing with IoT devices for the appropriation of OER. The higher education sector has received increased interest in terms of the adoption of IoT services for learning activities (Alhasan, Hussein, Audah, Al-Sharaa, Ibrahim & Mahmoud, 2023). IoT now driving transformations that have gone far beyond internal process optimizations because they have the potential to alter business models, organizational structures, teaching, innovation, administration, access, openness, society, and research (Alenezi, 2023). In the advent of IoT the creation of OER is not an internal source since have to be globally accessed as part of open access and collaboration.

Besides, the variety of technologies used by academics in a CODEL, they were very innovative some developed applications for OER which are IoT driven. Furthermore, academics recommended artificial intelligence as a better tool for OER appropriation, however, none of them created AI for OER. In this context, several leading organizations have focused specifically on the use of AI technology to unleash the power of open educational practices (Tlili, Burgos & Looi, 2022). Since United Nations Educational, Scientific, and Cultural Organization (UNESCO) (2019) have created a workshop on how to combine OER and AI for better learning practices. Some researchers have started to explore the AI and realised that AI could play a vital role in enhancing both open educational practice (OEP) based teaching and learning experiences (Tlili et al., 2021).

For example, Zhang et al. (2021) coin that to aid students in learning about AI, we combined an open e-book with Jupyter, an open-source web-based interactive development environment that can support a wide range of processes in data science, scientific computing, and machine learning. In a CODEL institution, the AI adoption of AI has not been explored or developed. Therefore, the study proposes that in an IoT-driven context such as CODEL, where OER are appropriated, there is a motive for academics and institutions to develop an interactive robot for creating and locating OER. It is possible to use sophisticated machine learning and natural language processing techniques to analyse the generated metadata of the published OER to map all these resources together and build OER recommender systems (Tlili, et al., 2022).

8. CONCLUSION AND RECOMMENDATION

This sought to establish how IoT affordance play a role during the appropriation of OER by academicians in a CODEL. To get insight, the technology affordance model was used in this research. Opting for this theory enabled to the identification of LMS and IT technologies that are appropriated by academicians in a CODEL. Affordance theory was used in line with the qualitative approach as the research methodology. The study found that CODEL is an IoT-driven institution. However, some discrepancies were identified where the institutional systems is not always integrated with IoT. For example, academics pointed out that the mostly used LMS cannot allow to upload OER or any other teaching material which has grater capacity. The minimum could handle is only 10 megabytes. That was found to be the main contrary with IoT characteristics since IoT encourage the integration and collaborative approach of sharing resources in the shared spaces (Ashton, 2009). The issue of space and capacity of data handling is not really stipulated in IoT driven infrastructure. This study suggests that academics and CODEL institution must consider the realignment of business enterprise system and IoT infrastructure for the purpose of catering of OER for tuition. This study open opportunity for future research to further investigate the IoT enablement for appropriation of OER to all different South African universities.

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