Technologies in Two Academic Libraries During the Covid-19 Pandemic

The Case of the Alma Jordan Library and the Open Campus Libraries and Information Services, The University of the West Indies

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Abstract

The global COVID-19 pandemic has ushered in a new environment described as the 'new normal,' changing the way people live, learn, work, and communicate. Academic libraries have followed the lead of other sectors – business, government, health, and education – in adopting Fourth Industrial Revolution (4IR) technologies to re-engineer operations and re-imagine services which are supportive of teaching, learning, and research. This chapter presents case studies that highlight existing and potential applications of 4IR technologies at two academic libraries in the Caribbean, the Alma Jordan Library (AJL) and Open Campus Libraries and Information Services (OCLIS) at The University of the West Indies (UWI). The chapter discusses the short-term implementation of an artificial intelligence-driven digital assistant responsive to first-line reference and research queries at the AJL and explores the future potential deployment of 4IR technologies such as augmented and virtual reality, robotics, the internet of things, and 3D printing in academic libraries to enhance experiential teaching and learning experiences. The chapter concludes by showing how academic libraries' adoption of a best practice model can enable the seamless integration of 4IR technologies into programmes, products, and services.

Keywords: Fourth Industrial Revolution; 4IR technologies; IR 4.0; virtual reality (VR); augmented reality (AR); artificial intelligence (AI); 3D printing; robotics; internet of things (IoT); the Alma Jordan Library; The University of the West Indies, St Augustine Campus; Open Campus Libraries and Information Services; The University of the West Indies Open Campus; The UWI; academic libraries (Caribbean Area)

Introduction

The COVID-19 pandemic has affected almost all countries globally, ushering in a period of disruption and unprecedented challenges within a new environment being characterised as the 'new normal,' where social distancing, mass sanitisation of facilities, frequent washing of hands, and the wearing of masks are now societal norms. All sectors have been impacted by this health crisis, and all have shown varying degrees of responsiveness. Retailers are aggressively promoting contactless e-commerce services to consumers who are keen on avoiding physical interaction; students and teachers are engaged in remote teaching and learning in virtual spaces, using information and communication tools; and workers in public and corporate offices are exploiting new opportunities for telecommuting while engaged in flexible working from home arrangements with employers.

This period of societal upheaval during a global pandemic coincides with the rise of the Fourth Industrial Revolution (referred to as 4IR and IR 4.0). Klaus Schwab, the founder and executive chairman of the World Economic Forum (WEF) describes the 4IR as a digital revolution 'which is characterised by a fusion of technologies that is the blurring of lines between the physical, digital and the biological spheres' (Schwab 2016). The 4IR builds on the foundations of the first three industrial revolutions and represents advances in technologies such as artificial intelligence (AI), augmented reality (AR), virtual reality (VR), 3D printing, robotics, and the internet of things (IoT) (McGinnis 2020). These so-called disruptive technologies are 'affecting almost every facet of our daily life, impacting how individuals relate to technology and changing how and where work is done' (Mhlanga & Moloi 2020:2 of 11 pages).

In a 4IR world, impaired on all fronts by the novel coronavirus (2019-nCoV), the adoption of disruptive technologies in a concerted response to mitigate its impact, is evidenced in all sectors as shown in the following examples:

- *Health*: AI-driven telemedicine consultation services such as the UK-based *Ask Babylon* (Babylon 2021), enable patients to interact with a chatbot or virtual doctor to diagnose their symptoms, thus reducing the need for physical crowding at hospitals and clinics.
- *Industry*: In the manufacturing sector, 3D printers are being used at scale to supplement a shortage in the supply chain for the production of personal protective equipment (PPE), N95 respirators, ventilators, and nasal swabs (Javaid, Haleem, Vaishya, Bahl, Suman, & Vaish 2020).
- *Government*: The increased demand for driverless deliveries and non-contact operations has created new opportunities for self-driving smart cars as governments worldwide reimagine creative solutions for the transportation of medical supplies and food for healthcare professionals

and the frequent sanitisation of hospitals and other public facilities to reduce the spread of the coronavirus.

- *Public*: Every day, consumers are donning wearables (activity trackers such as smartwatches), which offer predictive analytics on monitoring heart rates, blood pressure, sleeping patterns, stress management, and healthy eating habits, in their attempt to stay healthy during a raging pandemic.

The information sector has been similarly affected, proving that libraries worldwide are not immune to this cycle of disruption in the health and technological spheres. Academic librarians in particular are being called upon to step up their game and master new skills and technologies in a reimagined future.

The agility of academic librarians in navigating this unfamiliar COVID-19 landscape by developing enhanced and innovative services have been well-documented in recent library literature and ventilated as main discussion points at online conferences. This chapter seeks to highlight the pre-emptive responses of two academic libraries in the Caribbean – the Alma Jordan Library (AJL) in Trinidad and Tobago and the Open Campus Libraries and Information Services (OCLIS) at The University of the West Indies (UWI) – to the COVID-19 pandemic. These libraries, where the authors are presently employed, presented a unique opportunity to conduct research on how two libraries, enabled by different service models – re-engineering of operations and services in the case of the AJL, and enhancement of existing offerings at the OCLIS – were able to maintain mission-critical services to communities being served. The chapter documents the integration of 4IR technologies where possible and explores the potential of implementing 4IR driven services in the future – the 'next normal' – by profiling real-world examples of 4IR adoption at other libraries.

It is worth noting that these library services as highlighted at The UWI, whether newly implemented or enhanced, when rolled out, had to adapt and conform to the 'new normal' of maintaining social distancing practices; working remotely from home; facilitating online teaching and learning; and supporting the psychosocial needs of campus communities dealing with a global health crisis. The chapter draws attention to a collaborative collegial team approach and support from campus/library administrators and librarians in the design, development, delivery, and marketing of library services during the COVID-19 pandemic.

Methodology

The chapter aims to highlight existing applications of 4IR technologies in libraries and explore the potential integration and implementation of these

technologies at two academic libraries in the Caribbean. To provide a contextual framework and articulate current trends on this topic, the authors employed secondary data analysis. Johnston (2014:619) asserts the following on the use of such methodology in conducting research, '[S]econdary analysis is an empirical exercise that applies the same basic research principles as studies utilizing primary data and has steps to be followed just as any research method.' The authors consulted a wide array of secondary resources inclusive of library databases (peer-reviewed articles), authoritative websites, institutional reports, and newsletters, and incorporated these resources to support key areas under discussion. The authors were also able to incorporate practical experiences and insights which were garnered from projects undertaken at the two academic libraries being studied, where they are presently employed.

The University of the West Indies, St Augustine Campus and the Alma Jordan Library COVID-19 Response

The University of the West Indies, St Augustine Campus COVID-19 Response

The UWI, established in 1948, comprises five physical campuses located in St Augustine in Trinidad and Tobago, Mona in Jamaica, Cave Hill in Barbados, Five Islands in Antigua, and The UWI Open Campus which offers multi-mode teaching and learning services through virtual and physical site locations across the Caribbean region. Although The UWI campuses are separated by the Caribbean Sea, they continue to strive to operate as one unified institution, *One UWI* promoting a cohesive single UWI brand consciousness (UWI 2017:8). Collectively, the university serves approximately 50,000 students and offers over 800 certificate, diploma, undergraduate, and postgraduate degree options in Culture, Creative and Performing Arts, Food and Agriculture, Engineering, Humanities and Education, Law, Medical Sciences, Science and Technology, Social Sciences, and Sport (UWI 2021).

Mirroring the lead of other regional campuses in Mona, Jamaica, Cave Hill, Barbados, Five Islands Antigua, and the Open Campus, The UWI St Augustine Campus initiated a proactive, progressive response to the COVID-19 pandemic with the launch of multiple initiatives that were focused on giving priority to the health, wellness, and safety of the campus and the wider Caribbean community. This first indication of commitment was the immediate activation of a campus incident management team (IMT) and the development of a COVID-19 response plan. A centralised webpage (UWI St Augustine 2020a) was quickly established as an online resource to provide a trusted source of relevant information on the campus' response to the coronavirus. Select key COVID-19 initiatives adopted at The UWI St Augustine Campus are highlighted in the following section.

A UWI press release, *Launch of the UWI COVID-19 Task Force on 29 February 2020*, announced the launch of a UWI COVID-19 Task Force (UWI St Augustine 2020c). Prof Clive Landis, Chair of the Task Force stated, 'It is right that The UWI should deploy its full expertise as a public academy to help Caribbean communities cope at this instance of the COVID-19 epidemic. The primary emphasis of the COVID-19 Task Force will be to provide accurate and reliable information' (UWI St Augustine Campus 2020/21c). Membership of the Task Force was drawn from the regional UWI campuses (including the St Augustine Campus and Open Campus), and comprised multi-discipline specialists, scientists, researchers, and public health professionals with combined expertise in virology, epidemiology, laboratory diagnostics, critical care, respiratory medicine, veterinary medicine, tourism, trade, international relations, and communication (UWI St Augustine Campus 2020/21c). The AJL, in partnership with The UWI Marketing and Communications Office developed scholarly profiles in the university's research management information system *UWIScholar*, for members of the COVID-19 Task Force team of experts. These profiles provided brief biographical information on each researcher and highlighted their record in research, university/public service, and professional endeavours.

With regard to the online delivery of essential services, the business continuity necessitated that the Campus had to migrate from face-to-face to online mode. In this regard, staff – administrative, professional, and teaching staff – were encouraged to engage in campus-wide training efforts aimed at the delivery of essential services, including teaching and learning in an online/blended model. The Centre for Excellence in Teaching and Learning, located on the St Augustine Campus, was one of the designated departments which was instrumental in delivering webinars and other learning opportunities to facilitate this move to online delivery.

As a key collaborator in partnership with the government of Trinidad and Tobago in the national response to the pandemic, The UWI St Augustine Campus approved the use of three quarantine/step-down facilities: Two Halls of Residence – Canada Hall and Freedom Hall – and the South Campus located in Penal-Debe, as quarantine/step-down facilities for returning students and citizens requiring access to such locations in accordance with the national guidelines.

The AJL, The UWI St. Augustine, COVID-19 Response

The UWI Campus Libraries consist of a network of libraries across the St Augustine Campus. The AJL is one of the largest libraries in the network with hybrid holdings of print and electronic resources and a West Indiana and Special Collections division noteworthy in its efforts as a repository of international

significance for research on West Indian-related topics. Sustained efforts at 'continuous upgrade and expansion of the Libraries' technological capacity over the past decade has created a robust and stable online platform' which provides access to resources for key stakeholders (Soodeen 2013). In 2008, the campus libraries' first venture into digital scholarship resulted in the launch of an institutional repository branded as *UWISpace*, built on the DSpace platform, which in 2012, was adopted as the regional institutional repository for all The UWI campuses. Other digital initiatives followed, including the deployment of a unified e-information portal, UWI*linC* and research information management system, *UWIScholar* and the establishment of an open-source platform, and Open Journal System to provide online access to university-published journals.

On 13 March 2020, the St Augustine Campus declared the closure of the campus and indicated that in keeping with national guidelines, all classes would be suspended. By 23 March 2020, although most campus departments (including the AJL) remained closed, classes had resumed for most programmes, but in virtual mode. The AJL reopened in a limited capacity on 20 July 2020, and on 14 September 2020, teaching commenced in full virtual mode for the academic year 2020/21. To date (December 2020), the campus remains closed for access by students and the public.

During this period of lockdown and limited access, staff at the AJL continued to work in dual mode, on-site and remotely, to support the campus' teaching, learning, and research needs. The shift in operations from primarily on-site and face-to-face to remote and online has required some changes:

- Academic librarians engaged in professional training and development by attending local, regional, and international virtual conferences, webinars, and workshops to ensure that they are up to date with the resources, tools, technologies, and best practices needed for the virtual environment.
- Upskilling of support staff to provide greater support in the virtual environment.
- The library's website homepage was reorganised to offer quick access to key updates on facilities, resources, and services.
- The lending and return of materials now primarily take place off-campus via a 'request and pick up service.'
- An online payment system has been launched to facilitate the payment of fines and fees for photocopying, scanning, and other services.
- Orientation, information literacy sessions, as well as reference and research consultations, are offered via virtual platforms such as Blackboard Collaborate, Google Meet, Skype, and Zoom.
- A virtual chat service (*Ask Us*) and frequently asked questions (FAQs) knowledge base, leveraging Springshare's LibAnswers and LibChat

platforms, have been launched to enable users to ask, receive, and locate quick responses to their reference and research questions.
- In-house developed handouts, online research guides, and videos are guiding patrons on facilities, resources, and services.
- The promotion of all library services developed in response to COVID-19 is driven via the library's website, research guides, Facebook page, and other communication channels.

The UWI Open Campus and the Open Campus Libraries and Information Services Covid-19 Response

The UWI Open Campus COVID-19 Response

The UWI Open Campus, established in 2008, is a multi-mode campus that offers online, blended, and face-to-face programmes at the pre-university, continuing and professional education, undergraduate, and graduate levels (UWI Open Campus 2014:3, 5-6, 8-9, 11) to approximately 16,000 students, with 42 site locations, in 17 English-speaking Caribbean countries (UWI Open Campus 2021).

The UWI Open Campus, like its sister institution at the St Augustine Campus, and other institutions of higher education, had to confront and adapt with alacrity to the social, economic, and health impact of the COVID-19 pandemic. For the Open Campus, crisis management of this nature was not unusual, as there have been intermittent periods of disruption to services precipitated by hurricanes, storms, floods, and other natural disasters. During these periods requiring crisis management, business continuity has always been viewed as paramount to ensuring the seamless continuation of operational objectives to a geographically dispersed campus community. This *modus operandi* has been a mainstay of the Open Campus since it opened its doors in 2008 to 'life-changing learning.'

In March 2020, in response to mandates by regional governments to institute national (country-wide) lockdowns as a result of the pandemic, mitigation measures were initiated at the Open Campus to alleviate major disruptions and maintain essential operations. This plan of action was aptly conveyed in a *We Got This* campaign, launched by the campus' Marketing and Communications Department, signifying that for the Open Campus, a response to the pandemic was aligned to conducting 'business as usual' with integrated calculated changes to all stakeholders. Implemented measures were developed primarily for stakeholders in need of on-demand training to facilitate the transition from face-to-face to online delivery of teaching and learning. Towards this stipulated end, training sessions were conducted

with the use of Blackboard Collaborate (video conferencing tool) and Moodle (Learning Management System) for faculty and staff at regional campuses at Mona, Jamaica, Cave Hill, Barbados, St Augustine, Trinidad and Tobago, and Five Islands in Antigua. Open Campus staff wishing to work remotely were able to take advantage of flexible home-based work arrangements, while staff and students had access to COVID-19 counselling support systems. In a speech delivered during World Quality Day on 12 November 2020, the deputy principal of the Open Campus, Dr Francis Severin described this resilient support in the midst of the pandemic, as the Open Campus continued 'commitment to fulfilling operational mandates' (Severin 2020:3) of The UWI Triple A Strategy 2017-2022, and fittingly opined that this collective response was a demonstration of 'UWI Open Campus sailing over [the] COVID wave' (Severin 2020:3).

Open Campus Libraries and Information Services COVID-19 Response

The OCLIS is integral to teaching, learning, and research within the Open Campus network, and is perceived as an intellectual hub, serving students, tutors, and staff at dispersed geographic locations within the Caribbean and wider region. The OCLIS and its cadre of committed staff support the pursuit of academic goals and the achievement of academic success in multiple ways, providing access to resources (print, electronic, digital, open access, and open educational resources) through a unified e-information portal UWI*linC*, offering reference and research assistance through its *Ask A Librarian* virtual reference service, assisting academic units in programme planning, development and delivery, and facilitating orientation sessions and information literacy workshops in online, face-to-face and blended delivery modes to enable students, staff, and other users to become proficient users and evaluators of information.

As seen above, the AJL, acting in accordance with other academic libraries similarly affected by the pandemic, was compelled to make a significant shift from in-person to an online delivery of services. At the OCLIS, however, although there were some changes in the service model to users, this was not as extensive, as was the case at the AJL. For the OCLIS staff, the pathway to follow in the midst of a pandemic was evident: Follow the lead of the parent institution, the Open Campus, to ensure business continuity and operational consistency in maintaining current online offerings, while adding enhanced programmes, services, content, and collections, as required. The following points describe OCLIS' COVID-19 response:

- *Orientation and information literacy sessions*: Continuity was key in ensuring the sustained commitment to supporting online teaching, learning, and research. All library face-to-face orientation and information

literacy sessions were transitioned to online in synchronous and asynchronous modes.

- *Reference and research*: Reference and research assistance were offered to staff and students utilising multiple communication channels – e-mail, Skype, Zoom, WhatsApp, as well as mobile and VoIP phones.
- *Virtual reference service*: Recognising the need for the deployment of an extended virtual reference service for remote users, the OCLIS expanded its *Ask A Librarian* virtual reference service to 42 hours per week (an increase of 12.5 hours above the 29.5 hours previously offered). Implemented in 2015, this service continues to operate as an essential online platform, supporting reference and research and the enhancement of digital literacy skills for the Open Campus community.
- *Program/Course consultation*: OCLIS librarians are fundamental to the process of communication and consultation with the Open Campus' academic departments in the planning, developing, and delivering of programmes. One such programme for which librarians provided developmental assistance was a postgraduate diploma in Health Research and Epidemiology. This diploma was viewed as beneficial to health practitioners and essential to offering health services during the COVID-19 pandemic.
- *Professional development*: A series of webinars on the topic of the *Pedagogy of Online Learning* were delivered to staff to facilitate the seamless transition to full online delivery of library programmes.
- *Dissemination of COVID-19 related content*: 'Critical thinking is a key skill in media and information literacy, and the mission of libraries is to educate and advocate its importance' (IFLA 2017). This skill gained importance during the pandemic, as libraries witnessed an increase in the distribution of fake and misleading news in some media channels. The dissemination of legitimate news sources with related COVID-19 content on health and wellness, via an OCLIS-crafted online newsletter, was operationalised. This newsletter, along with an online information guide, highlighted expanded vendor subscription offerings and access to free online resources.

Covid-19 and its Impact on the Adoption of 4IR and other Technologies at the Alma Jordan Library and Open Campus Libraries, and Information Services

4IR Implementation at Libraries – An Overview

During the global pandemic, institutions of higher learning around the world discovered that in challenging times, opportunities abound to add value to current services, while engaging clients to seamlessly transition to operating

in a blended environment (online and face-to-face) from on-site and remote locations. The Vice-Chancellor of The UWI, Prof Sir Hilary Beckles affirms this engagement in the following comment: '[T]he pandemic has allowed us to embrace the technology and the future, we have had to do in the last six to nine months what we have been trying to do in the past six to ten years, and so in a short time, we were able to move speedily along into the future and we are not going back' (Mc Kenzie 2020).

As has been shown in the introduction to this chapter, this approach of embracing 4IR technologies has proven to be effective for other sectors – business, health, government, and education – and these sectors have been perceived as agile at harnessing the 4IR to deploy critical products and services, essential for survival during the COVID-19 pandemic.

The integration and implementation of 4IR tools have also enabled similar opportunities for libraries. In a COVID-19 world, librarians had to be on alert, adroit, and proactive in their efforts at embracing 4IR transformational innovations to fulfil a mandate of supporting the information needs of multi-generational clients. Supporting these diverse needs demanded a full-term commitment to learning new skills, with emphasis placed on critical areas such as 'information curation; in-depth research; digital scanning; preservation; Cloud data expansion; collaboration, teaching and facilitation' (Tella 2020:5). These skills are required to function effectively in a 4IR world, which as McGinnis (2020) cautions, is challenging our notion of what it means to be human and changing society like never before.

It is in recognition of this added value proposition of 4IR technologies adoption in libraries, that the potential benefits for integration of technologies, like AI, AR, VR, 3D printing, robotics, and the IoT at the AJL and the OCLIS are explored in the ensuing discussion. An exploratory examination of 4IR at other academic libraries was supplemented by an in-depth analysis of administrative university documents, the consultation of library literature, and the in-service experiences of the researchers and library colleagues. The researchers also sought to identify best practice recommendations for the present and future integration of 4IR technologies. This examination of existing models and future potential applications gives credence to the premise that such explorations should boost the AJL's and OCLIS' nascent efforts in this regard, and guide future policies and implementation strategies aimed at making these libraries and their parent institutions more relevant in a changing world.

The UWI AJL and OCLIS – Current 4IR Applications

AI is intended to create 'intelligent' machines that work and react more like humans. It has become very popular in recent times, finding mainstream acceptance in educational institutions, offices, and homes. In libraries,

discussions on the adoption of AI invariably drift toward the issue of whether such technology is, in fact, competing with the role of librarians in delivering information to stakeholders. Kristin Whitehair (2016) weighs in on this issue by pointing to the immediate disadvantage of AI in 'lacking human connection' and suggests that libraries offer inherent advantages as they 'can connect people to information and, more importantly, to other people.'

At the library of the University of Johannesburg (UJ 2021a), the deployment of a chatbot named *BOTsa* to respond to basic queries about the library such as service hours, access to wi-fi, printing services, online training, and booking library spaces is an example of an 'intelligent' machine at work. Contact information is on the library's website for facilitating advanced/complex queries that cannot be answered by the chatbot. This service ably demonstrates the enhanced opportunities that AI offers in expediting some basic processes while freeing up finite resources to focus on enriching the library experience for patrons.

A similar AI-driven service, the Alexa Skill (voice service) was launched by the AJL for the St Augustine Campus community as a pilot project in July 2019. This skill, which leverages Amazon's Alexa digital assistant, is named *My UWI Library* and facilitates the answering of FAQs about library facilities, resources, and services at the St Augustine Campus, and more specifically at the AJL (UWI St Augustine Campus 2019). Additionally, the service permits interested users to enable and access the skill on any Alexa device (UWI St Augustine 2019).

The pilot project principals, under the leadership of campus librarian Frank Soodeen (Jr), comprised an inter-departmental AJL team led by an AJL IT officer/applications developer. The *My UWI Library* Alexa Skill project is currently on halt due to staffing constraints, but the advent of COVID-19 and its impact on the library's offerings to patrons (which are constantly evolving), have renewed interest among library staff in resuming the initiative. The subsequent launch of the AJL's *Ask Us* live chat and FAQ services (powered by Springshare's LibChat and LibAnswers) in November 2020, are supportive of this resumption of the voice service, in that there is a rich source of new and updated FAQs that could be included in the *My UWI Library* database.

As is the case with the *BOTsa* chatbot, patrons can use smart devices like Alexa to discover information and generate quick responses on new library collections, programmes, and services. Both services at the UJ library and the AJL are excellent examples of AI at work in libraries, where intelligent digital assistants can respond to routine questions and redirect complex queries directly to a librarian. AI can also be integrated into the OCLIS' current *Ask A Librarian* virtual reference service and add value to this online platform,

providing continued support for the reference and research needs of the Open Campus.

The UWI AJL and OCLIS – Potential 4IR Technology Applications

- 3D Printing

The UWI St Augustine Campus joined a concerted global effort to combat the COVID-19 pandemic by partnering with external stakeholders to produce personal protective (and medical) equipment (PPE) for healthcare workers and the public. Projects included *Protect-a-Doctor* kits for use during the intubation process. The kits comprise, amongst other items, 3D printed laryngoscope blades. Engineers from the campus' Faculty of Engineering, encouraged by the campus Principal, Prof Brian Copeland, have led the way in these initiatives (UWI St Augustine 2020b).

To alleviate the ongoing health crisis globally, university libraries with 3D printers on-site are actively 'contributing to production efforts, working alongside engineering and health departments to create medical-grade equipment' (Balzer 2020). The University of Utah libraries have been using 3D printing for face shields and N95 mask production. At Columbia University, the library published a guide and design for producing face shields to be used by other libraries with access to 3D printers (Balzer 2020). Following the lead of these two universities, there is potential for The UWI libraries at St Augustine Campus to initiate similar collaborative projects with engineers at the Faculty of Engineering and contribute to production efforts in creating medical-grade equipment.

- Augmented Reality

AR technology, described as the technology available on mobile devices that 'allows users to experience a layered, computer-generated enhancement to their real-world perception' (Abram 2019) can provide new opportunities for librarians to develop engaging and interactive unmediated tours, inviting patrons to explore library spaces and service points. At the AJL and OCLIS, current efforts are focused on developing online video tours and embedding these videos in social media platforms and Learning Management Systems. These efforts are welcomed in a time when it is recognised that orienting patrons to library spaces, collections, and services is an important, but time-intensive challenge for many librarians when other tasks are equally demanding their attention. AR applications can enhance these learning opportunities, enabling the creation of engaging interactive programmes that connect patrons with context-specific information and facilitate seamless interaction between the real world and the virtual environment (LeMire, Graves, Hawkins, & Kailani 2018).

The Harrell Health Sciences Library at PennState College of Medicine in Hershey, Pennsylvania (US) currently offers a virtual library tour that employs AR functionality that the AJL can emulate. The interactive click-through tour facilitates the visual exploration of several library spaces, a service desk, collaboration workspaces, multimedia services, workstations, a recording studio, and a Technology Innovation Sandbox (PennState 2021).

- Virtual Reality

VR, unlike AR, which uses a real-world setting, is experienced within a simulated virtual environment, using special electronic equipment such as headsets and sensors. VR, like AR, can offer significant opportunities in the areas of adaptive teaching, learning, and research.

At The UWI St Augustine Campus, the Defensive Driving Simulation co-curricular course offers a 'virtual reality simulator [which] supplements theoretical instruction' (UWI St Augustine Campus n.d.). A similar approach was adopted at the VR lab, located in the Waldo library at the university libraries at Western Michigan University in the US. The lab is a designated creative space for faculty and students to explore and exploit VR technology and offers workshops and online tutorials for WMU students to experience both the entertainment and educational side of VR. Faculty, too, can access the facilities to learn how to integrate VR content into pedagogy and research (WMU 2021). At the OCLIS, there are plans, when grant funding is secured, to establish a similar prototype in the form of an AR/VR developer lab, offering similar teaching and learning experiences for library patrons to explore AR/VR and other 4IR technologies. Using such technologies, 'learners can develop scientific literacy, problem-solving skills, and content knowledge by interacting with simulated objects' (UWI 2019:5).

- Robotics

With the rise of the 4IR, 'many individuals across various sectors fear being replaced by technologies such as robotics and artificial intelligence' (IFLA 2020). Advocates for robotics make a case for the wide-scale deployment of robots, contending that as these machines become safer and assume more responsibilities alongside humans, people will be free to focus on performing complex and creative projects beyond the common ability of their mechanised counterparts.

At The UWI, St Augustine Campus, robotics form part of the curricula of both the Faculty of Engineering (UWI St Augustine Campus 2020/21a:50–51; 2020/21b:18, 83) and the Faculty of Science and Technology (UWI St Augustine Campus 2020/21c:166, 225). Indeed, the latter Faculty's Department of Computing and Information Technology has hosted an Annual Computing

Boot Camp, geared towards secondary school students, which has featured robotics as part of its activities (Mohammed & Ragbir-Shripat 2017:12).

For academic libraries, there is the potential of collaboration between lecturer and librarian in teaching computer science and using robots deployed in a learning lab as practical reinforcement of critical thinking and problem-solving skills for students, in effect working together, using pedagogical approaches (adaptive learning) to demystify robotics technology.

- Internet of Things (IoT)

'The Internet of Things, or IoT, refers to the billions of physical devices around the world that are now connected to the internet, all collecting and sharing data…connecting up all these different objects and adding sensors to them adds a level of digital intelligence to devices…enabling them to communicate real-time data without involving a human being' (Ranger 2020). The total number of 'Internet of Things (IoT) connected devices in use' is projected to amount to over 75 billion worldwide by 2025 (Statista 2016).

The *Book-O-Mat* automated book kiosk at the Hillsboro Public Library in Oregon, USA, harnesses IoT technologies 'to track usage, alert the library when restocking is needed, and identify popular selections for informed collection development' (ALA 2017). Located in a 'high-traffic, high-visibility location' (Washington County Reader Contributor 2019), the kiosk serves the dual purpose of increasing access to library resources without adding significant staff costs (Washington County Reader Contributor 2019).

Contactless services at libraries are guaranteed safeguards at maintaining the US Centres for Disease Control and Prevention (CDC) recommended guidelines on social distancing and less physical contact, the now required norms in a COVID-19 world (CDC 2021). The AJL has made some progress in the development of this type of contactless service for users, with the introduction in January 2019 of a self-checkout station in the lobby on the first floor of the library. In response to the heightened need for maintaining social distancing protocols and less contact with patrons, as libraries reopen their doors to offer full services, there is the potential for libraries, once the required funding is available, to upgrade to similar automated self-checkout kiosks and explore the full benefits of other time-saving applications such as Radio Frequency Identification.

The commercial juggernaut, Amazon has already made rapid strides in merging disparate technologies – computer vision, sensor fusion, and deep learning algorithms – to create this type of desired unique contactless user shopping experience with a service called the *Amazon Go 'Just Walk Out Shopping Experience*.' At selected Amazon stores, customers walk in, select products that they need off the shelf, and walk out. There is no need to wait in

long lines, and there are no registers or checkout counters. All that is required for the purchase is the *Amazon Go* app and an Amazon account (Amazon 2021). Using similar technology, with inbuilt checks and balances to protect patrons' privacy, library prototypes can be developed for 'on the go patrons' with a potential implementation at the AJL and landed sites libraries at the OCLIS in the future. This marks progression towards the touted re-imagined post-COVID-19 library which can be branded and promoted as the *Just Walk Out Library Experience*: Walk-in, select items, walk out, no checkout!

Recommendations for Implementing 4IR in Libraries

In adopting 4IR technologies amid a global pandemic, librarians are often faced with the dilemma of choosing the best-fit technology options to meet their community needs. Developing a best practice model is one solution that librarians can adopt to circumvent the pitfalls of choosing the inappropriate optimal technology at the workplace. This method of best practice, if adopted, can produce programmes, products, and services that allow for the seamless integration of 4IR technologies and engaging experiences for library patrons. The following best practice recommendations offer instructive insights which are obtained from consulting library literature (Library of the Future 2021; Chigwada & Nwaohiri 2021; Waite 2018):

- *Set 4IR technology goals*: Conducting a comprehensive evaluation of technology needs in the workplace with strict adherence to organisational goals and gathering in-depth knowledge and understanding of the needs of the communities being served. View this 4IR initiative as a project, setting SMART (specific, measurable, achievable, realistic, and timely) goals.
- *Review budget options* by giving consideration to applying for technology grants to supplement library budget allocations.
- *Identify flexible multifunctional spaces* within the library to house technology devices and consider a multi-mode delivery of programmes (face-to-face, online, and blended modes).
- *Engage in a process of obtaining staff commitment and 'staff buy-in' to IT projects* by ensuring that there is acceptance, enthusiasm, and support for projects among staff. Additionally, provide the required training before launching programmes.
- *Commence with a pilot* of the identified project, focusing on a targeted group of patrons for a small-scale rollout.
- *Leverage local vendor/stakeholder partnerships* for much-needed resources and engage in strategic alliances with technology giants for early access to prototypes of products and services.

- *Promote services* by marketing new services on social media and other communication channels to expand community outreach and promote engagement.
- *Offer classes on digital privacy* as it is imperative that libraries, when rolling out 4IR services, recognise and address associated issues of ethics, security, and digital privacy. Library consultant, Mary Ellen Bates (2019) proposes that this can be done by adopting a proactive approach and urges librarians to adapt to the role as 'digital privacy infomediaries,' leading digital privacy discussions at their institutions. Librarians are also charged with a designated teaching role in educating patrons on topics such as enhancing personal security online and safeguarding personal data online (Bates 2019:5).
- *Give consideration to the development of virtual learning hubs* as platforms for librarians and patrons to gain in-depth knowledge and an understanding of established and emerging 4IR technologies. The UJ library is a designated 4.0 library and as such, developed an *innovative learning hub* as a searchable online platform where patrons can utilise a customised Google Search engine to access information on key 4IR concepts such as VR, AR, mixed reality, and AI. Patrons can also search the platform for instructional and educational resources, to support and enhance teaching, learning, and research relevant to the UJ community needs (UJ 2021b).

Conclusion

This chapter has indicated that the COVID-19 pandemic has drastically changed existing societal norms, ushering in a new environment described as the 'new normal,' changing the way we live, learn, work, and communicate. Libraries have followed in lockstep with other sectors – business, government, health, and education – in adopting 4IR technologies such as VR and AR, AI, 3D printing, robotics, and IoT to re-engineer operations and provide supportive services for teaching, learning, and research, all in an attempt to return some semblance of normalcy to existing library operations while adhering to strict, newly implemented health protocols and national guidelines.

The chapter highlighted the existing and potential applications of 4IR technologies at the AJL, St Augustine, Trinidad and Tobago, and the OCLIS at The UWI. The small-scale adoption of these transformational advanced technologies at The UWI libraries has demonstrated that librarians are aware of the need to be in responsive mode in a reimagined future, agile and adept at mastering new age technological skills to proactively roll out ground-breaking services during a global pandemic. Projects for short-term implementation include the AI-driven deployment of a digital assistant at the AJL, responsive to first-line queries. Potential 4IR driven services for further in-depth

examination and exploration include self-mediated VR/AR tours to enhance students' adaptive, experiential learning and digital fluency; the development of VR labs and the engagement of robots to support teaching and learning; the use of IoT to leverage collection development opportunities; and 3D printing support facilities in libraries for the production of PPE and other medical equipment. These exploratory studies show demonstrable evidence that The UWI librarians, like their global contemporaries, are in a future-focused mode, preparing for library operations and services in the 'next normal.'

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