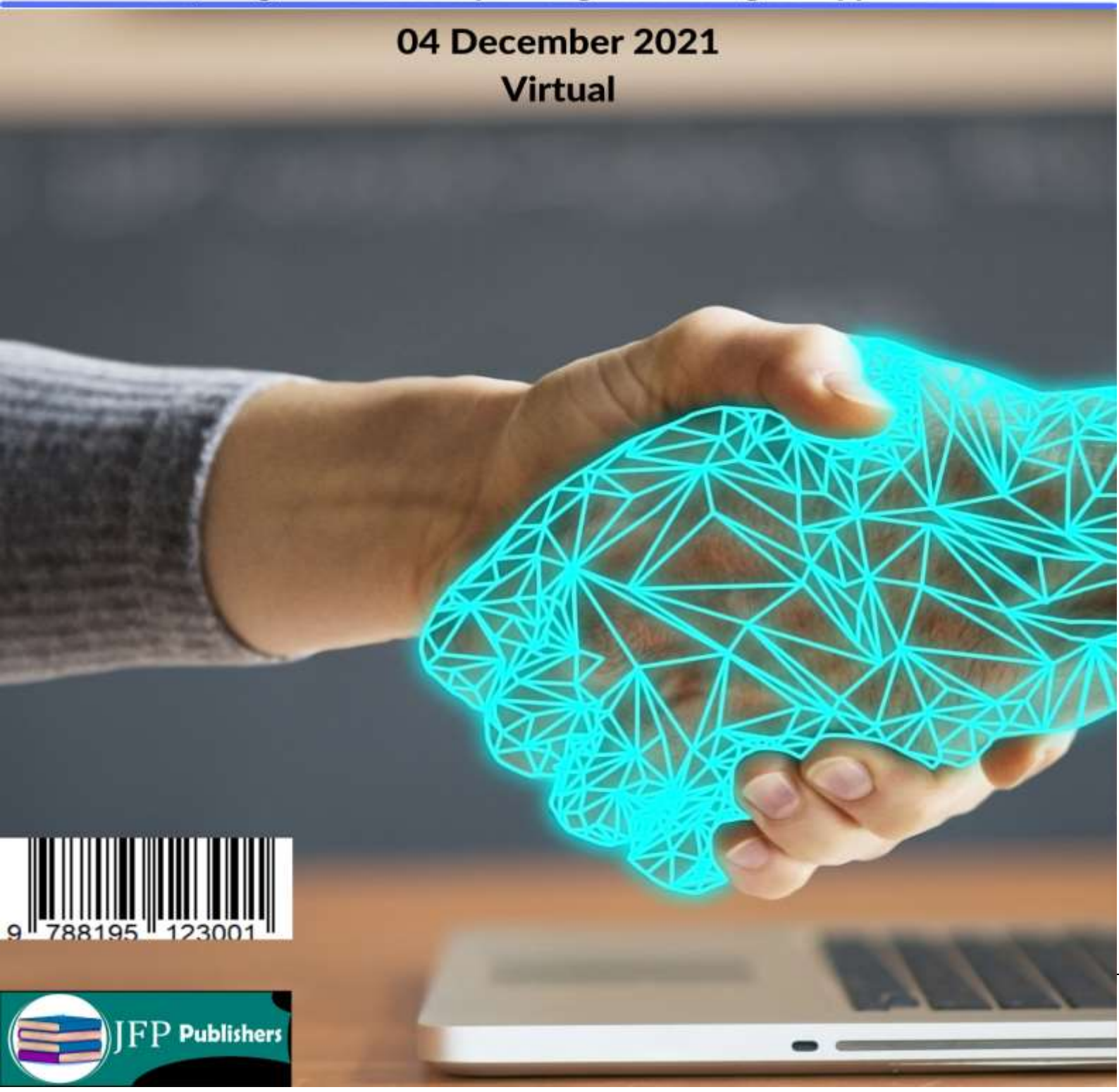
International Conference on Emerging Technology and Interdisciplinary Sciences (ICETIS 2021)

Redefining human society through technological applications

04 December 2021

Virtual



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Our society is being shaped by emerging technologies through ideas and research. The International Conference on Emerging Technology and Interdisciplinary Sciences (ICETIS 2021) with **ISBN: 978-81-951230-0-1** assembled experts and students from different world regions to share knowledge and ideas on emerging technologies in their faculties and research disciplines. The proceedings contain research findings and abstracts from expert's views to advance knowledge and build a better society for all.

A good number of research papers were received and were editorially screened and evaluated for suitability for the conference, and the best was selected for presentation and publication on the proceedings. Every submission was subjected to a plagiarism check through Turnitin Plagiarism Check and was peer-reviewed by experts on the topics. The peer-reviewed reports were recorded and sent to corresponding authors to address the expert reviewers' comments and suggestions.

The papers contributed to the academic body of knowledge in advancing emerging technology roles and applications in different disciplines and society. The readers will be educated on empirical and practical evidence-based research findings and conceptual information.

Preface

The first virtual International Conference on Emerging Technology and Interdisciplinary Sciences (ICETIS 2021), held on 4th December 2021 with the theme: "***Redefining human society through technological applications,***" presented an international platform for students, scholars, professionals, and other research-minded individuals to share knowledge on interdisciplinary research topics on AI, IoT, machine learning, block-chain technology, social media, digital technologies and transformation, mathematics, aeronautics, physics, chemistry, engineering science, health, social sciences and many more. An international keynote speech was presented to highlight the significant roles played by emerging technologies in this digital age.

ICETIS 2021 received several papers from academics, experts, students, and industrial professionals. Each submitted paper was peer-reviewed by subject (topic) expert reviewers in providing their unbiased opinions on the topic matter. The conference proceedings aimed to provide the readers with recent and newest research findings and conceptual ideas in emerging technology on different topics on interdisciplinary themes and areas of research.

The conference's success is credited to organizers who devoted quality time and efforts, experiences, and experts in promoting and guiding every activity to organize and successfully execute the conference. The paper contributors are well credited for devoting their quality time to producing the papers in advancing and providing the recent emerging technological application in society.

ICETIS 2021 was a success for the international audience in an exchange of concepts, ideas, and findings that will advance academia and industry practice in advancing technology in our society. We hope the first virtual ICETIS 2021 presented an environment (platform) for exploring emerging knowledge and ideas.

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4th December 2021

ICETIS 2021 Conference Proceedings

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Table of Contents

Theme 1:

Aspect of emerging technologies (AET)

International Conference on Emerging Technology and Interdisciplinary Sciences (ICETIS 2021)

Social media accessibility: Opportunities and challenges for rural communities

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Abstract: Social media breaks traditional barriers to human communication and access to information. It has become a global platform for the great and small (rich and poor) to source and share ideas and participate in a citizen-centered society. Social media offer opportunities, and some challenges hamper the accessibility of the platforms. The accessibility of social media platforms is no longer in doubt, but it has become an issue of concern for rural communities, especially those in developing countries. This paper looks into social media accessibility and the opportunities and challenges to define the next step in order to ensure social media accessibility. This paper applied the narrative literature review (NLR) principle to understand the topic and provide the way forward. This paper discovered the need for investment and acceleration of social media accessibility and availability in rural communities to improve empowerment and access to resources.

Keywords: Accessibility, Availability, Digital accessibility, Rural communities, Social media accessibility, Social media

Introduction

Social media has become a familiar 'word' in developing countries because of its ability to connect people. However, the accessibility, opportunities, and challenges are still in doubt with mixed reactions from the public. Many researchers have explored the opportunities and challenges of social media in different sectors of society, such as health, education, finance, and many more (Anderson, 2019; Raja, 2016; Brown & Hollier, 2015). The role of social media platforms and their accessibility in rural communities are still questionable. In setting the context of this paper, the paper outlines what social media accessibility and rural communities entail. The paper addresses social media accessibility, the opportunities, and challenges in rural communities by addressing these basic questions: **a)** Is social media available for rural communities? **b)** Is it accessible for rural communities? **c)** What are the opportunities for rural communities? **d)** What are the challenges for rural communities? and **e)** The way forward in making social media available and accessible for rural communities. These questions are begging for answers to address accessibilities in rural communities. Accessibility challenges and barriers are an issue of concern for rural communities, especially those with physical disabilities. According to Brown and Hollier (2015), Social media accessibility impacts people with disabilities into participating in the electronic society (e-society). The accessibility also impacts many people in rural communities. However, good social media accessibility can benefit everyone in the rural communities by bringing all social, economic, political, and educational activities to the people. Although the benefits of web and internet accessibility are known by many (Abuaddous, Jali & Basir, 2016), there are limited or known studies on the opportunities and challenges of social media accessibility in rural communities.

Research method

This paper deployed secondary data (existing literature) in exploring the opportunities and challenges in social media accessibility in rural communities. There are different literature review methods: narrative, descriptive or mapping, scoping review, aggregative, meta-analysis, and many more. This paper used narrative literature review (NLR) to search various academic online databases to understand the opportunities and challenges in social media accessibility for rural community dwellers. According to King and He (2005), NLR guides the formation of the research topic under investigation. At the same time, Yang and Tate (2012) believed that NLR is a qualitative research methodology to investigate research through a review of past and existing academic research. To effectively apply NLR in a paper, the research topic was formulated – accessibility, opportunities, and challenges of social media – and ways to improve social media accessibility in rural communities were searched. Keywords such as social, accessibility, challenges, opportunities, and others were explored in relevant academic databases such as ResearchGate, Google Scholar, and many others. The suitable papers were collected and analyzed in addressing the questions mentioned above.

Related literature

Social media accessibility and availability in the rural communities

Social media can serve as a tool for inclusivity (Bitzer-Wales, 2014). According to Kulkarni (2018), accessibility has everything to do with the ability to access products, services, environment, or devices for all respective social standings and disabilities. The accessibility recognizes social, political, and economic challenges, aiming to break or eliminate them. Social media accessibility within the context of this paper is centered on access to social, digital technologies, products, and services through social media platforms. Digital accessibility provides the accessibility of social media platforms in rural communities. Digital accessibility provides digital technologies, products, devices, hardware, and services (Kulkarni, 2018). Digital technology accessibility focuses on removing all forms of the digital divide (barriers and obstacles) that drive the center point of social media accessibilities. Social media accessibility promotes a good ground for access to every person with or without disability to participate in society's inclusive social, political, economic, and educational activities. The accessibility and availability of social media contents promote inclusiveness and usage for everyone globally, which benefits everyone with and without disabilities in rural communities. Lack of social media (technology) accessibility and availability deepen the digital divide, whereby improving access and availability will strengthen the 'accessibility' and 'availability' in rural communities.

Digital technologies

Digital technologies promote social media accessibilities and availabilities for everyone in developed and developing countries. Digital technologies are electronic devices such as social media, the Internet, smartphones, telecommunications, and many others. These technologies are sources used to gather, process, interpret and store information (data) to bridge the digital divide to cause digital disruption. The digital divide can be eliminated through digital disruption, which improves decision-making. However, social media accessibilities keep asking if digital technologies are available.

The availability of digital technologies, in this case, social media accessibility, is determined by some factors, which are *infrastructure*, *hardware*, and *software*. Infrastructure in the rural communities is a determinant factor in building people's perception and attitude on social media contents and activities, which open doors for access to education, employment, health benefits, and many more. Infrastructure, such as the Internet and networks, provides the basis for types of equipment that assist in powering social media platforms and other technological components. However, the digital technology ***infrastructure*** should be improved in order to address the rural communities' critical needs and expectations. Improved infrastructure enhances the accessibility of social media platforms in rural communities.

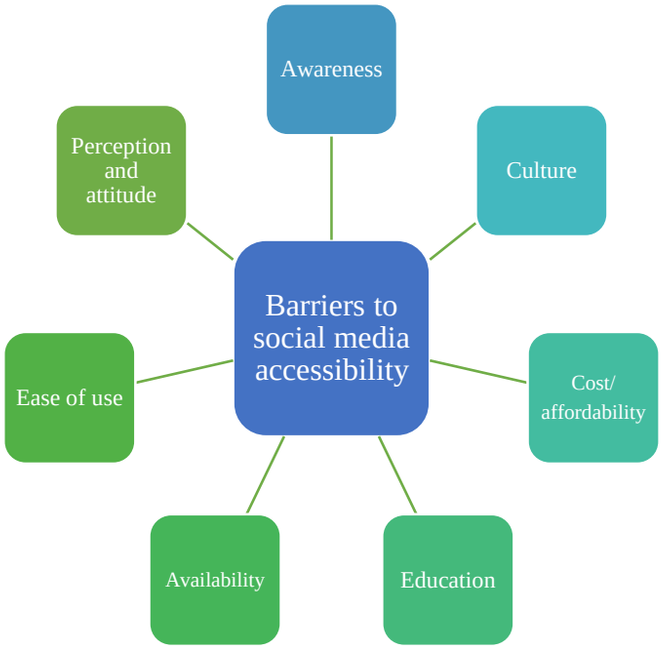
Hardware is a physical component of digital technology. It houses digital technology and the device components that enable people to interact with social media platforms. The availability of hardware and the associated cost increases the accessibility of social media content. ***Software*** programs, such as applications, inform the hardware on what to do. Social media platforms have applications that run hardware and software. For example, Facebook, WhatsApp, and many more interact with Android or iOS to provide users with a user-interface experience to engage

with an application. Therefore, any software's perception and ease of use will improve social media accessibility in rural communities. These three factors (infrastructure, hardware, and software) are critical components in social media accessibility in rural communities. When talking about social media accessibility, digital availability comes to mind.

Digital accessibility (social media accessibility)

Current technologies and tools are becoming more accessible for everyone in rural communities (areas). According to Raja (2016), accessibility reduces technological divides (digital divides). Accessibility deals with inclusiveness for the wider population. One can always ask, is digital technology, in this case, social media, accessible for all? To answer the question, Figure 1 presents several factors or barriers such as awareness, culture, cost/affordability, education, availability, ease of use, perception, infrastructure, and policies that affect social media accessibility in rural communities.

Figure 1: Barriers to social media accessibility



Awareness: According to the Internet Society (2018), rural communities have no basic understanding of the application of technology and the benefits it can offer. There is a lack of awareness about the social media platforms' benefits and opportunities in rural communities, which affects their usage. Often, many believe that the platforms are made for young people (youths), difficult to use, distractive, and many more. However, Brown and Hollier (2015) suggest that awareness of online accessibility, including social media, increases accessibility.

Culture: Rural communities are dominated by their culture and traditions. Internet Society (2018) believes that culture could restrict people for different reasons in using technologies. The impact of culture can be a function of lack of training, innovation, digital transformation, education, awareness, infrastructure, and a few others in dealing with social media accessibilities.

Cost/affordable: Cost/affordability can aid the accessibility of social media platforms. According to the Internet Society (2018), developing countries have a challenge with low incomes. The cost of internet connectivity and data in developing countries is high, and many cannot afford it, especially those in rural communities. The income level in the rural communities can determine social media accessibility in the areas. The higher the income, the more likely access to social media platforms, even in rural communities.

Education: There are limited education and training opportunities in rural communities. However, education and training bring economic and social empowerment (Raja, 2016). Lack of education opportunities and facilities in rural

communities plays a critical role in people's social media accessibilities. According to the Internet Society (2018), a lack of appropriate educational infrastructure goes a long way in hindering people in adopting technology.

Availability: Isolated and rural areas may have limited internet access (Internet Society, 2018). The limited access to digital technology and Internet access and availability may determine social media accessibility in rural communities. The availability of the Internet and other infrastructures strengthens social media accessibility.

Ease of use: People in rural communities may find social media platform usage challenging. This can result from a lack of education, training, and perception, impacting the accessibility of social media platforms. Therefore, the ease of use of social media platforms increases accessibility.

Perception and attitude: Rural communities have limited education and training exposure, which defines the adoption of social media platforms. User perceptions and attitudes will affect social media accessibilities.

Infrastructure: There is always a lack of or limited basic infrastructure in rural communities. The lack of infrastructure such as the Internet and other technological equipment in the rural communities will affect social media accessibilities in the area.

Policy: The government is mandated to provide an appropriate policy framework to enable rural development and advancement. The level of developmental policies will foster infrastructural development to enable social media accessibility in rural communities in assisting the populace to be engaged in the digital society. Internet Society (2018) suggests that digital accessibility policy (law and regulations) prepares an environment to innovate technology.

The opportunities of social media accessibility in the rural communities

Social media accessibilities open equal access and opportunities for people in rural communities. The opportunities to be derived from social media accessibilities are many. Still, it begins with equal access and opportunities to education, healthcare, government, employment, healthcare services to the world, and many others. Rural communities lack many basic human and social needs, including technology. The COVID-19 pandemic has laid bare the level of the digital divide that exists in society. Through social media accessibility, rural communities have equal access to information, which improves personal and social well-being. They can access government services and information such as healthcare, education, politics, employment, training and capacity building, and many more in building a human-centric society.

Social media accessibility promotes equal opportunities to communicate, interact, share content, and participate actively and effectively in the digital society. People in the urban settlements (cities and towns) have better opportunities from social media accessibility to share and interact with the rest of the world. The same opportunity should be awarded to rural communities when social media accessibility challenges are addressed. Furthermore, the opportunities can be possible through increased awareness, formulating regulation and policy to bring change.

The challenges to social media accessibility in the rural communities

Institutional context limitations: These limitations encompass different stakeholders, but mandates are placed to accelerate positive accessibilities. According to Kulkarni (2018), access to technologies opens the door for information access for a person with a disability as mandated by the United Nations Convention in the Rights of Persons with Disabilities (UNCRPD). The UNCRPD discussion and documents stressed the need for access and availability of information for persons with disabilities and beyond. However, institutions such as government, private organisations, and others can promote social media and its content accessibilities through inclusivity. Conversely, these institutional actors may unintentionally stand as barriers to promoting the same accessibilities without good policy and willingness.

Technology context limitations: The technology itself is mandated to promote access to information beyond borders. The same technology itself can lead to challenges in carrying rural communities through wrong attitude and perception.

Lack of accessibility awareness: In rural communities, the awareness of social media platforms' opportunities and their accessibilities is limited. The limited accessibility of information brings a challenge in the adoption and access to social media platforms. Abuaddous *et al.* (2016) suggest that the accessibility of web content is challenged by lack of accessibility, especially for those in rural communities.

Limited and lack of resources: Tangible and intangible resources impact web or online accessibility (Abuaddous *et al.*, 2016). Basic resources such as tech centres, internet connection (internet coverage), trained experts, infrastructure, and others are always limited in rural communities. These resources will affect social media platforms' accessibility in rural communities. Lack of awareness and knowledge hinders technology accessibility (Raja, 2016).

Cost and affordability: The high cost of technology limits access and usage (Raja, 2016). Furthermore, the cost of data to access social media platforms hinders the usage and penetration into rural communities because of it's economic challenges.

Lack of professionals to understand digital tools: Access to education, training, and educational resources is always limited in rural areas. Rural communities lack professionals and knowledgeable individuals who understand and can manage digital tools to access social media.

Security: Security plays a vital role in the adoption of any emerging technologies. Many are concerned about their personal information regarding online or Internet activities. Everything over the Internet is prone to security threats and attacks. Lack of awareness of social media security will hamper social media accessibility in rural communities. The security concerns involve privacy issues that affect human 'liberal democracies' because of the amount of data humans deposit on social media platforms (Anderson, 2019). The wrong perception of security will affect social media accessibility.

Culture and language: This can influence users' adoption and perception. Social media accessibility depends on users' belief that social media platforms will not interface with their culture and tradition. Rather, the technology deployed in the rural communities should support the indigenous culture and language of the people. Raja (2016) suggests that technology should support local languages.

Regulations: Lack of legal framework and policies affects technology adoption and perception. Regulations will foster courage and a positive perception of the users. The social media accessibility in rural communities depends on the available regulations and policies framework. According to Abuaddous *et al.* (2016), the availability of laws and policies addresses the issue of accessibility of technology. The accessibility includes social media platforms and other emerging technologies. The availability and accessibility of technology are addressed through legislation, laws, regulations, and policies (Raja, 2016).

Unavailable skills: There are limited or no skills to manage and maintain technology in rural communities due to a lack of technological investment and infrastructure. Social media accessibility in rural communities is a function of skilled personnel and individuals.

Availability: Lack of technological infrastructure in rural communities makes it difficult for social media accessibility. The accessibility of social media is the function of its availability in an area.

Return on investment: The use of technology keeps increasing, but the users want to understand the benefits and the impact on their lives and activities. Investors want to know whether the amount invested can be regained within a particular period. This concern impacts investment in the aforementioned resources and social media accessibility in rural communities.

Way forward in improving social media accessibility in the rural communities

Technology is evolving continually and touching humans in many ways. Addressing social media accessibility in rural communities involves the following:

Create awareness: Awareness drives adoption and implementation. According to Raja (2016), technical assistance, workshops, training, campaigns, and capacity-building are necessary to create awareness. These programmes are essential for addressing social media accessibility in rural communities and equipping rural dwellers with the required knowledge and skills to function digitally.

Investment and infrastructure building: The investment in the necessary infrastructure that can enable social media accessibility in rural communities comes in various forms. They can be investing and building emerging technology, smart technology infrastructures, and creating policy and legislative frameworks.

- **Emerging technologies:** These are technology tools and applications such as AI, blockchain, machine learning, social media, and others with disruptive features to change lives. Government, private sectors, and other stakeholders can invest and build great infrastructure in the rural communities to bring technology such as social media accessibility closer to the people. Emerging technologies and devices have the ability to improve access to information and empowerment for those in rural communities.
- **Smart technologies:** Today, the world is evolving technologically. This advancement comes in various ways, such as smart cities, smart townships, smart schools (education), smart healthcare, smart human, smart streets, smart roads, smart communities, smart homes, smart buildings, and so many. These smart technologies disrupt the status quo in addressing basic and complex human and social challenges. The ability of the government and other stakeholders to invest and build infrastructures that incorporate smart technologies will equip the society in handling common rural community challenges. Then, social media accessibility be addressed in rural communities.
- **Improve legislation and policy:** Countries can create a policy framework to facilitate technology accessibility at the local level (communities) (Raja, 2016). Improving the legislation and policy landscape to increase social media accessibility involves creating guidelines and codes of conduct to increase implementation. Create technical requirements and standards, define a language and quality of service regulations (Raja, 2016).

Digital equity and equality: Provide access to social media resources and technology accessibility. According to Miller (n.d.), access to digital tools and technologies may guarantee equity. However, it assists in eliminating different forms of digital divides that may exist in rural communities.

Eliminate the digital divide: Our societies and communities are digitally divided between those who have and those who can and cannot afford it. The digital divide can be defined as social and digital inequality between people accessing and using technological tools (Chisango & Marongwe, 2021; Ercikan, Asil & Grover, 2018). The digital divide hinders the accessibility of social media and other digital tools in communities. Going forward, this digital divide should be eliminated through investments, creating awareness, and other things. Chisango and Marongwe (2021) suggest that digital skills, knowledge, competencies, usage and material access, and many more, should be afforded to everyone towards eliminating the digital divide in societies and rural communities.

Conclusion

Social media accessibility is good for social and human development in rural communities. Empirically, research on social media accessibility is missing in the literature, especially in addressing rural communities' challenges. This paper has uncovered different opportunities that rural communities can derive from social media accessibility in their area. This paper also discovered the challenges that can prevent the opportunities from being realised. Furthermore, the study provided ways to manage and address social media accessibility in rural communities. Social media accessibilities should be explored more to understand the level of facilities in rural communities that aid the adoption and usage of social media platforms.

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State of medical record systems and the adoption of cloud-based medical record system in public healthcare facilities in Free State

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Abstract: Information technology (IT) innovations such as cloud computing has received interest from businesses and government. Cloud computing provides access to the network in a cost-effective and easy way, requiring less management. In health, cloud computing can help integrate EMR systems for the improvement of healthcare services by providing real-time access to patient data, the sharing of medical information, monitoring a patients' health progress and access to medical data to conduct research. However, cloud computing adoption is still slow in the healthcare industry compared to other industries. In South Africa, cloud computing adoption has been very slow and most research on cloud adoption has been carried out in developed countries with very few studies conducted on emerging economies such as South Africa. This paper aims to determine the impact of demographics on the adoption of cloud computing as well as the state of the health information system in public healthcare facilities in the Free-State province. Data was collected through a questionnaire which was surveyed to thirty-one public healthcare facilities in Free State, South Africa. Results showed that the demographics have no impact on the intent to adopt a cloud-based medical record system.

Keywords: Adoption, Cloud computing, eHealth, EHR, EMR, Healthcare, HIS

Introduction

The need for healthcare service has greatly increased in the past few years resulting in an increased burden of medical data and costs (Akkay, Sari & Al-Radaideh, 2016). In South Africa, most of the public healthcare centres still make use of a paper-based filing system (Katurura & Cilliers, 2018). In addition, health information systems (HIS) in South Africa are scattered with no integration of electronic health record (EHR). The priority of developed and developing countries is to make use of technology to provide healthcare services (Furusa & Coleman, 2018). Implementation of new technologies in developing countries are often hindered by the lack of resources and infrastructure (Mekawie & Yehia, 2019). Inadequate health institutions and healthcare personnel form some of the challenges faced by certain countries (Idoga et al., 2018). Moreover, rural and remote villages suffer the most to access healthcare service as most healthcare facilities are situated in urban areas.

Proper use of ICTs in healthcare could provide a solution to the above mentioned issues (Idogaet al., 2018) Cloud computing offers developing countries access to information resources, sharing, storage at low costs (Mekawie & Yehia, 2019). Healthcare industry can benefit from cloud computing as it offers reduced integral costs and access to real-time data which can help improve the quality of services (Akkay, Sari & Al-Radaideh, 2016). This enables hospitals to make informed diagnosis and decisions on treatment (Almubarak, 2017). With issues of limited budgets and debts in developing countries, getting a third party to provide services and applications to healthcare organizations would reduce costs associated with purchasing software, hardware and IT personnel (Akkay, Sari &

Al-Radaideh, 2016). Therefore, to provide quality healthcare migrating to a cloud-based systems such as e-health is necessary as it provides a platform for sharing information with ease (Furusa & Coleman, 2018).

The adoption though of cloud computing remains slow in healthcare industry compared to other industries, especially in public healthcare facilities (Almubarak, 2017) (Akkay, Sari & Al-Radaideh, 2016) (Furusa & Coleman, 2018). Compared with other industries when it comes to implementing IT solutions, the healthcare industry is 10 – 15 years behind (Akkay, Sari & Al-Radaideh, 2016). Implementation of cloud-based systems such as e-Health do not depend only on the technology, but also on other factors (Furusa & Coleman, 2018). Few studies, such as the one conducted by Mekawie and Yehia (Mekawie & Yehia, 2019), study the effect of demographics on the factors which influence the implementation of cloud computing in health. This paper therefore aims to determine the impact of demographics on the intent to adopt cloud computing as well as the state of health information systems in public healthcare facilities in the Free-State province.

Failure of the UK teaching hospital to implement e-health system raises the need for those planning to implement e-health to understand underlying factors affecting the implementation of e-health in order to device strategies which will ensure the successful implementation of e-health (Ross et al., 2016). Thus, it is significant to understand the impact of demographics and the state of health information systems at public healthcare facilities by stakeholders as outlined in this paper in order to make informed decisions when planning to adopt cloud computing.

Literature Review

State of public healthcare in South Africa

In South Africa, delivery of healthcare is a constitutional obligation. The South African government has therefore developed numerous strategies and programmes with the means to make improvements on the quality and accessibility of public health care services by making considerable changes in health policy and legislation to ensure compliance in delivery of quality care (Katurura & Cilliers, 2018; Maphumulo & Bhengu, 2019). One of the strategies that were introduced is the National Health Insurance (NHI), which is intended to provide health insurance cover for all South African citizens, enabling improved access to quality health care services to all South African citizens irregardless of their financial status (Katurura & Cilliers, 2018). Despite these efforts, the performance and outcomes of the public health programme remans poor with the burden of disease escalating. The same case was faced in Free State where major challenges in the public health system arised around 2012. (Malakoane et al., 2020). In order to achieve the NHI goal, an electronic health record (EHR) system for registering and tracking patients will have to be developed. Various vendors have implemented different EHR systems in South Africa, with 42 health information systems (HIS) scattered with no integration of the electronic health record (EHR) (Katurura & Cilliers, 2018; Summit, 2018). Although these systems are implemented in some areas, most of the public healthcare centres in South Africa still utilize paper-based filing system (Katurura & Cilliers, 2018). Furthermore, insufficient budget is allocated with less prioritization of eHealth and HIS (Summit, 2018).

During the period 1997 – 2010, the public health sector moved from second to fourth in the list of spending priorities in South Africa, despite the increased utilization of public healthcare due to high disease burden and increased patient load (Malakoane et al., 2020). In 2009, (Maphumulo & Bhengu, 2019) reported that services at public healthcare fail to meet basic standards of care and patient expectations which has led the public to have no confidence in the healthcare system. Several issues have also been raised by the public regarding public institutions and the health system incurred major challenges including long waiting time, shortage of human resources, negative staff attitudes, unhygienic facilities, poor infection control measures, medicine stock-outs, lack of safety and security of staff and patients, increased litigation and poor record keeping (Malakoane et al., 2020; Maphumulo & Bhengu, 2019) . Such poor performing health systems could fail to contain epidemics as was the case in Guinea, Sierra Leone and Liberia where there was an outbreak of Ebola in 2014 (Malakoane et al., 2020). The healthcare system in South Africa has therefore been described as ruined and in dire need of repair (Maphumulo & Bhengu, 2019). In the next section, we take a look into cloud computing and how it can perhaps help mitigate some of the issues faced by the healthcare industry and help improve quality of care.

Cloud computing

Information Technology (IT) can help improve the effectiveness and provide great advantages to businesses and organizations (Harfoushi et al., 2016). With the introduction of cloud computing, organizations can have a competitive advantage and improved performance. Cloud computing promises great benefits such as access to unlimited storage, ubiquitous access to resources, scalability, cost effectiveness and flexibility (Griebel et al., 2015). Over the years, cloud computing has been defined in different ways. In this paper we will use the National Institute of Standards and Technology (NIST) definition of cloud computing as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Hogan & Sokol, 2013).

Cloud computing comprises of five characteristics, three service models and four deployment models. These are tabulated on Table 1 below as outlined by NIST (Hogan & Sokol, 2013).

Table 1: Cloud Computing

Characteristics	Service Models	Deployment Models
On-demand self-service Broad network access Resource pooling Rapid elasticity Measured service	Infrastructure as a Service (IaaS) Platform as a Service (PaaS) Software as a Service (SaaS)	Private cloud Community cloud Public cloud Hybrid cloud

Cloud computing services are web-based and require little to no managerial efforts. This is because the cloud service providers have the necessary skills to operate and manage resources offered to their cloud customers. In addition, cloud services enable the sharing and access of information easily and securely, anytime, anywhere via the internet (Barton, 2017). With cloud computing, there is no need to buy expensive high tech IT infrastructure. Cloud computing offers access to centralised applications which do not require to be installed on local computers but can be accessed on the internet (Nkhoma & Dang, 2013). This in turn saves the organization costs associated with purchasing IT infrastructure and the technicalities associated with maintaining and updating the IT infrastructure. Due to its flexibility, scalability and demand, the technology is considered to become the 5th most used resource after water, electricity, gas and telephone in upcoming years (Almubarak, 2017). With the correct application, the technology can offer great benefits to organizations including the healthcare industry (Gao & Sunyaev, 2019). In the next section, we provide literature on cloud computing in healthcare.

Cloud computing in healthcare

Information Communication Technology (ICT) is recognized as an enabler of the growth and development of economy in SA (Gillwald & Moyo, 2016). Information technology (IT) innovations such as cloud computing has received interest from businesses and government (Ali et al., Exploratory Study to Investigate the Factors Influencing the Adoption of Cloud Computing in Australian Regional Municipal Governments). Cloud computing provides access to the network in a cost-effective and easy way, requiring less managerial effort, providing storage centres which can be used by organizations at a low-cost (Hogan & Sokol, 2013; Paquette, T.Jaeger & Wilson 2010). Cloud computing brings a major twist on the way IT services are established, implemented, maintained, and paid for (Gao & Sunyaev, 2019). It provides organizations an opportunity to focus more on the important aspects of the business and thus increasing the productivity of the organization (El-Gazzar, 2014). Cloud computing services are web-based and can be deployed with less management effort. Cloud computing enables access to IT services via the internet on a pay-as-you-go pricing model to healthcare facilities with less IT resources/infrastructure (Gao & Sunyaev, 2019; Zhang, Cheng & Boutaba, 2010). In addition, healthcare centeres in the rurals can greatly benefit cloud resources which are offered at a reduced cost (Padhy, Patra & Satapathy, 2012). Cloud computing can help bridge the gap faced by resource-poor areas regarding the adoption of EMR by eliminating the need to gave individual IT infrastructure for each healthcare center but having one centralized storage for all healthcare facilities (Haskew et al., 2015).

Transitioning to a cloud-based EMR will enable healthcare providers to interact with each other, access patient health records, previous and current treatment, and lab results reducing the risk of misdiagosing a patient and giving the wrong treatment (Banica & Stefan). Further, having medical data stored on the cloud allows physicians and medical personnel to collaborate on medical research in order to provide better healthcare to all people (Yu et al., 2013;Singh, Singh & Bansal, 2013). However, there are several risks associated with using clou-based EMR, such as security and confidentiality of patient data, as compared to having an internal private owned data storage (Paquette, T.Jaeger & Wilson, Identifying the security risks associated with governmental use of cloud computing). Also, due to the limited use of cloud computing in the public sector, progress towards development of e-government services in SA has been slow (Gillwald & Moyo, 2016). In addition, despite the increase in cloud awareness and with cloud providers such as Microsoft, Amazon and Google are operational in this market, its adoption in South Africa is still slow (Adendorff & Smuts, 2019).

Despite these issues, if the technology is applied correctly, it can provide many benefits for most organizations including the healthcare industry (Adendorff & Smuts, 2019). However, external and internal elements in an organization might have a favorable or negative impact on the adoption of an innovation such as cloud computing. It is therefore important to know of these elements or factors as they can either help speed up the adoption of an innovation or prevent it from being supported.

Methodology

In this study, we followed a quantitative research approach. This involved conducting a survey in a form of questionnaires to collect data. The study carried out the survey in the Free State (FS) province covering the five districts namely: Fezile Dabi, Lejweleputswa, Motheo, Thabo-Mofutsanyana, and Xhariep, see Figure 1 below.

Figure 1: Free State Province, South Africa (Frank, n.d.)

Thirty-one public healthcare facilities participated in the survey. This included six Community Health Centers (CHC), 15 Clinics, and 10 Hospitals. Ethical issues were considered by ensuring that proper procedures are followed to protect human subjects and to conduct the study, and obtaining ethical approval from the University of Free State (UFS) Health Sciences Research Ethics Committee (HSREC) and the FS Department of Health (DoH). The data was analysed using a Statistical Package for Social Sciences (SPSS) version 19. Data was tested for Frequency and correlation. To test the impact of demographics on the intent to adopt cloud computing, a Spearmans' Coefficient Correlation was conducted. The following section presents the results of the analysis.

Result and discussion

This section presents results about views on the use of a paper-based record system and correlation results between the demographics and the intent to adopt cloud computing. We first take a look at the effects of demographics on the adoption of cloud computing.

Results: Effects of demographics on the intent to adopt cloud computing

In this paper, we aimed to determine the impact of demographics on the intent to adopt cloud computing at public healthcare facilities in the Free-State province. The Intent (intent to adopt cloud computing) was tested against: District(district where the healthcare facility is situated in the province); TypeHF (the type of healthcare facility); Size (the size of the organization in terms of the number of employees); NoOfPPD (the number of patients per day); Role (the position/job title of the participant); Gender (Male/Female); AgeGrp (the age group of a participant); hQual (the highest qualification of the participant). In addition, we examined the effects of cloud computing knowledge on the intent to adopt cloud computing.

The relationship between the above demographics and the Intent to Adopt was investigated using Spearman's Correlation Coefficient. The correlation coefficient rho (r_s) measures the strength and direction of a linear relationship between two variables on a scatterplot. A p-value less than 0.05 indicates that there is a statistical significance between the variables. Table 2 below provides the results of the Spearman rho.

Table 2: Spearman's Correlation

Variables	District	TypeHF	Size	NoOfPPD	Role	Gender	AgeGrp	hQual	Intent
District	1								
TypeHF	0.007	1							
Size	-0.177	-0.739	1						
NoOfPPD	-0.059	0.515	.	1					
Role	-0.029	-0.037	-0.264	-0.379	1				
Gender	-0.02	0.261	-0.154	0.469	-0.06	1			
AgeGrp	0.231	-0.137	0.236	-0.075	-0.269	0.269	1		
hQual	0.186	0.108	-0.095	0.246	0.307	0.068	-0.067	1	
Intent	0.102	0.133	-0.127	-0.347	0.196	-0.075	-0.07	0.023	1

District = District in which healthcare facility is situated; TypeHF = Type of healthcare facility; Size = Number of employees at the healthcare facility; Role = The role of the participant at the healthcare facility; Gender = Male/Female;AgeGrp = Age group of the participant; hQual = Highest Qualification; Intent = The intent to adopt cloud computing

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

District & Intent: There was no statistical significant difference between district and intent to adopt at the 0.05 significance level (r_s =0.102; p>0.05).
TypeHF & Intent: There was no statistical significant difference between the type of healthcare facility and intent to adopt at the 0.05 significance level (r_s =0.133; p>0.05).
Size & Intent: There was no statistical significant difference between size and intent at the 0.05 significance level (r_s =-0.127; p>0.05).
NoOfPPD & Intent: There was no statistical significant difference between number of patients per day and intent at the 0.05 significance level (r_s =-0.347; p>0.05).
Role & Intent: There was no statistical significant difference between role and intent at the 0.05 significance level (r_s =0.196; p>0.05).
Gender & Intent: There was no statistical significant difference between gender and intent at the 0.05 significance level (r_s =-0.075; p>0.05).
AgeGrp & Intent: There was no statistical significant difference between age group and intent at the 0.05 significance level (r_s =-0.070; p>0.05).
hQual & Intent: There was no statistical significant difference between qualification and intent at the 0.05 significance level (r_s =0.023; p>0.05).

To compare the responses of participants who have no knowledge of cloud computing and those who have knowledge of cloud computing, nn independent samples t-test was conducted to see if there is any difference between the two groups. The results of the test are presented in Table 3 and 4 below.

Table 3: Independent Samples Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Intent to Adopt	Equal variances assumed	.042	.838	.288	57	.774	.059	.204	-.350	.468
	Equal variances not assumed			.289	49.834	.774	.059	.204	-.351	.469

Table 4: T-test Group Statistics

	Cloud Computing Knowledge	N	Mean	Std. Deviation	Std. Error Mean
Intent to Adopt	No Knowledge of Cloud Computing	35	3.97	0.773	0.131
	Have Knowledge of Cloud Computing	24	3.91	0.767	0.157

There was no statistical significant difference in the scores between respondents with no knowledge of cloud computing (M=3.97, SD=0.773) and those who have knowledge of cloud computing (M=3.91, SD=0.767) ; t (57) =0.288, p=0.774. Therefore, the assumption of equality of variance between respondents who have knowleged of cloud computing and those who do not have knowledge of cloud computing was not violated. In the following section we take a look at results on the current state of health information systems at public healthcare facilities in Free State.

Results: Current HIS state

The study conducted a survey asking multiple choice, Yes/No, and Likert scale questions related to the current patient management system used for capturing, processing, and storing patient data; ease and convenience of the paper-based system to better understand the current state of health information systems (HIS) used for storing and capturing patient data at public healthcare facilities in the FS. Participants were asked to rate how much they agreed or disagreed with statements on how easy and convenient paper-based medical systems are. Figures 2–7 depict the results gathered from the participants in a graphical format.

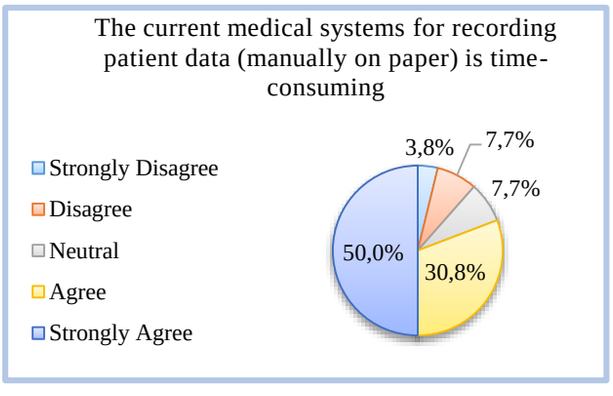

Figure 1: Results on time consumption of the current medical system

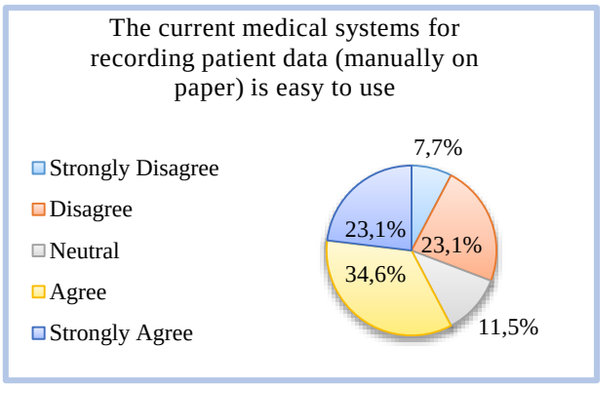

Figure 2: Results on the ease of using the current medical system

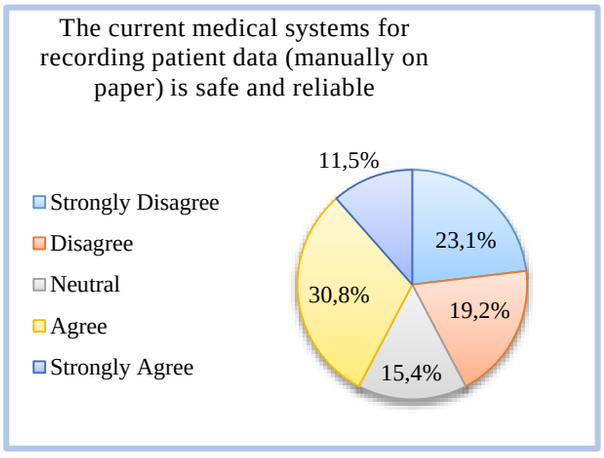

Figure 3: Results on the safety and reliability of the current medical system

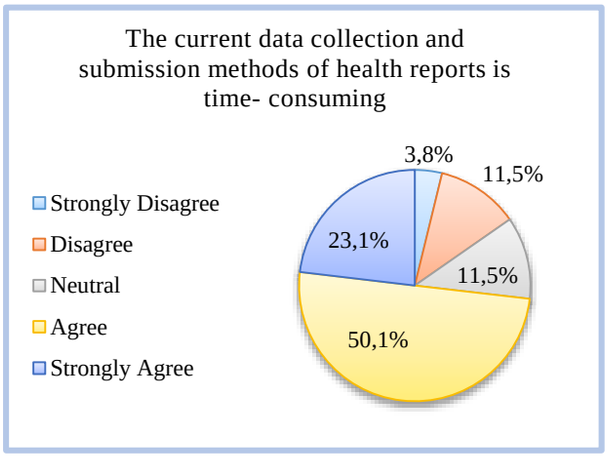

Figure 4: Results on time-consumption of reports using the current medical system

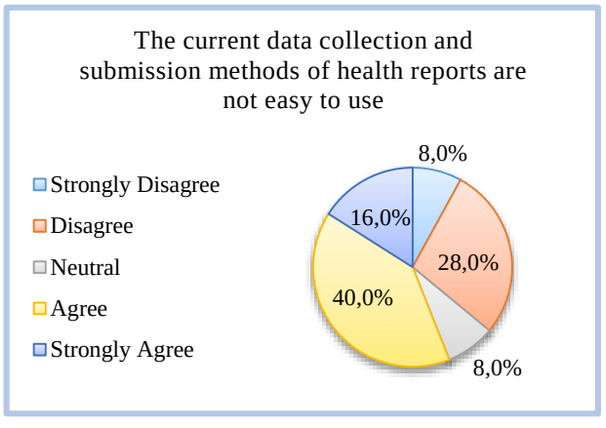

Figure 5: Results on the ease of use for reports using current medical system

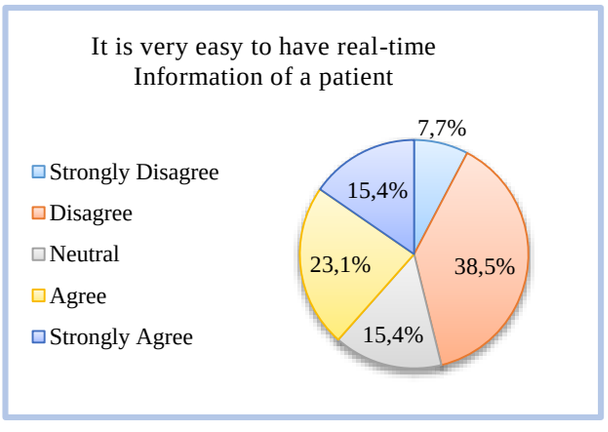

Figure 6: Results on the ease of getting real-time information of a patient

In addition to the above statements, three additional questions were posed to participants. These questions and their results are presented below.

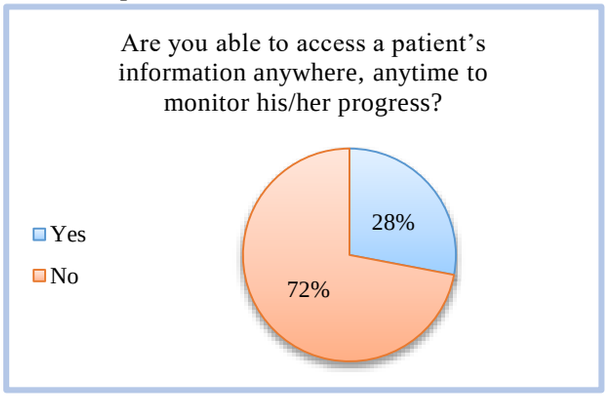

Figure 8: Results on access of patient information

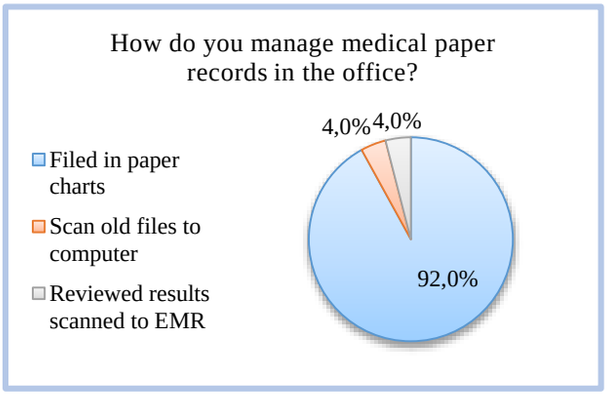

Figure 9: Results on management of medical paper records

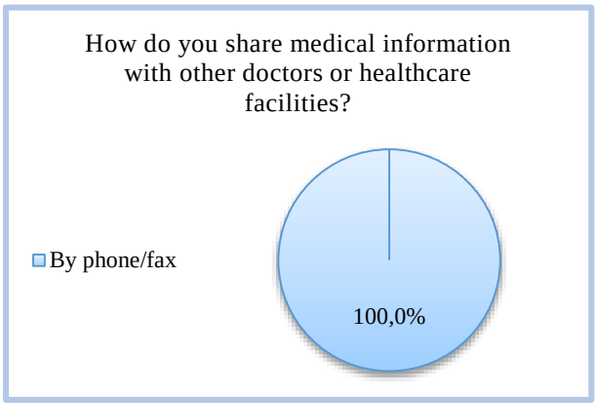

Figure 10: Results on sharing of medical information

The following sections discusses the findings of the study.

Discussion: Effects of demographics on the intent to adopt cloud computing

The Spearman's Correlation test revealed that there is no statistically significant difference between the demographic characteristics and the desire to embrace cloud computing, implying that none of the demographic variables influences cloud computing intent. Results of gender and qualification on the intent to adopt are supported by a study that was conducted by (Mekawie & Yehia, 2019). They discovered that gender and educational level had little bearing on factors influencing cloud computing adoption intentions. Their discovery of the influence of age and experience on human and technological elements, on the other hand, contradicts this. In addition, they also discovered that legal and financial aspects were influenced by position and sector, whereas human factors were influenced by cloud awareness.

However, in this study, results obtained from the independent samples test informs us that results obtained from participants who have and who do not have knowledge of cloud computing are the same in relation to the intent to adopt cloud computing. Cloud-based health knowledge has little effect on the adoption of cloud-based health systems, according to a study by (Idoga et al., 2018). As a result, knowledge of cloud computing is found to have no influence on the intent to adopt cloud computing.

Discussion: Current HIS state

When it came to real-time access to patient data, only a few individuals thought that it is simple to obtain real-time access to patient data, while the majority disagreed. Because most of the participants did not have real-time access to patient data when needed, these findings complement previous research claiming that lack of real-time access to patient data is connected with the usage of paper-based records (Shaker & Farooq, 2012). This is due to the patient's information that is stored on paper files and scattered across different healthcare facilities, making it difficult to have a full medical history of a patient. Furthermore, data revealed that using paper records and compiling health reports is time-consuming. On the other hand, majority of participants agreed that recording patient data on paper though is much easier. The safety and reliability of these paper records was found to have equal cases, with some participants believing that paper records were safe and dependable while others did not. We can therefore conclude that some of the participants trust more in the paper-based system than others. With the emergence of cloud computing, it is possible to have one system to store medical data and patient data which is accessible by all healthcare facilities.

Furthermore, it is evident that a patient's health progress is not possible to monitor as healthcare personnel are unable to get access to a patient's information anytime anywhere. Medical records are mostly filed in charts with few scanned to a computer or an electronic medical record system. Lastly, the sharing of medical information among healthcare professionals and other healthcare facilities is done strictly via phone or fax.

Contribution and implication of the study

A limited number of empirical studies on the adoption of cloud computing in health, especially in SA, are limited. This study contributes to the body of knowledge by studying demographics and their effect on the intent to adopt

cloud computing and providing the current state of HIS in Free State. In addressing this gap, the study identifies and explores demographics which contribute towards the adoption of cloud computing in health. The study provides a South African perspective on the adoption of cloud computing in health, especially in the public health sector. The study provides new knowledge on the adoption of cloud computing and an opportunity for transitioning to a cloud-based electronic system to improve healthcare. It informs of the ubiquitous model of cloud computing which offers cost-effective and flexible solutions. The public health sector is informed of the benefits provided by cloud computing and how it can be incorporated into the operations of the organization for improved productivity and quality healthcare services. Furthermore, the study provides information on the current state of HIS within healthcare facilities in the FS. This will help the decision makers to make an informed decision on the next step required to be taken by the Department of Health (DoH) to have all healthcare facilities running and operating at maturity stage 5 (which means a fully integrated, centralized national EMR system). In addition, the study may serve as a preliminary understanding towards the demographics that can drive the successful implementation of healthcare information systems.

Conclusion

The need for healthcare services is forever increasing across the globe with the growing population and the burden of new diseases. The use of technology and access to information puts pressure on healthcare services rendered by healthcare providers, as patients are now able to get health advice on symptoms via the internet. This calls for the healthcare industry to make use of new technologies and IT solutions in order to meet the demand to render quality healthcare services at an affordable cost. Cloud computing offers the health industry the opportunity to provide quality healthcare services in a cost-effective manner. With the cloud, access to medical and patient data is possible anywhere anytime, making it possible for healthcare providers to monitor patient health progress and make informed decision on treatment. However, successful cloud computing adoption in healthcare necessitates investments in information technology as well as awareness of the internal and external factors that influence technology acceptance. As a result, the paper reviewed literature on cloud computing adoption and presented findings on the effects of demographics on cloud computing adoption intent as well as the condition of HIS at public healthcare facilities in the Free State. Although none of the demographics reported in this paper had an impact on the intention to use cloud computing, this is a gap in literature which has not received much attention. Few studies have examined the influence of demographics on the intent to adopt cloud computing in health, while others examined the intent to adopt cloud computing in other industries. This paper further informs us that the current HIS is mostly paper based where medical and patient data is recorded on paper. This paper-based system is time-consuming although easy to use. The safety and reliability of the system is 50/50. Furthermore, the collection and submission of health reports is time-consuming and is not user friendly. Access to a patient's medical data in real-time is unachievable with the current HIS. Thus, having one medical cloud-based system was deemed to be a good idea to help improve healthcare. This paper therefore recommends a thorough examination of the operations and systems involved in the recording, storing and access of medical data at public healthcare facilities in order to obtain a clear understanding when planning to create a cloud-based medical record system. Incorporating IT with health can bring tremendous changes into the healthcare industry, address some issues faced by South Africs' health system in order to provide quality healthcare for all South Africans.

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A narrative study on the usage of mobile educational applications by the university students

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Abstract: Today's youth are digitally affluent and most, if not all of them, own and or use mobile communication devices daily, making them digital natives. A sizable percentage of university students in South Africa and Africa are active on smartphones for different activities, including teaching and learning purposes. There is an immense demand for higher education authorities to support distant and affordable education through the appropriate use of mobile educational applications and employ similar mechanisms to assess academic competency and student promotion decisions. The planned incorporation of mobile educational applications into the management and administration of teaching and learning in higher education institutions can present enormous opportunities to students and academics, resulting in knowledge and learning explosion. However, limited studies exist on the usage of mobile educational applications at the university level. Then, a narrative literature review (NLR) research approach was adopted, looking at academic materials covering the research topic to determine their usage of mobile educational applications for their academic purposes. The finding shows that university students invest a good amount of time using mobile educational applications to improve their academic performance.

Keywords: Mobile, Mobile educational applications, Mobile learning, Smartphones, Socio-cognitive mobile learning, Students, Teaching and learning

Introduction

The emergence of educational applications on a mobile platform for students offers them enormous opportunities to learn without boundaries of time, human resources, age, sex, economic background, and geographical location limitations. "Mobile learning is an opportunity to overcome some of the obstacles and problems related to information delivery and, therefore, to involve learners belonging groups such as mature-aged, gifted, international or remote learners, as well as those with cognitive, behavioural or social problems or with physical or mental difficulties" (Tetrad & Patokorpi, 2008: 7). Additional resources and new knowledge are being added and updated daily on such platforms by experts and area specialists, making learning current, engaging, and meaningful. Today's youth are digitally affluent, and most, if not all of them, own and or use mobile communication devices daily and are considered digital natives. As a policy imperative, it is expected of every South African manager, teacher, and student across the general, further, and higher education bands, to be Information and Communications Technology (ICT) capable and develop the skills they require to contribute fully to the global community profoundly (Beatriz, Deborah & Hunter, 2008). Integrating ICT services to support teaching and learning is also captured in the government's National Development Plan (NDP). "From 2005 to 2009, the number of South Africans owning, renting and/or having access to a mobile phone increased by 20 percent, and the country now experiences 100 percent mobile penetration among its total population of more than 50 million people" (Beger 2012: 5).

The acceptance of mobile learning as an emerging paradigm has its roots in the fact that these devices are portable, can be connected to mobile networks, are relatively cheaper, and find their use in different settings. Mobile platforms and applications provide enhanced opportunities for communication and interaction among students, between students and lecturers, and members of communities of practice (Brown, 2005)..

The pattern and impact of usage of mobile educational applications on students learning process

University students acknowledge that mobile educational applications and platforms facilitate and assist with academia. The conclusions reached by Guma, Mbabazi, Andogah and Lawrence (2017) that students use mobile devices for different academic-related activities such as sharing tutorials and notes with peers, accessing course materials, and sending and receiving emails and messages. Studies have reported that smartphones and devices have become second nature among students as they use them in lecture rooms and for completing assignments and projects (Ng, Hassan, Nor & Malek, 2017). Students connect to the Internet frequently for personal efficacy and study-related issues. Students use mobile apps for communication and collaboration; gain access to academic materials; get organized and access academic news; for cloud computing and storage; prompt interaction; and share files and documents (Wai, Ng, Chiu, Ho & Lo, 2018). Students progressively find the need to integrate the use of mobile applications into the lecture rooms. According to research reports published by Normalini, Lurudusamy and Arokiasamy (2018), perceived social effectiveness and perceived satisfaction were important reasons that impact university students' regular use of mobile devices.

It was noted by Ng et al. (2017) that the use of smart devices and mobile apps helps students to get responses swiftly, permits for collaborative learning, gain access to web-based resources, makes studying dynamic, and subsequently enhances learning. According to Baguma and Pettersson (2018), substantial degrees of fulfillment were reported by students when using their mobile devices to gain access to educational resources, to improve their learning experience. According to Gomez-Garcia, Soto-Varela, Moron-Marchena and Pino-Espejo (2020), mobile phones in an educational atmosphere certainly influence students' academic performance. The authors have further noted that academically weaker students demonstrated substantial advancements in their studies after integrating mobile devices and apps into teaching space and exhibited an improved degree of enthusiasm towards education. Again, Fadzil (2018) had reported that the 'effort expectancy' directly impacts the intention to adopt mobile apps by students. In simple terms, applications that are not easy to use due to ease of use are not readily adopted by students. Singh and Samah (2018) have found that the use of smartphones by students in the university environment influences their performance positively through assumed activities, such as accessing course content, retrieving information regarding students' performance, distribution of academic information, and stirring discussions among students and lecturers.

Mobile educational applications

Mobile educational applications and platforms are the newest entrants to the mobile communication and technology environment and have gained public attention progressively. These smart devices and applications make education lighter, smarter, and convenient for students. As the popularity of mobile educational applications gains momentum, their accessibility and use among students need to be assessed. Technological advancement in the last decade has changed the facet of all spheres of life beyond human imagination. The influence and adaptation of technology gadgets have revolutionized the teaching and learning scenario in ordinary lecture rooms (Salavati, 2016). Hand-held devices, such as mobile smartphones, tablets, and Personal Digital Assistants (PDAs), offer the possibility to access information from multitudes of sources and enable real-time interaction with anybody and anywhere possible. These devices are gradually replacing the role of a personal computer in an affluent person's life, such as from information management to banking, entertainment, learning, and other activities (OECD, 2016). The advancement of technology is also bringing education and learning materials closer to students. These inventions brought about the concept of mobile learning, or m-learning, which is defined as "the ability to use mobile devices to support teaching and learning" (Mehdipour & Zerehkafi, 2013: 93). The arrival of mobile technology and wireless data connectivity can help teaching and learning reach new dimensions beyond the limits of traditional classrooms, where learning can materialize anywhere and anytime.

When young people have access to mobile communication devices and data connectivity, a world of possibilities is opened to learn through interaction and collaboration. This becomes more profound when educational applications that are more focused and subject-specific become available to them. According to Angeli and Valanides (2009), 21st Century learners are envisaged to be critical thinkers who should be technologically affluent and be able to solve problems through communication and collaboration, using the latest technological tools and applications. There are ongoing interests and efforts from technical developers and educationists to exploit the unique capabilities and abundance of opportunities that mobile technologies and platforms offer towards developing applications to assist teachers and learners with formal learning (Naismith, Lonsdale, Vavoula & Sharples, 2004).

However, Jaffer, Ng'ambi and Czerniewicz (2007) state that teaching and learning in higher education institutions in South Africa is largely characterised by lack of personal contact between lecturers and students and among students, large-sized classes, limited opportunities for students to integrate and apply knowledge from various fields, and other more deep-rooted issues of economic and racial diversity. According to the authors, educational technology can leverage and extend traditional learning-teaching activities in certain aspects and improve learning outcomes. Furthermore, mobile educational technology affords both lecturers and students an entire continuum of possibilities that can outspread beyond physical and geographical boundaries.

Mobile educational applications in education

Mobile learning has the potential to change the educational landscape in bringing borderless education and classroom (Drigas & Angelidakis, 2017). Readily available mobile technologies and applications provide users with enormous opportunities anytime and anywhere for learning to be possible. Mobile learning applications provide the kind of support that enriches interaction and engagement between learners, learning contents, and the environment (Naismith et al., 2004). This support is facilitated by the portability nature of smart-mobile communication devices and their progressive affordability to the larger student population. Through mobile educational applications, lecturers can engage and share learning materials with students and other students. It makes learning borderless and breaks the digital divide in learning. Al-Fahad (2009) posits that appropriate mobile learning systems can improve communication and enrich students' learning experience 'in their open distance learning' space. However, m-learning has redefined learning by providing multiple learning platforms that accommodate young and students (Drigas & Angelidakis, 2017). Content is easily shared, and students can engage with each other in a teaching and learning process. Academic attention has been drawn to the effective usage of mobile applications to improve academic teaching and learning. There are several mobile applications designed for educational or academic purposes. These applications are sometimes not known or used by students for various reasons. Then, this study aimed to determine using narrative research on the usage of mobile educational applications by university students.

Students usage of mobile educational applications

The mobile educational application continues to provide students with better opportunities to learn and play. Students can read academic materials and participate in academic activities like quizzes, assignments, tests, exams, and other mobile educational applications. Academic institutions can are using mobile and emerging technologies to make teaching and learning possible (Mohammadi, Sarvestani & Nouroozi, 2020). According to Majeed (2014), academic materials can access learning materials, videos, listen to lecture teachings, participate in learning assessments, and engage with lecturers and other students. The authors further suggest that smartphones and mobile devices assist students in interacting with course materials (content), develop learning knowledge and understanding, participate in corporate or group learning, and establish a learning environment. Students and lecturers can use mobile educational applications to share common learning materials, and the content will directly improve and affect the learning process.

Mohammadi et al. (2020) the capacity of m-learning promotes learning without limit and improves critical learning, problem-solving, participatory and collaborative learning, and lifelong learning and communication. Globally, the benefits of mobile educational applications are a welcome development to those who are able to understand its role in strengthening the teaching and learning process and making students engage more. Presents students are tech-savvy with the ability to understand and use mobile applications effectively and efficiently. Higher education institutions and students need to embrace the platform to improve their teaching and learning processes. Learning

on the move has been promoted through mobile educational applications. According to Demir and Akpinar (2018), m-learning promotes learning on the move with open access to skills, knowledge, and experience for the 21st century.

Mobile educational applications improve students learning process

Classroom teaching and learning are no longer limited to four wall environment. Virtual learning environments provide real-time and real-world connections through m-learning in support of lifelong learning at all times (Demir & Akpinar, 2018). Mobile applications provide a good opportunity for teaching and learning in motivating students to engage, create knowledge, and understand learning content better (Farrah & Abu-Dawood, 2018). The application of m-learning in higher education institutions is influenced by "trust, ease of use, context, character and personal qualities, perceived usefulness of use, behavioral intentionality and use culture" (García-Martínez, Fernández-Batanero, Cobos Sanchiz & Luque de La Rosa, 2019: 2). Many of the students in the classroom today are tech-savvy with the ability to understand quickly emerging technologies. However, there can lead to distraction and other forms of disadvantages. Mobile education applications and m-learning will provide educational access and sustainability within and outside the learning environment (Demir & Akpinar, 2018). To improve students learning process, mobile educational applications will:

- provide quicker access to learning materials,
- interactive learning,
- flexible learning to suit individuals learning needs and abilities,
- provide distributed and shared learning,
- student-oriented learning and,
- limitless learning at all times and places.

Academic researchers continue to search for the benefits of m-learning and the potential to influence and improve the learning process. García-Martínez et al. (2019) suggest that m-learning and other applications can improve students' commitment, active participation and feedback, active interaction, responsive learning, and engaging learning. These works towards enriching students learning experience and academic performance. Then, it can be said that mobile educational applications greatly impact the learning process and progress and make open access for all.

Research motivation

When mobile technology is used as a supporting aspect to enhance learner involvement in the classroom, there is evidence that this can increase students' motivation and satisfaction, leading to effective learning (Ferreira, Moreira, Pereira & Durao, 2015). The researchers further note that the use of appropriate educational applications allows learners to personalize learning. "The mobility, communication features and computational capacity of handhelds provide learners with authentic learning activities by simulating a situated learning environment" (Jeng, Wu, Huang, Tan & Yang, 2010: 7).

Furthermore, according to Jaradat (2013), students accept that mobile applications and platforms afford them increased flexibility to access various resources for independent learning beyond the limitations of time and space. The same survey also revealed that mobile learning applications enhance learning experiences inside and outside the classroom. Even though students know about the academic benefits attached to mobile devices and applications, it was observed that 'students used their mobile devices (mainly) for surfing the web and mobile applications to engage in entertainment activities, such as playing mobile games and for social networking activities' (Jaradat, 2013). Based on the enormous benefits attached to the efficient use of mobile educational applications, the researchers were interested in investigating the usage of mobile educational applications by university students, especially university students in South Africa and Africa at large.

Problem statement

The popularity and acceptance of mobile communication devices, such as smartphones, have grown exponentially around the globe during the last decade (Montjoye, Quoidbach, Robic & Petland, 2013). A common person has integrated Mobile Applications (Apps) to address his daily needs, from data processing, communication, banking, networking, shopping to entertainment and leisure (Wong, Dastane, Satar & Ma'arif, 2019). This is the case with developing and developed countries, irrespective of age groups, academic or social status, gender barriers, and other

demographic factors. The International Telecommunication Union (ITU) estimates that ownership of the mobile phone exceeded 90% of the world adult population by 2013, and "the active number of mobile cellular subscription had reached six billion around the world" (Montjoye et al., 2013: 1). The ease of availability and affordability of these devices and amenities present users with enormous benefits, new opportunities, related advantages, and some drawbacks.

It has been argued that the use of Mobile Apps in a classroom can serve as a useful pedagogical aid to enhance students' learning (Diliberto-Macaluso & Hughes, 2016). According to Sung, Chang and Liu (2015), the unique functionalities of mobile devices are well suited for certain specific teaching methods, resulting in better educational outcomes. Most students are currently using mobile learning apps and platforms to the best of their advantage to enhance their learning experiences and performance (Garcia-Martinez, Fernández-Batanero, Cobos Sanchiz & Luque de La Rosa, 2019). However, suppose such is not the case. In that case, there is a need to investigate reasons for this poor appeal in the use of mobile educational applications focusing on the following: lack of awareness among students; the inability of educators to promote the use of suitable apps to support learning; difficulties around access to mobile devices and data connection; and the role of parents in the provision of appropriate resources.

Research objectives and questions

Mobile devices, such as cell phones (smartphones), are an ideal medium to make educational opportunities accessible to scholars, irrespective of their geographical location and beyond inflexible time schedules. When mobile devices are used prudently, they transform into excellent out-of-school learning tools for lecturers and students. This study aimed to determine the usage of mobile educational applications by university students. The objectives of the study are to understand:

- To determine how students are using mobile educational applications.
- To explore how mobile educational applications improve students learning process.

Research questions:

- How does students use mobile educational applications?
- How can mobile educational applications improve students learning process?

Research methodology - Narrative literature review (NLR)

The sole purpose of conducting research is to find answers to unsolved problems or broaden existing knowledge (Goundar, 2012). Research methodology entails the decisions regarding the method of conducting research and the tools and techniques to carry out the research (Kothari, 2004). The distinction regarding quantitative, qualitative, action research, or mixed methods and choices concerning the population and sample size, sampling method, data analysis, research strategy, and design, method of communication of results are but some of the important aspects of research methodology. The objective of a literature review is to survey the existing academic material, including journal articles, books, and conference papers related to a particular topic or area of research. Reviews are aimed to deliver the essence of published literature and explain its relevance to the current state of affairs of the topic (Ferrari, 2015). The multitude of data, conflicting opinions, and lack of consensus are factors that demand a literature review on a topic.

The reviews are mainly categorized as systematic reviews and non-systematic reviews (Jahan, 2016). Non-systematic or narrative reviews summarise previously available knowledge relevant to the topic without replications, and there are no recognized guidelines for writing narrative literature reviews (Ferrari, 2015). The narrative reviewer has the discretion to choose the articles and book chapters they want to include for the exercise, and this subjectivity in the study choice leads to some biases in the findings (Yuan & Hunt, 2009). Narrative literature is indispensable when tracing the development of a scientific principle from a historical point of view as the narrative loop could be lost in any rigours systematic review with restricted focus (Buckley, 2016).

To this study, narrative reviews are useful for looking at a topic from a broad perspective, evaluating earlier studies on the topic, identifying the knowledge gaps in the area, and detecting the motivations for future investigations (Ferrari, 2015). Narrative literature reviews are not explicit on the assumptions devised, the choice criteria used, and the resulting estimation biases (Snyder, 2019). Narrative literature review in the study leads to a qualitative

interpretation of existing literature where the emphasis is given to frameworks and theories that describe hypothesis relationships as were established by prior studies (King & He, 2005). The researchers used a narrative literature review mechanism, the reviewer desertion is utilized to select the relevant literature, and the process followed. However, restricted focus on the topic and having relevant criteria for the inclusion of literature are helpful to improve the quality of narrative literature reviews.

Furthermore, the authors have adopted the narrative literature review approach for this paper. The study aimed to determine university students' level of usage of mobile educational applications for their academic needs and how these utilities improve students' learning processes. The topic under consideration entails the concept of 'mobile learning', which materializes using a set of artifacts, namely mobile devices, educational apps on mobile platforms, and social media, that result in what is termed as socio-cognitive learning. The topic has its pillars put up across a vast area of knowledge, and the analysis of such can only be subjectively possible for a research paper of this scope. For this reason, the narrative literature review (NLR) was used.

The flowchart portraying the researcher's step-by-step process in preparing this paper as captured in Figure 1 below.

Figure 1: Research process flowchart

Topic identification: The researcher had noted the heightened use of mobile technology, mobile educational apps, and platforms among university students in South Africa. More specifically, to investigate the usage of mobile educational applications by university students.

Research questions: A research questions aimed to gather data and ensure that the purpose of the research is comprehensively addressed within the set scope and boundaries of the research. Research questions were devised to provide the direction and focus of the study. Questions are:

- What are mobile educational applications and their role?
- What is the usage implication of mobile educational applications?
- How are students using mobile educational applications?
- Can mobile educational applications improve students learning process?

Literature review: Screened the available literature that are relevant to the topic and those that are directed in the questions of the research. The researcher evaluated a range of sources, including academic journals, web-based resources, and books, to answer the research questions.

Findings: The summary of results ensued from the literature review form the essence of the findings.
The figure below (Figure 2) depicts how the NLR was used progressively in this paper to analyze the topic at hand.

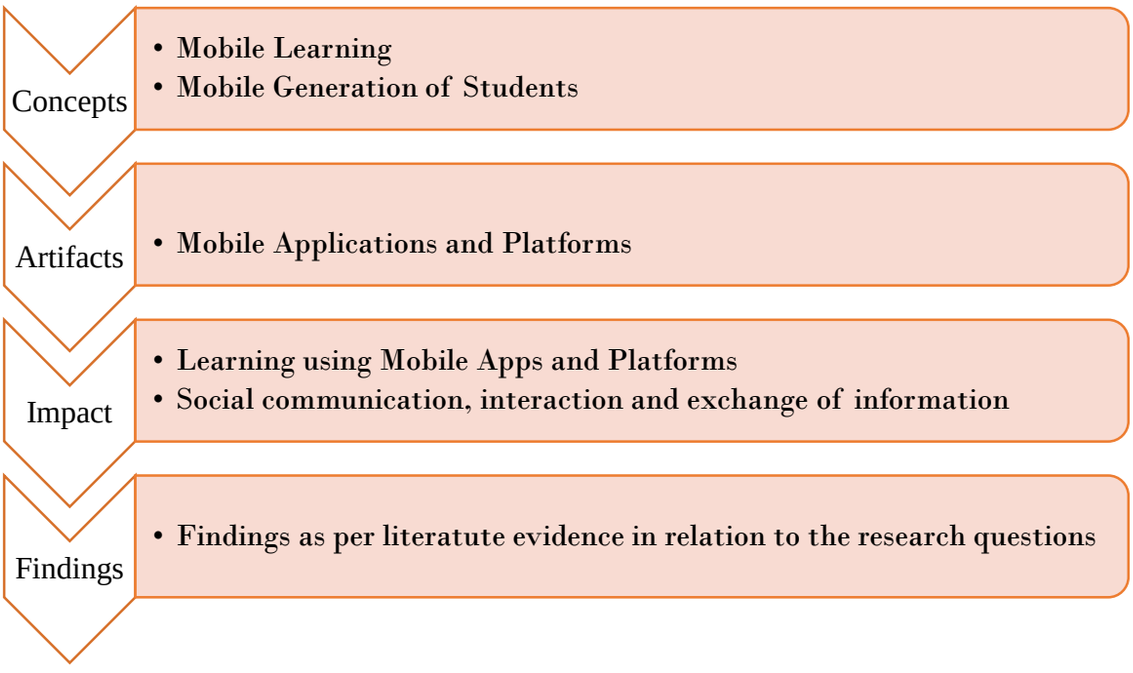

Figure 2: Use of Narrative Literature Review (NLR) to analyze the topic from concept to application

This paper progressively used the narrative literature review technique to analyze the research topic. The researchers started the exercise by analyzing the **concepts**, namely **mobile learning** and **mobile generation of students**. The next step was to look at the artifacts pertinent to mobile learning, namely **mobile applications and platforms**, as was captured in the literature. Then moved on to analyze the **impact**, which covers mobile educational apps and platforms through social communication, interaction, and exchange of information. The last step includes the **findings**, which are the results obtained through the analysis of literature based on the research questions.

The implications of the paper

The study investigated a narrative study on university students' usage of mobile educational applications for their academic learning. The outcomes and results are beneficial additions to the current frame of knowledge. The results directly impact the effective incorporation of mobile educational applications into university education in South Africa. These findings point to the existence of a delicate but healthy mode of learning backed by social platforms, educational apps, and technology. The use of mobile educational applications among students will increase at an exponential proportion with technology innovation.

University students use mobile technology and social media platforms expansively for academic and non-academic purposes. Students use social media platforms and mobile applications as per the appropriateness of their needs. Students use their mobile devices for communication and online learning. Students use a variety of mobile applications daily and utilize them to access educational material. Students frequently connect to the Internet to access educational material and electronic resources and share academic knowledge with peers through mobile educational applications, social media platforms, and many others. Mobile learning as a substitute for face-to-face lectures will be a new facet in university education that may reform towards a hybrid form of education. Mobile educational applications will provide effective and efficient hybrid learning.

Conclusion

Mobile learning takes place in a global environment of different complementary components. The consumer is the student who is always mobile, socially interactive, and constructing knowledge through mediation over mobile devices, applications, and platforms, and directed or assisted by lecturers and/or peers. Learning becomes robust and insightful when students build understanding and knowledge through constructive engagement, collaboration, assimilation, and appropriate technology. Learning is an active, vibrant process and, at the same time, a social

activity that is profoundly connected to the culture of the community they live in. Fitting integration of mobile technology in a socio-constructivist learning environment will have a favorable bearing on the learning process.

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Deep Learning: Foundational preparation for upskilling

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Abstract: Emerging technologies are disrupting industries. The products and services are undergoing a quick revamp in their process of production. The service levels of engagement and delivery are radically varying upon digital transformations that are influencing the workflow. Artificial intelligence which marked the initiation with data science is leaping it's presence from machine learning to deep learning accommodating with multiple layers of non-polynomial algorithms handling unbounded width of information. Deep neural networks are with many-layer structure or even hidden layers, wherein the answers to the early layers pave way to simple and specific questions in a hierarchy that brings solutions to complex and abstract concepts. Artificial intelligence in machines includes machine learning, where they learn by experience and acquire skills without human involvement. Machine learning algorithms analyze the raw data and decide the relevant features, however in Deep learning the neural data networks improves and trains the data appropriately. Deep learning is an extended relation to machine learning, where neural networks algorithms learn from large amounts of data with artificial intelligence. The machine is capable to position it's performance based on various sensory inputs with a marked difference to the normal automation. To work in such an advanced setting, employability poses to be requirements for new skill sets. This paper attempts to cover the rudimentary requirements which are falling into the skills basket. Right from students to professionals the varying degree of skills acquisition can position them for greater demand in the job market.

Keywords: Artificial Intelligence, Cognitive process, Deep learning, Industry 4.0, Machine learning

Introduction

Manufacturing resilience, rural demand, and consumption are affected by digital transactions to cushion the economic development, unravel the growth prospects for sustenance towards recovery measures, reinforced by the rural digitalization and financial inclusion driving seamless implementation of demand pressurized due to COVID-19. The digital reformation bolsters trade facilitating to transform the ecosystem through transparent, coordinated technology and efficiency driven processes (GoI, 2021). Disruption is a journey, with strategic choices as response to markets, by revisiting in an agile way. Digital services centered disruption in the industry will forever affect markets in the future to develop new resources and core capabilities to survive (IBM, 2016). Digital implies services for business superiority and competitive advantage in the service that are influential affecting innovations and advancements with reduced financial intermediation, pave way for an ecosystem to render service to attract new customers through service delivery reflecting the firm's capability to offer components that deliver services/products that can gain customers' attention (Leticia et al., 2020). Data can drive outcomes, processes while new technology can bring disruption and breakthrough. Organizations absolutely believe that with existing technologies, they would be unable to transform, and competition will disrupt the business (Dell, 2019).

Technological interrelatedness of Artificial intelligence (AI), with Big Data (BD), Algorithm, and internet of things (IoT), accelerate businesses performing with less resources and yield results, with decrease in time for ideation to

product conception and client delivery, by means of scarce people resources (Wilburn & Wilburn, 2018). Intelligence is a quick response to the need. Intelligence is the ability to collect, process data and quickly respond to decide. However, the intelligence of machines which is termed as artificial intelligence deals with big data, through a processing algorithm, which takes care of the past experience, to either adjust or Scale-up the delivery possibility of the machine. Hereafter the term machine shall include all machines, or equipment, or devices, or any gadget (Umachandran, 2020). The growth of digitalization, marks the organizations to technology adoption to speed up the processes by responding with market changes, adapting productivity and cost-efficiency. It is also a significant aspect which influences the frontend and backend resources with direct effects and greater employee engagement (Leticia, et al., 2020). Deep hierarchical structure and circuits are intrinsically more powerful, when adapted to solve real-world problems, using sensory recognition, generally where the neural networks can compute empirical functional evidence and suggest the best adapted learned functions useful for solving real-world problems. Enumerating on the convolutional assemblage of layers into a linear form, the resultant architecture would have bundled non polynomial hidden layers, many more than the shallow networks. The real breakthrough in deep learning is realizing to go wide as explorative and layer of networks often hidden in nature, with significant breakthroughs, upon the exploration using tools which are expressive models offer to achieve better classification accuracies (Nielsen, 2018).

DL Constructure

The construction of the skill set for Deep learning is intertwined with the machine learning skill set. Hence DL-ML Skills, as per figure 1, can be classified as Human oriented and Machine oriented. The featured skills towards humans include basic qualifications in Cognitive sciences, human oriented intelligence covering Stimuli-Response, Intelligence, Meticulousness and/or smartness. The machine orientation has the device by itself, along with Artificial intelligence, Algorithm, and Big Data leading to an automated learning experience termed as Machine Learning. The combination of these human and Machine oriented learning offers the platform for the evolution of Deep learning with Cognition correction and/or amplification, through Sensors and Smart tools.

Cognitive science is a multidisciplinary science with Biology, Computer science, and Neuroscience towards applications for artificial intelligence through learning, inference, concepts, and activities. These preparatory inputs can make the potential employee understand well the applications for AI and empathize well with body and brain coordination's. Mind has thoughts and feelings, expressed, or controlled, however thoughts here are meant to be in conscious state, while the feelings are expressed as unconscious emotions. Human Oriented Intelligence is associated with 1). Stimuli-Response identified with Stimulus-Organism-Response or Stimulus-Organism-Behavior-Consequence. 2). Intelligence comprises collection, data processing, quick response and decision making. 3). Meticulousness or smartness involves Detailing action, careful, attentive and application of learning. Then the deliberation, from where does the Need for Machine intelligence come. Human life has a continuous demand and wish towards comfort and coziness of an esteemed life and living. To provide this objective Machine Oriented Intelligence, comes as a support and deliver an intended process intelligently, using sensors, transducers, and computing device, communicating with the Physical Machine through IoT.

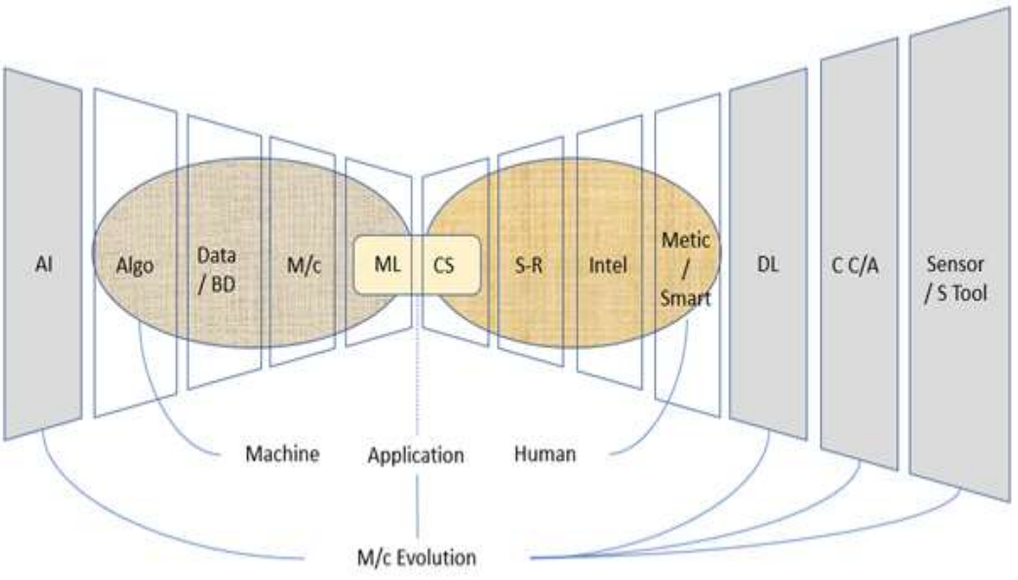

Figure 1: DL-ML Skills
Source: Umachandran (2020). DL-ML Skills

Big Data, refer figure 2, comprises a large chunk of data in 1). Volume, 2). Velocity meaning the speed of capture, 3). Variety including the source; people involved; and location dependent, 4). Veracity (situational accuracy), and 5). Variability referring to the frequency. This big data is Warehoused, Computed, Engineered and Data mined at various stages. The reason behind archiving and operating on this big data depends on various data options states, such as to use, misuse, manipulate, or hush. The inference of data depends on the user's intent, they derive meaningful associations and use based on the objective on which the data gets related to. The data relationships are identified at 1). Warehouse, data is identified for use or misuse, 2). Computing is where the data is either misused or manipulated, 3). Engineering derives relationships for manipulation or hushing, 4). Data Mining is for deriving relationships in data either to hush or to move it use state. All the relationships of data analysis are through the applied Modes of Reasoning such as 1). Logical, where the data processed in between Mining and Warehouse, 2). Patterns are commonly applied between Warehouse and Computing, 3). Opportunity, is identified either during Computing or Engineering, 4). Hacking, happens anywhere between Engineering and Mining (Umachandran, 2020).

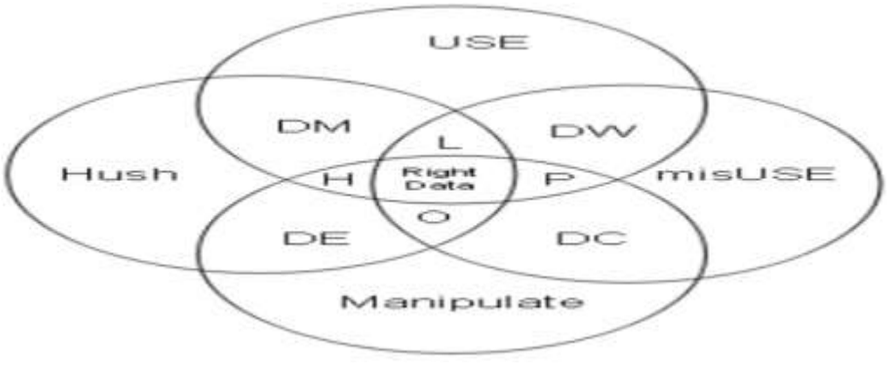

Figure 2: Big Data Framework

Source: Umachandran., (2014), Framework – Manufacturing Data Science

Smart intelligence indicators

Human Intelligence includes specific, fluid, and crystallized intelligence for convergent and divergent thinking, based on the contributing components such as expertise, imagination, risk taking, intrinsic drive, and facilitating environment. To display their smartness, human beings use various tools such as Organizers, Knowledge sources, Visualizations, Expert opinions, and Signs. When machines are also connected to such tools, they can also deliver smart deliverables. Unlike in human beings, where the knowledge or information is in a transient stage resulting in short term memory storage; the machine has its learning in its long-term memory, a permanent space (Umachandran, 2020). Machine learning algorithms struggle to adapt to defective and non-linear process

characteristics. Deep Learning is a computational technique that improves the ability to characterize system complexity, discover causal patterns entrenched in the series of time, capturing system degrades, and appropriate predictions (Zhang et al., 2018).

Use tools such as Organizers will coordinate activities planned, initiated, ongoing and completed to be followed through Calendars, Schedulers and Reminders. To obtain enhanced knowledge output or updated information reaching to Knowledge Sources such as Wikipedia, use of robust search engines like Google, and retrieving research information through university library Resources etc., will throw more data and information. Enrichment of data and follow-up on the progress using Visualizations tools such as Charts, Maps, Graphs and Dashboards, can position timely initiation of actions and make course corrections to the processes being carried out. Falling back for support from Expert Opinions can lead to astonishing breakthroughs, identifying new pathways, also would also throw light on surprising research. Capturing and fine tuning the activities is through following the Signs, Symbols, Sounds, Signals & Gestures which can make timely alignment with the intended process results and deliver better service satisfaction. Sensors that are superior to provide customer delight are evolving, Electrophysiological methods to measure, and learn the intent that is not explicitly conveyed through text or visuals but by emotions and feelings. Electrooculogram (EOG) measures eye movements, which can lead to training the machine or device for analyzing perceptual processes, attention control, etc. and thereby take suitable processing actions. Electroencephalogram (EEG) identifies the brain activity, which is like seeing through the thinking and information process flow in one's mind. Electrodermal (EDA) measures the stimulus response reactions happening in the individual or organism and analyses the activity based emotional reactions. Electromyogram (EMG) picks signals that can read the facial reactions of the individual and relate it to subjective decisions. Devices or machines can store information in their memory, which can be also kept in backup for easy retrieval and use in case of any mishap or accident, such features enable the dependency on the machines for long term serviceability and use. Thus, the Short-Term Memory which is transient is mobilized to Long Term Memory, a permanent position (Umachandran, 2020). Application of such interventions make smart decisions without human intervention and keep progressing automatically the functions, to be more adaptive to new settings change, with increasing tolerance, easiness in use leading to higher production efficiency without any intervention. (Qinghui et al., 2015).

Cognition Amplification is the process of using Big Data, through a processed Algorithm, and then applying the change initiation of Cognition with a Correction and/ or Amplification, which results in control mechanism of the device or machine or gadget to make 1). Adjustment ie., making auto correctional measures and accommodating variations, 2). Resilience which is for coping up with adversities or unexpected changes and finally 3). Recommendations in such a way facilitating people to overcome their disabilities or in general the Human Deficiencies. This discomfiture can encompass Attention difficulties, Memory facilitations, and offer support in Processing Skills (Umachandran, 2020). Cognitive learning can be implemented only by involving a deeply dependent cognitive knowledge base and learning engine to facilitate deep learning imitating a human brain process. Cognitive computing when applied has extraordinary potential in both diagnostic and research settings, alongside challenges. The wide scope of advantages brings about helping, complementing, working on the quality and results, lessening the expenses of conveyance, and foster new comprehension of the processes and variability (Wang et al., 2016).

Preparation

The technological applications in education offers a level playing field for the students. Technology will be a valuable tool for transforming learning through strengthened relationships between educators and students, as well as revamped educational approaches that reduce gaps and accelerate the adaptation of learning experiences among learners. The technology role serves an increasingly diverse and dispersed learner to grow and evolve in various ways to enable the educational ecosystem with collaborative applications to systemic issues of access and affordability (US DoE, 2017).

Machine learning is a neural network of nature employing artificial intelligence and allows the system to automatically learn and improve based on its experience without being explicitly programmed. In this case, the machine learns and performs tasks without the need for any additional programming. It is a linear perceptron with

Interactive data inputs and processing as included in Graphs, Maps, or Charts. ML associates with features such as Modelling, Timing, and Deployment. While its data mining happens through Algorithm, with hyper parameters such as Learning rate, Epochs, Momentum, Regularization constant, decision tree, Classification Regression for predicting Label or quantity, Time Series, Cluster Analysis, and Anomaly detection. Finally, there is a chat bot which either or both Voice and Text enabled (Umachandran, 2020). Machine Learning technologies are taking a great leap to use data in work and achieve a competitive advantage that gives the systems the ability to learn from data. From spam filtering in social networks to self-driving cars, companies such as Tesla, Facebook, Amazon, Microsoft, and Google are having great opportunities to hire specialists in these areas. Data scientists combine principles, applications, tools and algorithms understanding the random data clusters, generating volumes of data that are difficult to monitor, store them for modelling and data warehousing to track applications that guide business processes towards organizational goals. Multiple layers of deep abstraction offer gains in learning to offer solution even on composite pattern recognition glitches (Nielsen, 2018). Like ML, Deep Learning is also an artificial neural network, but with multiple layers of network, which functions by non-polynomial activation and hidden layers of unbounded width. It uses more bioinformatic inputs such as Vision, Smell, Speech, Sound, Touch and Taste. These inputs are called higher level features with sensory Inputs which get recognized, probabilistically analyzed, and translated. To provide these inputs various sensors are used. The string of hardware connectivity is the pertinent one for the success of deep learning. The connectivity components are Sensors, Transducers, Binary converters and IoTs interconnecting the devices or machines. Sensors such as for Vision include Image CMOS where CMOS is complementary Metal Oxide Semiconductor which is Monochrome or Colour. Smell sensors are Volatile Calorimeter, Infra Spectrometer, Gas Chromatography, and Mass Spectrometer. Speech sensors are either speaker dependent or independent. Sound sensors capture Acoustic, Pressure, and Amplitude. Touch sensors are either Capacitive or Resistive. Taste sensors include Chemical, or Microbial, or pH, and Titration (Umachandran, 2020).

Predictive and prescriptive analytics

The selection of data to infer as information is critical. It should be devoid of biased choices and unimplementable or poor outcomes; sensibly manipulation of the environment can improve situations to become advantages through relations or conditioning (Hossein, et al., 2020). Hence predicting and prescription analysis are vital in deep learning. Predictive causal analytics use models to derive forecasts that anticipate the results of different activities in quantifiable terms dependent on the comprehension of things to come move. Prescriptive Analysis: This sort of analysis assists organizations with defining their objectives by endorsing the activities which are probably going to succeed. Prescriptive analysis inferences from the predictive model and suggests the optimal ways for achieving the goals. Both these methodologies utilize a wide exhibit of data-oriented advancements including Python, Hadoop, and R etc. to extensive statistical applications such as distributed architecture, data visualization, and analysis extracting meaningful outcomes from the datasets. AI and ML skills for specific requirements to predictive reporting and pattern discovering. AI enables machines to reason and teach machines from previous experience, feed information and auto correct natural language processing (NLP) and deep learning (DL) to identify inferences and patterns. ML Predictive Reporting uses algorithms for transactional data to derive authentic predictions. These are supervised learning models implemented to guide effective courses of action. While the ML Pattern Discover sets the business parameters from various reports as an unsupervised learning in the absence of pre-decided parameters by clustering.

Recurrent neural networks (RNNs) permit the components in the network to continue to change in a powerful manner, where the behavior of hidden neurons is simply not determined by past hidden layers, however by the enactments which occurred at before events. Hence the activations of hidden and output neurons get stimulated not simply by the prevailing input to the system, but through extra inputs. RNNs were challenged by models that became very hard to train, due to the instability in the gradient problem, where the manifestation of the problem gradient is gradually smaller as it propagates through the layers. The problem worsens in RNNs, as the gradient in backward propagation doesn't happen through layers, but over a period the network operates for quite some time that could trend an inclination incredibly inconsistent and difficult to study from. However, in long short-term memory (LSTMs) units it gets addressed with the unstable gradient problem, to get good results when trained with RNNs (Nielsen, 2018).

Cognition Amplification is a transhumanistic Human to Machine Interface. We generalize that people are superior to machines, but with such an intent to create products which can be integrated with their intelligence functions

akin to human beings is quite a challenging task. Evolution includes the body and brain, along with the Information and cognitive capacities, which are extraneous, and rely on continuous evolution for immense advancements. However intelligence-gap amid the user expectations and the machine/gadget requires complete harness of the technology-cognition-information layer, preparing the device with attentive intelligence to understand, comprehend and perform in real time (Niforatos, et al., 2017). Cognition through machine learning has both right and wrong actions that need to be predicted in advance and programmed into the machine. The logic of right is when programmed improves the delivery, productivity and quantitative benefits the user. The wrong is to devoid the device to stop its performance and correct based on the Know-what, and feedback inputs. Additionally the cognition amplification and correction through deep learning also expects to use its learned intelligence to offer novelty in its delivery by overcoming constraints and challenges through upgrades, creativity, and innovation, on its own (Umachandran, 2020).

ML Algorithms

Algorithm is a computation of Mathematics and Science using Algebra, Spatial measurements, metrology inclusive of mensuration, and finally bioinformatics. All these inputs shall be in different formats such as aggregate data, or from computational analytics, or value-added enriched data, as well as from an informed decision (Umachandran, 2020). Cognitive enhancement is diverse in forms and implications based on the technologies for authenticity, decent life, and the contribution in our lives (Bostrom et al., 2009). Decision making is at time cannot be justified with rationalism; it also includes suboptimal choices, based on the capability to leverage on the intangible concepts and lessen the complications through model evolutions, testing empirically, validating the understanding for accepting information towards decision making. Options and conveniences to utilize information and control the setting is the consistent outcome of the capacity to learn, adjust to new circumstances and work on ideas which are conceptual (Hossein et al., 2020). Notable ML tools are Naive Bayes, K nearest Neighbour, Support Vector Machine, Linear Regression, Decision Tree, Logistic Regression, Random Forest, Apriori, Hierarchical and K means Clustering.

DL Algorithm / Networks

Training the deep networks algorithms happen with workhorse learning, which is stochastic gradient descent through backpropagation. The different layers in deep networks learn at variedly different speeds, those get choked when later layers learn quickly, while the early layers fall behind. This slowdown in learning also occurs, when they are connected by use to the gradient-based learning techniques (Nielsen, 2018). Learning rubrics founded on mistake rectification, observation, and competitive learning are used in both supervised and unsupervised learning paradigms. A typical network on Layer feed-forward has various stages such as contribution, hidden, and layer of output with units that are linked in a feed-forward mode, either fully or locally, with no influences among units in the similar layers and no feedback influences among layers. Networks with Multilayer feed-forward has perceptron's with a computational unit employing thresholding function / sigmoid function, build arbitrarily complicated decision boundaries, express Boolean functions, and determine weights in a multilayer perceptron using the back-propagation learning technique.

Artificial Neural Network (ANN)

Though the human brain is significantly faster than any computer at tasks like pattern recognition, vision, and motor control, algorithmic modelling of biological neural systems was started to provide the ability to learn, memorise, and generalise for a variety of applications. Classification in ANN predicts the class of an input vector, Pattern matching produces the best pattern associated with the given vector, Pattern completion completes the missing parts of the vector. Optimization determines the best parameter values, and then a control action is proposed using function approximation based on times series modelling, relating the input and desired output vectors. Furthermore, data mining uncovers hidden patterns in existing knowledge (Kumamoto (2010). It employs some of the Boltzmann learning rule, which is a learning rule of stochastic type bringing derivations from principles which are information-theoretic besides thermodynamic; Hebbian rule, which is based on neurobiological experiment observations; and learning of Competitive nature, which clusters or categorizes the contributing datas on comparable patterns, which are automatically assembled and characterized as a solitary unit based on data correlations.

Conventional Neural Network (CNN)

This is a network of multilayer neural deep architecture learning that can be used in a change of computer vision and processing of natural language applications. CNN comprises of one or more blocks of convolution and layers of pool, tracked by one or more fully linked layers and performance layer. The CNN layer is the central feature, which contains the input and numerous learnable CNN kernels or filters for computing different feature maps. The model complexity is reduced by connecting respective units of the feature map to a receptive field in the earlier layers using an elementwise non-linear initiation purpose. Pooling decreases the number of parameters that must be calculated via network translation. This subsampling layer requires a minor area of the CNN output as input decreases it to an only output using pooling of max / min / average, and other techniques (Ghosh et al., 2020). CNN is prominent in vision tasks because it is created to routinely and modified learn spatial hierarchies of structures by backpropagation utilizing blocks of multiple building including CNN, pooling and fully connected layers (Rikiya et al., 2018).

Recrrent Neural Network (RNN)

RNN has small range of context that is impacted by hidden layers, either depleting or constantly blowing up exponentially as it cycles. The solution architecture is the Long Short-Term Memory (LSTM), which involves of a collection of repeatedly subnets / memory blocks which are connected in various versions housing many memory cells that are self-connected, as well as multiplicative three modules that provide constant similarities of read, write or reset of cell operations. Memory cells can stock and reach to data over long periods of time thanks to the LSTM multiplicative gates, which prevent the disappearing gradient tasks. When the input gate is shut, the cell's stimulation would not have any overriding impact by new contributions inward in the network and could thus be completed as an approach to the network, providing ample sequences by signalling the output gate (Tingwu, 2017). RNN is a predecessor LSTM neural network (Sherstinsky, 2020).

Generative Neural Network (GNN)

The GAN framework predicts an adversarial process with simultaneous training of two models at a time. GAN includes the distribution of data, estimated discriminatively the likelihood that a sample could be generated from the data which is trained instead of the distributed data. The training procedure, which is based on a two-player minimax game, maximizes the likelihood of trained data making a mistake. Backpropagation trains the entire system with multilayer perceptron. This is simple and does not involve Markov chains or networks of unrolled approximate inference throughout the training or sample formation. (Goodfellow et al., 2014). GAN is used in computer vision, featuring representation in Natural Language Processing (NLP) tasks involving Document Modeling, Dialogue Generation, Sentiment Analysis, and Domain Adaptation (Wang, 2017).

Deep Belief Network (DBN)

DBN is a training procedure of layer-wise, with numerous features in every layer raising since respective additional layer indicate on the log probability of data the lower bound variations, so the training is repeated multiple times to understand a deep hierarchy, since each layer provides excellent higher order correlations among the layer's featuring activities (Hinton, 2009). Back propagation involves labelled training data, however all data is unmarked, learning time doesn't quite scale well, is abnormally slow in multiple hidden layer networks, frequently resulting in unreliable local optima, less optimal deep nets, thus resulting in a MLP not a generative model, and therefore solution is Deep Belief Networks (GBN), is modelled on generative graphs. DBNs are generative networks, probabilistic in nature with several layers of hidden variables, each capturing correlations among the tasks with features hidden in the lower layers to form a directed network of sigmoid belief type via an undirected bipartite graph (Barnabás, 2017).

Long Short-Term Memory (LSTM)

Long Short-Term Memory networks are RNNs that can learn long-term dependencies. LSTM operates well with a broad variation of problems, which are obviously created to prevent the overt dependency as a long term issue. They take the form of a chain of repeating neural network modules with a single tanh layer. The cell state is similar to a conveyor belt that goes directly down and is strictly monitored by gates that optionally allow information to pass through a network layer of sigmoid neural and its operation becomes a pointwise multiplication (Staudemeyer,

2019). LSTM can model longer-term dependencies by using memory cells and gates to control information flow, as well as memory cells that are regulated by Forget, Input, Reset, and Output gates. These are gates of affine transformation with Sigmoid activation functions (Jeong, 2018).

DL framework

Deep learning frameworks offer either usability or speed, but not both (Adam et al., 2019). There are many deep learning frameworks available such as TensorFlow, scikit Learn, Theano, PyTorch, DL4J, Keras, Microsoft Cognitive Toolkit and Caffe,. As an illustration to coverage, some of the above are narrated below.

TensorFlow

TensorFlow is an end-to-end free-open-source-software (FOSS) for dataflow library, a framework with differentiable programming built on machine learning applications (Jian, 2020). The architecture contains a Simple Python API and Low-level core (C++/CUDA) defining the computational graph and High-level API (TF-Learn, TF-Slim, soon Keras…), The graph computed has auto-differentiation, C++ multithreading, simple multi-GPU/multi-node, device-efficient operation for various processes, graph does pipeline of the whole including loading, pre-processing, and prefetching of data (Vicky et al., 2017).

Theamo

With Automatic differentiation flexibility, the lasagne is well understood, saving on code when approaching new tasks. Implementation is quick with simple modifications of existing layers. To tackle issues like compiling time of big models, error messages are cryptic and sudden pops up requires smart solutions. Theano provides even lesser number of models, like batch size = 1, or fewer units per layer, or fewer layers. Theano is written on modular code with checks that are defensive, where even unit test covers everything, It also has debugging tools, but the limitation is that it has no prints (Vicky et al., 2017).

scikit learn

It is an open-source simple tool, quite selective on algorithms and uses graphical models or sequence prediction for predictive data analysis in various contexts, that are accessible and reusable. Scikit is built on NumPy, matplotlib and SciPy. It comprises classification, regression, clustering, dimensionality reduction, modelling and pre-processing (scikit, 2017).

PyTorch

This is an open-source ML framework which quickens the deployment path of prototyping till reaching upto production (Jian, 2020). PyTorch ML library that shows usability and speed as two goals compatible, by providing Pythonic programming with code support for modelling, easy to debug and has consistent computing libraries, efficient and GPU supported hardware accelerator. It is a program on Python with full user control (Adam et al., 2019).

Keras

Keras is a high-level neural network of Python API, applied with TensorFlow, CNTK, or Theano. This was created with the goal of facilitating quick experimentation (Jian, 2020). It has advantages such as an easy-to-use Python library, as well as the ability to wrap Theano and TensorFlow. Modularity, minimalism, extensibility, and Python-nativeness are among the guiding principles. It includes numerous user-friendly tools such as real-time data augmentation and call-backs via Tensor board visualization. Keras is starting to gain official Google support despite flaws such as limited flexibility, lack of RBM, and a multi-GPU that is not fully functional (Vicky et al., 2017).

Mathematics

Knowledge of mathematics covering the following, such as probability, statistics, linear algebra, calculus, and programming skills, is required in the personnel skills for deployment in Deep learning.

Probability & statistics

Probability is a measure of uncertainty or chances, while the Statistical inference is concerned with making inferences about characteristics of the probability measure. These inferences based on information is given by an observed outcome or response data. Applications for statistical hypothesis testing and statistical inference could be found in a wide diversity of arenas, which include biology, finance, business, marketing, psychology, medicine and social sciences. Particularly, such as the identification of differentially expressed genes in biology, the competence of campaigns or the modification of customer behavior in marketing, surgical procedures as well as medical care, or the efficacy of medicines and treatment methods in medicine, the impact of medications in pharmacology, or the evaluation of the effect of meditation in psychology, and so on. (Frank & Colleagues, 2019). The following methods such as Bayes Theorem, Probability Distribution, Sampling and hypothesis testing, have more prominence for application in deep learning.

Linera algebra

Computer scientists need to be exposed to Linear Algebra, which is based on continuous math rather than discrete, and very essential for understanding ML algorithms. Though there are many methods in linear algebra such as scalars, vectors, matrices, multiplying matrices/vectors, Inverse, Span, Linear Independence, SVD, PCA (Sargur, 2019). The important inputs on Matrices and Vectors are vital for deep learning. Linear algebra is concerned with vector spaces and linear mappings among such spaces. It comprises of the study of lines, planes, subspaces, and vector space properties. Characterize and function the sets of linear equations, especially suited to ML, and matrix data notions and formalisms through Linear Algebra (Abhinav et al., 2016).

Retrieved The fundamental theorem of calculus connects differential and integral calculus to compute area under a curve. The integral calculus applications in machine learning provides us with a metric to assess the classifier performance (characterized by both high recall and high precision, to detect many of the true events correctly), as well as the selection of appropriate performance metrics. Calculus in deep learning is to assess precision and recall. The proportion of correct detections reported is Precision model, whereas the proportion of true events detected is recall.

Programming – Python, R, C & Java

Basic skills in Python scripting is sufficient to perform enhanced DL research, Development of Theano and TensorFlow are two types of auto differentiation tensor-manipulation frameworks of Python, largely designed to simplify model implementation. Keras is user-friendly library which makes deep learning simple as interacting with LEGO bricks (François, 2018). In comparison with the traditional scripting languages, Python code is readable, reusable, and maintainable, making it simple to understand and write. Furthermore, Python supports object-oriented programming (OOP) (Mark, 2009). Scikit-Learn is a popular open-source Python tool that includes a large library of DM/ML algorithms (Nguyen et al., 2019). Java applets are for animations creation, presenting multimedia's, gaming through real-time videos, networked games with multi-user access, and real time on Java Web pages interactions. Applets are a significant step beyond classic Web design because they can be downloaded from the internet and performed by a browser within a Web page supported by Java. Furthermore, programming skills in R and C++ add value to deep learning.

Conclusion

Deep Learning technologies have more potential to significantly augment cognition and assist in the role of continuous evolution to cater to human inability such as attention, thinking and memory expectations. The collection and processing of information when influenced by technology and the communication systems greatly influence the way of transfer and consumption of information, disrupting the entire human cognitive methods like attention, observing, learning, memory, decision making and problem solving. The deep learning technologies and the IoT hardware of sensor-transducer-binary converters, can handle more information which human brains are still unprepared to handle. Based on the volume of information from various sources, and human difficulties, disorders and abnormalities such as attention deficit, multi-tasking difficulties, learning acumen, lack of sleep, weak memory, and lasting stress, impose the necessity for widened inclusiveness and offers options for the pervasive technology to

improve quality of life, and realize full potential of its use. Additionally, unlike human beings, deep learning technologies do not have the attribute of improving general health to achieve cognition-enhancing effects or distracters which directly impair conditions requiring rest or immune function development or even exercise for that matter.

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A conceptual e-health readiness assessment framework for students in higher education

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Abstract: Healthcare extends across all races, genders, ages, culture as well as geographical boundaries. Therefore, as a concern to all, to promote general development in developing countries, their healthcare needs should be tackled. This can be tackled by using modern information and communication technology (ICT) such as e-health to deliver health services to patients with limited access to care. However, readiness for e-health should be assessed first in developing countries. Although several articles have been published on e-health readiness assessment frameworks, existing e-health readiness assessment frameworks and tools have not been found to be entirely suitable for assessing e-health readiness in developing countries. Therefore, this paper proposes a context specific e-health readiness assessment framework that could be used in developing countries.

Keywords: Context, E-health, Framework, Healthcare, Higher education students, Readiness, Student

Introduction

Healthcare extends across all races, genders, ages, culture as well as geographical boundaries. Therefore, as a concern to all, to promote general development in developing countries, their healthcare needs should be tackled (Li, Land, Chattopadhyay & Ray, 2008). Developing countries have a problem of healthcare issues such as infectious and chronic diseases, lack of basic healthcare programmes, facilities as well as a shortage of skilled healthcare workers (WHO, 2006). These problems result in poor healthcare, which inhibits developing countries' prosperity and business profitability hence directly affecting the mortality rate of inhabitants of these countries (Li, et al., 2008). However, due to healthcare provider's recent movement to making sure they use modern information and communication technology (ICT) to deliver health services to patients with limited access to care, there has been a massive use of electronic and wireless technologies (Bervella & Al-Samarraie, 2019). These technologies, such as electronic health (e-health) help to manage, distribute, and share health-related information that resulted in new opportunities for patients in developing and developed countries (Bervella & Al-Samarraie, 2019). The application of e-health systems has been reported by previous studies as an effective platform in advancing healthcare services, and one of the key solutions is to aid healthcare practices (De La Torre-Díez, López-Coronado, Vaca, Aguado & de Castro, 2015).

Electronic health, shortened e-health, is a generic umbrella term referring to the use of information communication and technologies in health-related services and processes (Austrian Federal Ministry of Health Telemedicine, 2019). Furusa and Coleman (2018) also agree that the e-health concept operates in the field of medical informatics. Similarly, Busagala and Kawono (2013) also state that e-health is defined as a combination of the healthcare system

and the use of ICT to allow better health and healthcare. Put simply, World Health Organisation, WHO (2016) defined it as using ICT for health purposes. It is used worldwide and includes the use of various applications such as telemedicine related services, electronic health records, as well as electronic medicine overview (Blaya, Fraser & Holt, 2010). Mugo and Nzuki (2014) also alludes to the fact that it aims to deliver health services and information by means of the Internet and related technologies both at a local site and over a distance. In difference, Qureshi and Shah (2013) state that e-health is any electronic exchange of health information within the health sector. Similarly, Mugo and Nzuki (2014) stated that it involves several actions that use electronic means to provide health-related information, resources as well as services. Furusa and Coleman (2018) also alluded to the fact that it is viewed as the integral infrastructure that forms the foundation of information exchange amongst users of the healthcare system and is a means for improved health outcomes for all. Other authors explained that it entails the electronic processes as well as communications that support and enables healthcare practices (Oh, Rizo, Enkin & Jadad, 2005). According to Bennani, Belalia and Oumlil (2008) and Kamsu-Foguem and Foguem (2014), e-health leads to a new vision in the health system due to its improvement in cost reduction, decreasing inaccuracies, and information quality. Its main objective is to improve different medical and healthcare services despite barriers such as geographical and economic factors (Geissbuhler, Bagayoko & Ly, 2007; Hussein & Khalifa, 2012).

From various researchers, the notion of e-health can be seen as the use of various ICT forms to improve the delivery of services by the healthcare sector for the betterment of patients' health. This study adopts this definition throughout. Using e-health is increasing rapidly, and it is widely accepted as an important element which supports and sustains the challenges of delivering healthcare services, clinical decision-making, patient safety, curbing of increasing health costs, efficiency, supporting research and ultimately improving healthcare (Maunder, Williams, Walton, Ferguson, Beck & Probst, 2014). However, the potential of e-health goes past supporting the already burdened healthcare system; it has the potential of contributing to health-related behaviour modifications and also improving healthcare accessibility to both rural and remote populations (Alkhaldi, Sahama, Huxley & Gajanayake, 2014). South Africa is not left behind in taking advantage of the potential of e-health. It was seen as the leading country of Sub-Saharan Africa to implement e-health technologies for various health interventions (Bervella & Al-Samarie, 2019). However, there are several factors to be addressed in effective implementation of e-health in South Africa, such as assessment of e-health readiness and many more. Therefore, this paper presents a conceptual framework that can be used to assess e-health readiness in higher education, taking into consideration the issue of context. The rest of the paper is as follows: Background and Context, Research Motivation, followed by Problem statement, Research questions, Literature review, Theoretical framework, Conceptual framework, Methodology, Significance of the study, and Conclusion.

Background and context

It is worth situating the descriptions that define South Africa where this study will be carried out in the broader configurations. Geographically, South Africa is located in sub-Saharan Africa (Howell, 2019). The country is specifically located on the southern tip of the African continent. It shares borders with its northern neighbours Namibia, Botswana, Zimbabwe, and Mozambique (Education South Africa, 2020). South Africa covers a large area of 1 221 040 square kilometers and is home to some 59.3milion people as of Saturday, August 15, 2020 (Worldometer, 2020). In terms of the race, almost 77% are black or African, 11% white and 9% "coloured", a term used as a local label for people of mixed African, Asian and white descent (Education South Africa, 2020). South Africa has 11 officially recognized languages being Sepedi, Sesotho, Setswana, siSwati, Tshivenda, Xitsonga, Afrikaans, English, isiNdebele, isiXhosa, and isiZulu (Education South Africa, 2020). The languages are spoken across the nine provinces of South Africa which are namely Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumulanga, Northern Cape, North West, and the Western Cape.

With regards to e-health, which is at the core of this study, South Africa is regarded as one of the leading countries in Sub-Saharan Africa in terms of implementations of e-health (Bervella & Al-Samarie, 2019). South Africa started putting healthcare reforms as a priority area on the country's development agenda at the end of apartheid in 1994 (Burger & Christian, 2018). Progressive policies that reformed the centralized, healing and hospital-based public healthcare system were put in place to promote access to affordable primary healthcare (Black, Siebrits & Van der Merwe, 2011; Van Rensburg & Engelbrecht, 2012). Despite these efforts by the government to improve access to

healthcare for all by expanding healthcare facilities and user fees for primary health care, South Africans were still faced by challenges of health outcomes remaining polarized, unequal and unfair (Ataguba, Akazili & McIntyre, 2011; Ataguba, Day & McIntyre, 2014; Marten, McIntyre, Travassos, Shishkin, Longde, Reddy & Vega, 2014; Sahn, 2012). South Africa's healthcare transformation results remained disappointing compared to those of peer countries (Burger & Christian, 2018). In response to these, the government of South Africa released a white paper on national health insurance (NHI) (Burger & Christian, 2018). The NHI was to improve the quality, equity, poor performance, and coverage of the healthcare system in the country.

Although the white paper on NHI was developed, South Africa 's health system is still faced with some challenges. In an article that appeared in *Sunday Times* on 25 March 2012 titled ('Public hospitals in Gauteng sick and tired'), it was stated that hospitals were under a lot of problems as doctors, nurses, and patients were battling with shortage of linen, medicine, and food as well as broken equipment. Additionally, the article stated that there was a problem with flooded theatres and no functional telephone lines (Bailey, et al., 2012). It is within this context that, like any other developing or developed country, access to quality healthcare services has been getting attention from governments hence the proposal of implementing healthcare systems centered around technology (Furusa & Coleman, 2018). In terms of "networked readiness" which is, in short, an evaluation of the impact of ICT's at a global level and to benchmark the ICT readiness and usage in a country's economy, South Africa was rated 65th out of 139 countries in 2016 which was high compared to other African countries (Healthenabled.org, 2019; Bilbao-Osorio, Crotti, Dutta & Lanvin, 2014). Furthermore, South Africa has strong policy and regulatory, business, and innovative environments, but it rates poorly in terms of affordability, infrastructure, and skills (Healthenabled.org, 2019). Additionally, it has impressive cellphone penetration but has expensive fixed lines and mobile broadband (Healthenabled.org, 2019). However, South Africa started aiming at improving healthcare services through the concept of electronic health (e-health) systems by analysing its potential role (Weeks, 2012).

Research motivation

The use of technology by students in South Africa has been demonstrated in different studies (Oyedemi, 2012; Shambare, 2014; Makura, 2014; Thinyane 2010). However, research on e-health, e-health readiness, and e-health readiness frameworks on higher education students' need to be done. Several studies on e-health have been done in South Africa (Coleman & Coleman, 2013; Fanta & Pretorius, 2018; Coleman, 2010). For example, a study by Coleman and Coleman (2013) was to compile a Provincial E-health Framework (PEHF) based on the feedback from electronic healthcare readiness assessments conducted in selected rural and urban hospitals/clinics in the North West Province in South Africa. Another study done on e-health in South Africa by Fanta and Pretorius (2018) focused on developing a conceptual framework for sustainable e-health implementation in resource-constrained settings. Furthermore, Coleman and Coleman (2013) investigated the different e-health readiness assessment models applied in health institutions of the North-West Province of South Africa. However, these studies focused on developing e-health readiness assessment frameworks or models with a focus on hospitals/clinics. The problem is that the end users, which are patients (higher education students) have been neglected in developing frameworks that assess their e-health readiness in South Africa.

Higher education institution students are used in this study as the target population in South Africa because they are convenient to reach out to by the researcher in this COVID-19 era. Additionally, several studies have been done on students with regards to different aspects of information technology such as technology use or technology adoption or technology readiness (Moate, Chukwuere & Mavhungu, 2017; Mavhungu, Chukwuere & Gorejena, 2018; Ntseme & Chukwuere, 2017; Chukwuere & Chukwuere 2017). These studies are proof that research relating to information technology can be conducted on students as they are digital natives, fond of using information technology products and initiatives and are also familiar with web 2.0 technologies. In terms of e-health, studies on e-health adoption,acceptance and literacy by students have also been done in different countries (Feuk, 2018; Gurkan & Ayar, 2020). Additionally, in Saudi Arabia Students were generally familiar with telemedicine and electronic health records (Jabour, 2021). With the current pandemic of COVID-19 where there is movement restriction everywhere in the world, higher education institution students use online learning as a mode of learning hence most could also be using e-health initiatives to get medical assistance from various medical personnel and facilities. Using the student population enables the researcher to get opinions from a diverse group of individuals

who are natives of South Africa and other countries of the world. Furthermore, the student population narrows down as possible patients or receivers of the healthcare system services as all people in South Africa are somewhat receivers of the healthcare system services hence, they qualify to be part of the study. Additionally, this study will be carried out because existing e-health readiness assessment frameworks and tools have not been found to be entirely suitable for assessing e-health readiness in developing countries (Mauco, Scott & Mars, 2019).

Problem statement

Several researchers have come up with different e-health readiness assessment framewoks (Campbell, Harris & Hodge, 2001; Jennett, Jackson, Ho, Healy, Kazanjian, Woollard, Haydt & Bates, 2005; Wickramasinghe, Fadlalla & Geisler,2005; Mauco, Scott & Mars, 2019; Kalema & Kgasi, 2014). Although these researchers provided e-health readiness assessment frameworks, there is a problem of the absence of an e-health readiness assessment framework found to be "entirely suitable" for assessing e-health readiness in developing countries. Meaning that the already developed frameworks lacked to address issues of context, which this study fills by catering for the setting of South Africa and all the different aspects such as culture, language, political, economic, social and the political landscape they live in, which may influence or affect the e-health readiness of higher education institution students who live in South Africa. This study, therefore, fills this gap by developing a conceptual framework which is a context-specific e-health readiness assessment framework. The framework will find determinants of readiness for e-health especially in higher education institution students.

Research questions

The primary research question is;

1. How should a context specific e-health readiness assessment framework for students in higher education be developed?

The secondary research questions are;

1. How do PEST factors impact e-health readiness of higher education institution students?
2. How does the e-health readiness of the higher education institution students relate with their demographic factors?
3. How do technology acceptance factors impact the e-health readiness of the higher education institution students?
4. How does technology readiness factors influence the e-health readiness of the higher education institution students?

The following objectives were derived

1. To determine how political, economic, social and technological (PEST) factors impact e-health readiness of higher education institution students
2. To establish how the higher education institution students' e-health readiness relates with their demographics
3. To determine the way technology acceptance factors impact the e-health readiness for higher education institution students
4. To determine how technology readiness factors influence the e-health readiness of the higher education institution students

Literature review

This section provides a critique of existing frameworks in order to show gaps that this study will address. The framework of Khatun, Heywood, Ray, Hanifi, Bhuiya and Liaw (2015) called a framework for mobile health addressed the technological, motivational, and resource readiness, however, the authors did not cover any language or political factors. On the other hand, the framework of Campbell, Harris and Hodge (2001) called the readiness evaluation framework for e-health applications to investigate multiple healthcare providers' view, differed in the sense that it dealt with readiness for implementing e-health strategies on healthcare providers' view, thereby neglecting organizational, public or patient readiness for e-health. The framework of Jennett, Jackson, Healy, Ho, Kazanjian, Woollard, Haydt and Bates (2003) and Jennett, Yeo, Pauls and Graham (2004) called e-health readiness framework is comprehensive in terms of the scope it covers. Its target is e-health readiness framework for patients,

practitioners and the public. However, the framework provides little information with regards to demographics or current technological practices.

The framework of Wickramasinghe, Fadlalla and Geisler (2005) name an e-health readiness framework, touched on culture, technological access, economy, political factors as factors affecting a country's readiness to harness the most from using e-health. However, the framework did not assess the impact of native languages on a country's readiness for e-health. Mauco et al. (2019) framework, named an informed e-health readiness assessment framework addressed the governance, resources, stakeholder issues and access as the themes that could assess readiness. However, in this framework, issues of language and education were not addressed. The framework of Ntseme, Jokonya and Chukwuere (2020) named an e-health technology readiness and acceptance model, addressed the technology readiness factors and the technology acceptance factors. However, it failed to address the political, social, economic and technological factors, explained further in section 8 which forms part of the context that influences individual's readiness towards a technology (Ejiaku, 2014; Kipsoi, Chang'ach & Sang, 2012). The framework also did not take into account demographics such as age, gender, language, and academic level as some of the factors that should be taken into account when accessing e-health readiness (New African, 2008; Kutlu & Ozturan, 2012). However, the framework of Ntseme et al. (2020) provides a good basis for this study.

The critique of the existing e-health readiness assessment frameworks demonstrates that most of these studies dwell much on the components of their frameworks reflecting perspectives on healthcare providers and organizations, thereby ignoring the development of frameworks that are tailored to assess individual readiness of end-users (patients), which in this study are higher education students since they are also the receivers of healthcare services. Additionally, these frameworks do not take into account the political, economic, social, and technological factors affecting individuals' readiness for e-health in developing countries such as South Africa.

Theoretical framework

Many information systems theories and models exist such as the Technology, organization and environment (TOE), technology acceptance model (TAM), Theory of Planned behaviour (TPB), Social shaping of technology amongst others. However, in this paper this section discusses the theoretical frameworks that are specifically selected to guide this study. These are the technology readiness index by Parasuramanan (2000) as well as the technology acceptance model by Davis (1993). In terms of adopting these models, the technology readiness index has been used as a whole and in TAM, only the constructs of perceived ease of use and perceived usefulness have been adopted.

Technology acceptance model (TAM)

Venkatesh, Morris, Davis and Davis (2003) posits that the technology acceptance model (TAM) is a model which was developed to use in the information systems context. The model's aim is to predict acceptance and usage of an information technology. It uses system design features (SDF), Perceived usefulness (PU), perceived ease of use (PEU) and attitude towards using (ATU) as the factors that influences user's intention to adopt and use an information system (Davis, 1993).

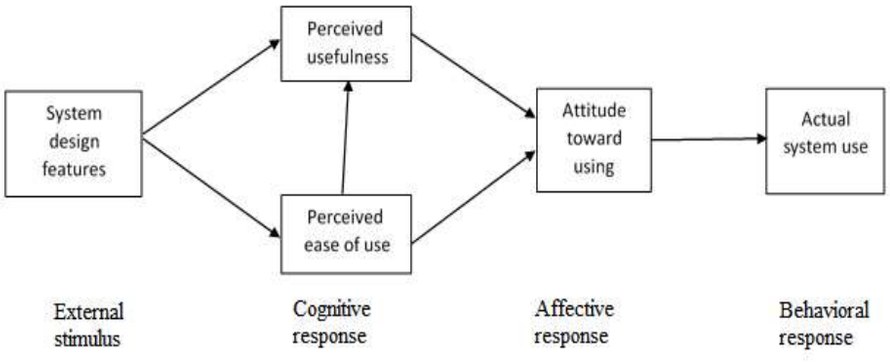

Figure 1: Technology acceptance model (TAM)
Source: Adopted from Davis (1993)

Technology readines

Technology-readiness refers to "people's propensity to embrace and use new technologies for accomplishing goals in home life and at work" (Parasuraman, 2000: 308). Basically, it means an individual's state of mind that is caused by the enablers and inhibitors which determines an individual's position to use any new technology. Dimensions included in this model include optimism, innovativeness, discomfort and insecurity. Whereas optimism and innovativeness are enablers of technology readiness, discomfort and insecurity are inhibitors to technology readiness.

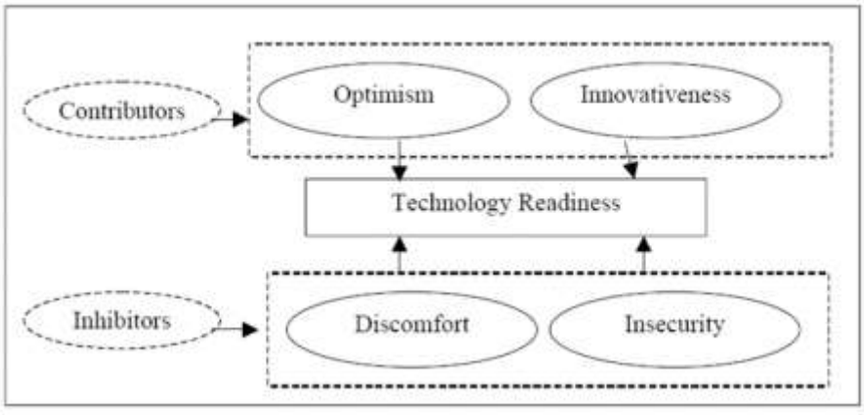

Figure 2: Technology Readiness
Source: Adopted from Parasuraman (2000)

Conceptual e-health readiness assessment framework

The study benchmarks on the information systems theoretical frameworks such as Parasuramanan (2000), and Davis (1993) as the basis to develop the e-health readiness assessment framework for a developing such as South Africa. Li, Ray, Seale and MacIntyre (2012), and Rezai-Rad, Vaezi and Nattagh (2012) recommended the importance of considering the context, while developing a model for e-health assessment in developing countries. According to Lexico.com (2020), context means circumstances forming part of a setting for an event, statement, or idea, and in terms of which it can be fully understood and assessed. Therefore context in this study means considering the setting in which this study is conducted, this meaning to cater to all the different aspects that affect people living in South Africa such as their culture, language, and the political landscape they live in when developing a model for e-health readiness assessment. In designing the conceptual framework of this study, from the TAM, this study adopts the themes of e-health perceived ease of use and e-health perceived usefulness. From the technology readiness index all the themes are adopted. New themes that covers the context aspect of this study are demographics, political, economic, social/cultural and technological (PEST) factors. There are in the model as part of the themes that can also determine readiness of end-users (higher education students) and are therefore added in the e-health readiness assessment framework for this study.

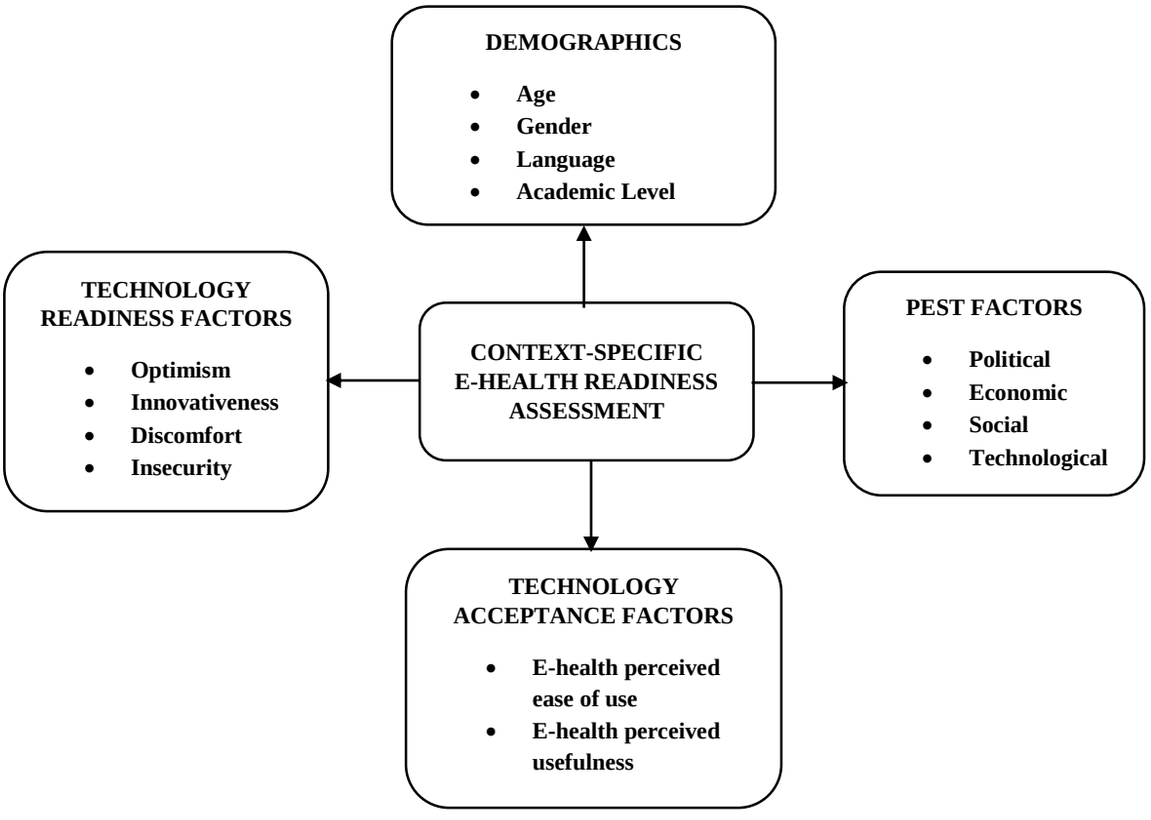

Figure 3: A context-specific e-health readiness assessment framework for patients
Adapted from Parasuramanan (2000); Davis (1993) and Ntseme et al. (2020)

Demographic

Age

Age plays an important aspect in technology readiness, adoption, and acceptance, especially in developing countries where the younger generation is technologically oriented and the older are less technologically oriented. In this study, age is defined as the length of time a person has lived from the time they were born. In the study of Kutlu and Ozturan (2012), age was seen as a significant factor that had an impact on online application usage, which is closely related to e-health technology in the way they are accessed (accessed online through the use of the Internet). The age group found to be using the online applications the most were those less than the age of 35. Although age cannot altogether hinder technology readiness, acceptance and adoption (Friederike, Maria, Andrea & Angelika, 2017), in this study, age is a determinant of readiness for e-health by higher education students.

Gender

This is defined as a personal attribute divided into male and female. It this research it may direct higher education students' consciousness and actions towards e-health readiness.

Language

Language is one other important aspect that must be considered when developing an e-health readiness assessment framework for developing countries. In this study, it is defined as a system of communication by a particular community or country. The use of African languages is an important aspect of technology (New African, 2008). Hence for every community to develop in science and technology, the use of a mother tongue, which affects the way individuals think, think of the world, and interact with others, should be taken into consideration (New African, 2008). In South Africa, 11 official languages are spread across nine provinces (Fawareh, 2013). The choice of being ready for e-health may be affected by the availability or the unavailability of indigenous language in the e-health technology, hence when assessing the e-health readiness, the issue of language must be considered in developing countries. Hence the inclusion of language in this study.

Educational Level

In this study, educational level is defined as the highest qualification obtained by an individual. According to Friederike et al. (2017) educational level of an individual enhances their positive attitude towards technology. A study by Kutlu and Ozturan (2012) alluded that education level had a unique effect on online application usage, which is related to e-health in the way they are accessed by users through the use of the internet. In developing countries, these could be the case where the level of education improves an individual's chances of being ready to use technology. Therefore, in this study, the level of education is also seen as one factor that must be looked at when one assesses the e-health readiness of higher education students.

Political, Economic, Social and Technological (PEST) factors

Political

This study adopts the definition by Friederike et al. (2017), that political factors are the policies, actions, and legislation that the government uses to guide their citizens. Therefore, the political factors provide an environment that guides citizens in acquiring access and the use of technology therefore adopting it (Ejiaku, 2014). In developing countries, research shows that there are weak or poor policies on innovative technology (Ejiaku, 2014). In this study, the political factors therefore mean the policies that have been put by the South African government to guide their citizens hence enabling them to acquire or not to acquire technology thus leading to their readiness for e-health and eventually leading to them adopting the technology.In a study carried out in Kenya by Tsuma (2011), Political interest was linked to the increase and educative role of information communication technology. Furthermore a study by Dana, Mehmood and Matloub (2021) explored the motivators of technology adoption in healthcare. In their study, they found out that government support was found to be the most relevant group of motivators to technology adoption practices in the healthcare sector in the United Arab Emirates (Dana et al., 2021).

Economic

Economic factors also affect an individual's readiness for e-health. Kipsoi, Chang'ach and Sang (2012) explained it as monetary issues that affect the buying power of an individual in terms of satisfying buying expectations. Therefore, the more the money, the more buying power and the lesser the money, the less the buying power of individuals. A study by Dana, Mehmood and Matloub (2021) indicated at that United Arab Emirates, financial support and international trade were the most influential in adopting the latest technologies in the healthcare sector. Therefore, in this study, economic factors are linked to the buying power of individuals to purchase technological gadgets that could be used in accessing e-health services, such as mobile phones to receive mobile health updates as well as purchasing tablets to allow them to consult with medical personnel over a distance.

Social/Culture

According to Friederike et al. (2017), social factors influence the adoption of technology by individuals. This influence comes in the form of societal as well as natural changes that are within an individual's environment. In this study, the social attributes such as cultural believes of an individual affects the perception and the readiness for e-health by individuals as culture forms an integral and guides social factors in developing counties.

Technological

These factors refer to the level of innovation, technological change in an environment that one lives in. When there is access or no access to technology around individuals, these may affect the individual's readiness for e-health initiatives. A study by Dana, Mehmood and Matloub (2021) found that in the United Arab Emirates, infrastructure motivated the health information technology adoption practices. Hence this factor should be considered when developing an e-health readiness assessment framework for higher education students in South Africa.

Technology readiness factors

Optimism

Optimism in this study means higher education students having a positive view of the e-health technology and believing that it will offer them increased control, flexibility and efficiency in their everyday life. With this view, Higher education students' optimism for e-health may affect their e-health readiness. Hence this factor must be taken into account when assessing the e-health readiness of higher education students.

Innovativeness

In this study, innovativeness means the tendency of higher education students being pioneers and leaders when it comes to using and accepting e-health technology in their everyday life. With this view, Higher education students' innovativeness for e-health may affect their e-health readiness. Therefore, this factor must be taken into account when assessing the e-health readiness of higher education students.

Discomfort

Discomfort in this study means higher education students having negative feelings towards the e-health technology in a way that when they use it, they have less control over it and become overwhelmed by the technology thereby using it less. Therefore, this factor must be taken into account when assessing the e-health readiness of higher education students hence its inclusion in the e-health readiness assessment framework.

Insecurity

In this study, insecurity means higher education students having challenges trusting the ability of e-health to work properly. This means the distrust they have on the functionality of e-health, hence finding it difficult to be ready for e-health. Therefore, this factor must be taken into account when assessing the e-health readiness of higher education students.

Technological acceptance factors

E-health perceived ease of use

In this study, E-health Perceived ease of use means higher education students' perceptions on the degree of effort needed to use e-health. That is, the difficulty to use e-health technology. This may affect the readiness to use e-health by higher education students hence including it as a factor in an e-health readiness assessment framework.

E-Health Perceived Usefulness

In this study, it means higher education students' perceptions on the relative advantage offered by e-health services as compared to the traditional ways of offering health services. This factor plays an important part in assessing the readiness of higher education students for e-health hence it must be included as one of the factors in the e-health readiness assessment framework.

Methodology

There are different philosophies such as positivism, critical realism, interpretivism, postmodernism, and pragmatism (Saunders, et al., 2016). This study will follow a positivism philosophy because it allows researchers to work with an observable social reality and also produce law-like generalisations. A inductive approach to theory development will also be followed to allow the researcher to develop a theory. The methodological choice in this study is therefore a mono-method quantitative study. This is because quantitative research generally associated with positivism philosophy. A survey strategy will be used to collect data from students using online survey in a cross sectional basis. A survey method is seen as an appropriate method to use because it is suitable for studies where the unit of analysis are individuals (Bhattacherjee, 2012).

Data collection techniques in this study include the use of primary and secondary data. Primary data will be collected using an online survey questionnaire. The questionnaire will be done on a self-completion basis by the students (Shambare, 2014). Similar to a study done by Alanezi (2020) this study's designed questionnaire will be accessible to students through the web,social media platforms as well as other digital platforms that are in the public domain. This also takes into consideration the current covid19 pandemic where minimal contact with people is adviced. Secondary data, on the other hand, will be acquired through a literature review from published sources that are seen as relevant to the study. In this study, the target population is 58,687 students from higher education institution in South Africa. Therefore based on Krejicie and Morgan (1970)'s sample determination table, a sample of 381 higher education students will be administered this research questionnaire.

This population is appropriate to use for this research as it has students coming from cities, semi-rural and rural areas thus making the research population representative of the diverse nature of the South African student population. However, the use of students as the target population of this study has also been justified further in

section 3 of this paper. Convenience sampling will be used to get data from a sample of students because it allows a researcher to gather information from individuals in a population who are conveniently available to provide it (Serakan & Bougie, 2013). In terms of data analysis, the researcher will apply statistical package for social science (SPSS) and Microsoft Excel to analyze the collected data. Data analysis will be done using descriptive and inferential statistical techniques through tables, frequency counts, percentages and correlations.

Contribution and significance of the study

This research will provide useful information on a context-specific e-health readiness assessment framework that can be used to assess the e-health readiness of students in higher education in a developing country such as the students in higher education institutions in South Africa to different stakeholders. Furthermore, the results of this research could be used by health care service providers and the government of South Africa as well as developers of e-health initiatives to make informed decisions on the implementation of e-health initiatives from patients (higher education students) point of view hence it will aid in avoiding the issue of failure to innovate after introducing the e-health technology to the student community.

In the field of information systems, this research provides insights on the context-specific factors affecting the e-health readiness of students in a higher education institution in South Africa. The research also adds knowledge to the research community by also reducing the disjointed research on e-health in developing countries as little research has been done on the development of e-health readiness assessment frameworks for higher education students who are treated as end-user of e-health in a developing country context such as South Africa. Other researchers could use the information from this research and do more research on e-health and extend it to do research on digital health.

Conclusion

To promote general development in developing countries, their healthcare needs should be tackled. This can be tackled by using different e-health initiatives. However, the readiness for e-health in developing countries should be taken into consideration first before rolling out any e-health initiative. Literature shows that existing e-health readiness assessment frameworks do not entirely focus on patients readiness for e-health and also lacks to address the issue of context in developing countries. This study therefore proposes a conceptual e-health readiness assessment framework which can assess readiness for patients (higher education institution students) taking into consideration the issue of context. Future work looks at operationalizing the framework, firstly by collecting empirical evidence to support the role and existence of these elements in higher education institutions in South Africa. Secondly, the framework needs to be used by developers of e-health systems.

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Theme 2:

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STEM education in ancient Mesopotamian period: Looking through few Mathematics Problems

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Abstract: This paper attempts to see mathematical teaching situations through few selected problems of Babylonian period which were worked out by other researchers. Thus, it was possible to relate present day situations both at colleges and in the construction fields. As mathematics is basic science and Sumerian – Babylonian contributed place value number system for future development of science, the study shows a streak in the past education system.

Keywords: Babylonian, Cuneiform, Diagonals, Mathematics, Square root

Introduction

George (2005) sees that edubba literature of Sumerians reflect the educational practice of the period of the king Sulgi reigns and his successors; he quotes Sulgi writing that for all eternity the edubba was never to change and for all eternity the place of learning was never to cease functioning. He, also notes that the kind of education of those periods spread out to other crafts and became traditional, all over the world. The quality expectation in edubba were very high with constant supervision, training, overseeing, rejection of wrong or bad clay tablets and heaping these destructed pieces immediately. He notes these destructed pieces were recycled, that such clay lumps could be seen in households from the archaeological diggings. Kramer (1971) notes that the school children prepared all sorts of mathematical tables and worked on many detailed problems and solutions. They were extensively taught on writing, reading variety of literary compositions, poems, but, little is known of the teaching methods and techniques practiced in the Sumerian schools. He notes that the major scientific achievement of Sumerian as contribution to humanity is by devising sexagesimal number system with place values.

Postgate (2004) highlights a student's self-assessment statement of Sumerian school as he or she could write tables of grains measures from 1-gur to 600-gur and weight measures of 1-shekal to 20-minas of silver. He enumerates use of mathematics in those ancient times by field surveyors, architects, irrigation, temple and army accountants. Schmandt (1982) sees Sumerians developed the counting system, gradually, from concrete to abstract forms, from 8000 BC to 2500 BC, and towards what we are very familiar with modern abstract mathematics. We could expect lots of efforts in thinking, correcting, teaching and training. Purushotaman and Suresh (2014,2021) reported about the Sumerian school environment as to very similar to our recent past of traditional Gurukula and Tamilnadu thinnai-palli systems, that students were trained to sharpen their eyes and they were trained to become leaders of their times. The education quality system was very strict with punishment, close supervision and hard work. They

were asked to find solutions to problems faced by people and find out answers on improving agriculture technology and to enhance water resources, that we do still face these problems even today. Further, Menon and Purushothaman(2017) brought out the possibility to refine our understanding of Sumerian literature through present form Tamil. Fowler and Robson (1998) through their research made our understanding of Babylonian mathematics better and enable us to see teaching situations of mathematics during Mesopotamian period. They note that most of the mathematical tablets were students' reference tables, exercise problems and solutions procedures; many were works of the students. In this paper we attempt to see the teaching situations of mathematics through few basic algorithms developed by Hoyrup (2002,2017) linking these at elementary level with modern thoughts (Dellajustina & Martins, 2014).

Mathemicatics

Square root of a number

Hoyrup (2002, 2017) tell us that Sumerian surveyors, engineers and architects saw their field problems as applied mathematics and saw land areas as squares, rectangles and triangles and in geometrical forms. Fowler & Robson (1998) and Hoyrup (2002, 2017) rightly explain the numerical solutions through geometrical representations. They give easy to visualize algorithms for working out diagonals, presumably of right-angle triangles, squares and rectangles. Given below is a slightly modified expression of what by Fowler and Robson (1998) had given to find out a square root of a number (say as seen in Cuneiform Tablet catalogue no. YBC 7243 as a possible solution):

Taking any number N, whose square root is to be found out with initial value of ai, the improved value of $\{a_{i+1}\}$ could be obtained as

$$\{a_{i+1}\} = a_i + [(N - a_i^2) \div 2a_i]$$

The initial value is a near guess of the square root and the difference between the given number N and square of initial guess is seen as difference in area, and factored correction is applied. Høyrup notes that Babylonians thought that side of a square is square root of the square area, and we see the correction factor maintaining dimensional equality and direction. Another equivalent expression often found, but abstract is

$$\{a_{i+1}\} = (\tfrac{1}{2}) \times \{a_i + (N \div a_i)\}$$

Diagonal of a triangle or a rectangle

The gate problem (as seen in Cuneiform Tablet catalogue no. VAT 6598 #6) and its solution given is interesting, particularly using of the similar expression or form used for square root but not as an iterative solution (Gordon 1912;Fowler & Robson 1998; George 2005).

The height of the gate is, H, it's base is B, but H is much higher than B, then the diagonal of the gate is given as

$$D = [H + \{\tfrac{1}{2} \times (B^2 \div H)\}]$$

There is another problem (as seen in Cuneiform Tablet catalogue no. VAT 6598 #7) mentioned by Høyrup (2002) that he initially exclaims it as nonsensical. As the solution procedure given in the Babylonian tablet is interpreted, translated and read through, he gives the expression for the diagonal as,

$$D = [H + (2 \times B^2 \times H)]$$

Even we can get the doubt whether this tablet was a student's answer written in an examination. An attempt is made to revisit the transliteration as given Hoyrup (2002, 2017) but through Tamil, for the problem (VAT 6598 #7) having some likely errors; however, keeping the translation and interpretation given by Høyrup, mostly intact. This attempt is provided herein below by translating back in English:

Problem

How will you get the diagonal, if height is 40 units and bottom width is 2 units? Consider 10 as tips to solve the problem?

Solution:

1. Taking (2/12) as (1/6) as 10(in sexagesimal) multiplying by itself get 1,40 as small side; multiply that with 40 (to get 1,06,40).

   [That is $B^2 \times H$].
2. With 1, 06, 40 multiply by two to get 2, 13, 20 and to that add 40 the height.

   [That is $\{(B^2 \times H) \times 2\} + H$]
3. we get 42, 13, 20 and say that is the diagonal. [Note as given sides are 40 and 2; the above answer of 42,13,20 in decimal system would be 42.22 which is not correct for the given side values of a triangle.
4. The correct value in decimal system would be 40.05; interestingly, if we apply the gate problem method here, that is $40 + \{(0.5 \times 2^2) \div 40\}$, again the diagonal would be 40.05;

It is also interesting that both methods were present in the same tablet, that it was not destroyed and thrown as debris. This requires further studies on different methods used by the Babylonians at different places and at different periods. Seeing the transliterations through Tamil was not much helpful to resolve this particular problem (VAT 6598 #7) that appear to have error.

Surveyors

Surveying has occurred since humans built the first large structures. Cooper (2013) has attempted to consolidate views on development of field surveying and office work calculations, which were then used mainly for irrigation, buildings, temples construction and commercial purpose ever since 3500BC, by Sumerians and Babylonians in the past. Cooper (2013) notes from the Sumerian literature that surveying techniques were passed down from gods to kings and the deity for surveying was a goddess. He highlights that field works were done by male and office work calculations by female scribes. He also highlights use of line threads and measuring rods and artefacts depicting such use. Further, he notes that the archaeological evidences also suggest use surveying techniques and good practices.

Cooper (2013) highlights that in Mesopotamia, the students after mastering the rudiments of metrological units and arithmetic were given numerical problems to solve. Where, the problems were relating to accounting, metrology, land surveying, construction and commerce. We find field surveying to have started during early civilizations. They started building structures such as construction of pyramids by Egyptians, Ziggurats by Sumerian, planned townships by Indus valley Civilization. Moreover Hoyrup (2002,2017) study reveals that the terms relating to surveyor and surveying have similar root words in Sumerian and Tamil. For example, fixing boundary contours in a pond using water level is called in Tamil as, "mulai maal" whereas one of a term for surveyor in Sumerian is, "mul'. A major application of mathematics during Babylonian period was also in the field of surveying. Babylonians knew how to divide trapeziums into two equal parts and many of the field problems could have come from surveyors and used to train students or apprentices. Hoyrup (2002,2017) and Postgate (2004) refer to surveyor field plan reworked out to scale by Thureau-Dangin's work (refer p-231 fig-12.3 of Postgate or p-102, fig-44 of Høyrup). As field engineers we can easily identify the field plan very similar to our closed traversing with baselines, offsets and forming rectangles, triangles and trapeziums, with all measurements, just the way we do chain survey using cross staff. We will not be drawing sketches to scale in the field, but do it at office. The correct to scale map or sketch as shown in the reference tell us our own experience how we come across with very irregular boundary in the field. Babylonians would have used cross staff to fix right angles in the field work which is similar to our current surveying methodology. Even, they would have used arc methods as they workout at office, all the three sides. Or, they could have used right set squares, even today we use wooden or steel frames to turn right angles.

Sumerian-Babylonian surveying has possibly paved way for today's surveying techniques and method. As Indus valley and Mesopotamian had trade relations; we could expect both to have taken advantage of new developments in science, engineering, technology and mathematics of their period. The Tamilnadu government rightly claims that Indian surveying was very ancient right from Indus period, Chola king Karikala period based on their works and even of modern British period in India; the first research was carried out by Captain Priestly (TNSCDA;TNSurvey2021). There were surveying manuals in use during the British period in India as per Gordon(1912) studies. Construction of dams, canals and townships were impossible without use of planning and surveying. It is also interesting to note that the British period survey manual (Gordon 1912) talks about traverse chain survey and even shows how areas of trapeziums are worked out. Postgate (2004) quotes from various studies that architects used mathematics, field lines which were straight and right angles were accurate. As George (2005) had noted on spreading of craftsmanship to other parts of the world, we could expect surveying methods to have spread out. Now this part history will have to be connected to the modern history with the British period. The history of survey of India happened in 18th century. Lt. Col. William Lambton started measuring India in 1802 under General Wellesley during a scientific survey to map and measure the Indian subcontinent land. His team, which was compiling the survey manually, acquired the name of the Great Trigonometrical Survey of India. Now a days if anybody wants to measure land can simply calculate the distance on google maps using AutoCAD application. The purpose of surveying remains constant irrespective of any civilization, the tools used to accomplish them have evolved drastically with human advancement. Revolutionary changes make Modern surveying techniques in digital manner. Equipment's like total station, GPS, Remote sensing, aerial photogrammetry, digital levels electronic theodolites has played a vital role in modern society.

Further discussions

We carried out a preliminary exploratory investigation on Sumerian terms relating to buildings and mathematics considering the transliterations, which would show terms presently used in India and in Tamilnadu. The study indicated some scope for further research, particularly Sumerian – Babylonian mathematical problems, solutions and procedures might give better opportunities to identify those languages and terms still in use. Hoyrup (2002,2017), highlighted how he could improve upon the earlier translation works with respect to understanding Babylonian mathematical problems and their solutions and how difficult was the research work George (2005) .The algorithm proposed by Fowler and Robson (1998) based on their and other's work appear to be very concrete and easy to visualize for students, particularly from field surveying specializations. However, the solutions to the gate problem (VAT 6598 #6) and a similar problem (VAT 6598 #7), but as appearing with an ambitious solution procedure are intriguing. The VAT 6598 #7 problem appear to use thumb rules say like students averse to using reciprocal tables or students under prepared or imaginative, though it is premature to label the writer of that cuneiform tablet.

Finding the diagonal problem (VAT 6598 #7) has probably mixing of units though both length units are same only base length is converted as 1/6th of a rod or kazhi (pole) but height is kept as cubits than converting into rods, this would have made a quick answer like what we use as few personal level thumb rules in the field. This also, alternatively remind us as students how we get confused while solving problems with mixing units, though dimensional homogeneity might be there. We shall also consider the high-quality expectations at Sumerian schools that tablets written with errors were immediately destroyed and sent for recycling. We learn similar quality approach was there during construction of Tanjore temple that the chief inspector would apply his hammer on imperfect stone works with defects, sending it to debris heaps. These observations suggest us to look for other similar tablets with similar solutions which could give us better picture. Of interest are both solutions for square root and finding of the diagonal as in the case of the gate problem. When it comes to solution of square roots, we cannot stop wondering how later days methods evolved with or without Babylonian Mathematics on Pell's equation and Newton – Raphson methods (Ramasamy 2004; Dellajustina et al., 2014). The Babylonian gate problem gives some indications of using half tangent value to find an approximate value of arc length to be added to the height, as engineers, many times we are satisfied with approximate values in the field. But another question arises on what was the need to find out a diagonal, if we can set a right angle with known bottom width and height, except when double checking is required or when only side slope is available than the vertical face for measurements. Naturally, the Babylonian mathematical problems, solutions procedures appear for a field survey engineer as office work and we have to look at how field work was managed in those days, though we get few indications through few poem lines how Gudea set the architect plan on the ground. Though these studies show historical development of science, technology, engineering and mathematics and how students were taught in those early development days give us confidence to progress and look ahead on future of humanity.

Mathematics has become such a specialized subject, if any Babylonian comes back, he or she would be astonished to see the current developments in the field. The study of mathematics from Babylonian period and how they used rough work tablets would be interesting and inspiring all of us.

Conclusion

A small attempt was made to understand how mathematics was taught by going through few selected problems. These problems pertaining to square roots as sides of square area or finding out of diagonals for square and rectangle areas offer interesting settings. We could relate present student and field engineers' situations as was then at Babylonian period. We also learn and appreciate development of mathematics as from concrete learning to abstract conceptualization in the course of time. There are lots of scope for research in this area with concrete mathematical problems, procedures and solutions both reading from tablets, transliteration, translation and relating to present day solutions as inspiring as any other subject of study.

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Disruption to didactic methods: Gracious through pandemic

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Abstract: Teaching is left to fend itself but forced to keep teachers on the job. Preparation of the talent pool of students to be employable, requires guiding the teacher not only to protect their employment, but also to upgrade themselves to overcome challenges, through technology swiftly, requires quick impetus to bring changes in curriculum. Technology tools facilitate education to proliferate distances, shrink the world to an unimaginable connection, and challenge the teachers on employability. Today everyone at all levels of education, across the globe are online, there are quite a few experienced teachers and experts still not sure of solutions that can accept the challenge. Administrators are struggling to propose a right methodology, where the digital involvement of technology in the didactic, can land into the near future. At home Mobile, and Laptops have replaced textbook and notebooks for both teachers and students, right from communicating, organizing the teaching, learning and evaluation has taken a new form. Textbooks in printed form have suddenly vanished. Students and teachers have been using textbooks to absorb, discover, and realize had been effective, till the COVID-19. Emerging technologies are on the way to replace the traditional didactic, and research processes, drastically shifting to digital form. The information drawn through the internet is going to be omnipresent, providing a flexible learning environment, processing fast search of information. However, digital education would still need to increase awareness, perception, and reasoning to distinguish the right from wrong, make decisions, enhance self-confidence, and much more as parameters for enriching their living.

Keywords: Augmented reality, Cloud computing, Education, ICT, IoT, Robotics, Simulation

Introduction

Education is a sound investment for the future, offering prospects towards growth opportunities impacting personal well-being and social development. Proliferating more employment opportunities, brings financial stability for health and well-being. Teachers are instrumental to ensure learning, share expertise, and transmit values and perspectives to students. Sustainable, well-paid, more employment and career options, motivate students to compete intensely in the relevant field of education. The national focus is to create and ensure students with job opportunities, once they successfully complete their education. Educational process should proactively use new resources and capabilities to achieve coherent transformation. Include both formal and informal education that are relevant, convert tacit knowledge assets to become open for social transformation and proactively collaborate to facilitate the purpose through ICT, content-sharing fulfilling the educational competences (Mansour, 2016). Education enhances the impulse to respond positively to change. Traditional education increases technical competence, builds interpersonal relations, facilitates planning, and focuses on goal setting. However e-learning intends to bring self-education and oriented on an individual's values such as openness, honesty, and authenticity for building a rapid scale up of knowledge through technological revolution suiting education to be a continuing, lifelong process. Advancements in technology require regularly reeducating the learning experience. Recently the education has transformed intensely with the arrival of online learning being carried remotely on various digital platforms. Online

learning continues to persist post pandemic and is expected to raise its impact on worldwide education. With the arrival of linguistic applications and natural language processing, e-tutoring, conferencing applications, and e-learning software's in the post pandemic have changed the infrastructural requirements of education (WEF, 2021).

The overwhelming consequences of pandemic have made education become adaptable and resilient among teachers, students and policy makers. Learning contents such as printed handouts, access materials, marked worksheets etc are all virtually unsupported by digital platforms and facilitated by educational technology information online. Pedagogical adaptations happened even in traditional lecturing models, to upgrade themselves with the use of technologies such as radio, TV, mobile, and online platforms. The teacher has to adapt their practices to be creative and keep the students engaged throughout the didactic process. During home learning lecture sessions, engaging the students to a rapt attention, is possible only when the educational process is being creatively approached, without getting them distracted and escaping to move on with the daily chores, which the family may pose on to the students (Maria et al., 2021). Technology has changed education towards a new path in both teaching and learning. Computing gadgets are a common phenomenon for this unique didactic methodology adoption. Students enriched learning happens through internet enabled technology for lectures, information access, globally communication, and learning experiences (Harisa, 2020).

Preparation for teaching

Virtual education has facilitated with the pedagogy of freedom, that whoever teaches can also learn; while whoever learns can pick the act of didactic. To understand the perceived effectiveness of remote learning solutions, the role of teachers is rapidly evolving and becoming more difficult, then the learning taking place in the student. Constant communication and feedback from the students through mobile applications can enable the teacher to understand better and have the concerns captured from the students' perspectives. The COVID-19 lockdown has changed the rules of teachers and prepared many of them to adapt to the change with a comprehensive strategy of social emotional monitoring and psycho social support, to ensure teacher well-being and avoid burnout. Enhancing the teacher's engagement with students improves the access to the data, content and networks that can be effective even during the remote learning phase, which can be integrated to the regular system, later when the pandemic ends. Balancing education and also taking care of administrative responsibilities such as audits, through digital technologies and in service programs can be organized through web portals of the institutions to capture real time data and feedback, on teaching and learning (Maria et al., 2021). The potential of emerging technologies in the didactic and learning process challenges and shapes the engagement of digital technologies from the inception stage exploring. Implications on education and accelerating an associated change, depends on the teachers resistance to such changes. Many are unaware of the emerging technologies that can be customized and applied for the didactic and learning process. Platform suggests Skype, podcast, digital audio records, MOODLE, wiki, and blogs etc., have already changed the traditional environment into an exciting, and cooperative learning, for knowledge sharing and development (Pradeep, 2010).

Digital paraphernalia in learning

Common populations not affected COVID-19 are unable to comprehend the density of the current issue in the pandemic coupled with lack of education to understand the implication of the lockdown (AIC-EEPC, 2020). Positioning the technology as driver into the educational system, which features with benefits that can overlay the human kind in its full cycle implementation, was attained within the shortest span of time during the pandemic. Computer based learning is overexposing students to spend time on social media sites, with an ample scope of freedom to the students, offering them to offshoot away from a teacher's planned lesson or offering the accessibility to sources with excessive information, leading them who be derailed in learning, fail to clear the assessments, and even learn different applications. Thinking and learning can enlarge the pipeline and preparation of students to engage in advanced coursework in mathematics and science, which will develop the competence, which is a neural process, required for bringing up a new generation of bright students, well-trained for bringing in transformations. Fostering world-class didactic requires high-quality curriculum, process, assessments and standards for students to get involved in inquiry-based learning, which can include internships, projects, and laboratories etc. that can add a vital nurturing experience for memory retention. However, that opportunity should also be blended with the online learning environment, else it may get localized, limited and time consuming for evolution, compared to a traditional connection of students. Earlier the use of mobile phones in educational institutions was restricted, but now it has become inevitable during the pandemic. All activities such as communication through email, searching educational contents through browsing, sharing pictures, videos, and documents are all through the mobile phones. The use of

the Internet through mobile telephone has opened up a new face for learning and teaching, and has disrupted the use of computer gadgets. Learning facilitated through MOODLE helps to create, share resources to students, conduct evaluation through innovative methods such as quizzes and online exams, keep track of the grades, inform updates on the syllabus, and also involve in discussion forums (Pradeep, 2010). The digital technology implementation in education is more valued by teachers, when the benefits in didactic and learning are maintained or strengthened by their peers and also by the administration to incorporate it into their practice (Sarah et al., 2015).

Emerging technology driven education

The implementation of online learning was unplanned and rapid with no sufficient time offered for infrastructural preparation, the pressure on education was such that it should be continued, and in whatever means possible, necessitated the use of online technology support (WEF, 2021). Communication has moved from being within the classroom to locations outside the classroom. The social networking sites also include educational and teaching management functions that are used in educational settings have provided new ways for student's feedback on their assessments or completing asssignments (Sarah et al., 2015). The use of emerging technologies by teachers requires changes in their styles and behavior towards a student centered application. The new areas of competence are concepts, environment, curriculum, evaluation, professional development, and empowered learner support. The knowledge, skills and understanding of concepts requires developing appropriate technological support for learning opportunities, technology driven strategies, stimulating learning environment to create an interest in the students, use of technology to support learner centered teaching, higher order skills and creativity development (Pradeep, 2010). Distance learning is now e-learning, which is web-based or network-based online learning which adopts pedagogical practices that can be adapted to a strong level of technological engagement, and supports institutional environments, positively impacting faculty transition to the online classroom along with the online faculty's teaching identity (Edwige, 2012). Educational technology has increased the access, aligned with affordability and availability of gadgets with everyone has increased the use of digital technologies in education. This student centric move has made them progress from being submissive buyers of information to becoming inspired producers and thus evolve as vigorous constructors. The new knowledge and understanding offer them an effective way to interact and integrate with the digital technologies in education (Sarah et al., 2015).

Threat to teachers

Online learning is self-paced computer based training appropriately involving multidisciplinary inputs and leveraging the affordances of the web to deliver training, courses, and programs. Distance learning is now widespread due to the spread of the Internet and large educational institutions or universities are leading the way in offering online courses and programs. Online teaching challenged teachers' professional identity, though it is a valid and effective learning mode, yet not fully accepted. Transitioning online has potentially disrupted the teachers, those who were active members of their community of practice after spending many years, experiencing and developing well-rounded professional identities (Edwige, 2012).

Teachers struggle to use new technologies, for various reasons, as it would not have been a preferred technology, insufficient device capabilities and instructions, quick to distract and affect the flow, limitation of technology reach and protection issue, and finally inadequacy of infrastructure and support. Students need to be encouraged to think ethically for social implications, with a need for a basic understanding of informal approaches to learning, and working with cross-disciplinary teams to appreciate its value (UNSG, 2020). Many institutions leverage the affordances of multimedia technology, including video conferencing, for streaming the lecture sessions, also facilitated with students to download on their gadgets, free of charge, attempting to replicate a telepresence. Further, a 3D immersive technology can give a higher degree of natural interaction and effective collaboration. Three-dimensional holographic conferencing represents a higher end technology mediated with identity projection, telepresence systems, dedicated spaces, hardware and software, which require investments of higher order in education. Significant changes have already happened in schools, where evidence shows that tutors take challenges and test with designing varying educational tasks and didactic interactions (Sarah et al., 2015). Learning management system LMS automates the administration, tracking and the educational events. It has email, chat, discussion board, and virtual whiteboards along with instant messaging application for file sharing, allowing teachers and students to exchange the documents in a secure environment along with tracking systems, roasters and grade books. Problems such as interoperability, usability, and flexibility are constraints which the teachers face when using the educational practices that have become student centered. Social media applications have a great support for pedagogical practices that are centered towards students, allowing the teachers to develop learning

spaces creatively to solve problems in the educational context. However, in this network, the privacy and boundary issues between teachers and students have come to a common plank of acceptability (Edwige, 2012). When instructors sense that they are under threat, their inputs gets constrained and rigid, therefore they will tend to reduce their confrontation or trials with new methods in the didactic and change. University or institutional leaders should recognize and limit the alleged threats to education where possible, by linking tutors in the proposal processes about technology associated change and the institution's vision for integration.

By providing appropriate technological and pedagogical support, teachers can have the access to new tools, strategize, team up and improve the new curriculum. Thus creating a situation which can diminish the anxiety on failure, disturbance and accommodate professional expertise (Sarah et al., 2015). Technology in some form is considered as a barrier to their growth by teachers. Even as institutions are providing support, many teachers, especially the more experienced, find it difficult to adapt to new technology for teaching. They are bound to be stressed, as this change questions their comfort zone, pushes them to increase their knowledge and application of new technology tools, in their daily practice (Harisa, 2020).

Employability challenges to students

Education has one of its goals of preparing students for the requirement of future work opportunities. It's found that use of technologies, effectively do not impact the learners to discover, arrive at solutions, generate and team up. Hence the learning should be devised to make students engage in critical analysis of the subject, where teachers co-create their vision, with the student's participation, as a shared-vision for investing the technology to be used for benefiting the community (Sarah et al., 2015). From various perspectives Digital literacy affects cognitive, and social information. It requires critical thinking skills and the right online behavior for building relationships between active learning and literacy constructions using the basics, background knowledge, competency centers, and attitudes and perspectives. Online learning is flexible, achieves learning outcomes, ensure students to learn continuously without a miss to any learning material, thus fulfilling the rights of students (Harisa, 2020). Though many organizations realize that the best way to get their employees continuously upgraded is over certain arrangements of online education, their view on new joinee or employees is however different. There are certain disadvantages perceived as derailleurs to the quality of education, such as business bias in contrast to online certifications due to the absence of pertinence for all syllabus content, challenges such as reduction in student - teacher interaction, and previous locational advantage. It also includes student's experience of seclusion from colleagues, anxiety about proficiency of new skills and software, with reference to the same courses when being imparted in-person. Therefore it is imperative that the educational online quality progresses and be dealt as same as the earlier styles of education, ensuring appreciation of attaining certifications through any mode of education as equal and in par with the required standards (Shailendra et al., 2018).

Conclusion

Digital technologies stand to quickly renovate education, and proceed to progress the condition of living with a profound and unparalleled challenge, with a swift change which is ever growing in agility, responsiveness and scope of cooperation through ICT and Cloud computing. Many societies are in the early stages of technology education and not ready with digital tools available for being implemented in teaching or learning, exposing young children to science, simulated with IoT and robotics, right from an early age, along with socio-emotional intelligence, creativity, collaboration and critical thinking. The global pandemic is making low-skilled jobs much more sought out, then the degree requirement for a job description which gets lower subscribed. The power of education rests on the communities, economies, and nations, on whose insights the emergence of virtual educational programs using Augmented reality in education, differentiates the predecessor of education which happened in the physical world learning setting prior to COVID-19, with that of the virtual learning scenario, revealing the major inhibitors that upscale the understanding and also interrupting the structural or architectural challenges, are double sided market problem.

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Dedicated to all those earlier researchers in this field

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Theme 3:

Emerging trends in engineering sciences and technology (ETEST)

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A comprehensive techno-economic model for analysis of the telecom operator potentials: Main facts, explanations and ideas

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Abstract: In the period that has already begun and will continue very intensively in the coming years and even decades (the period already called the "fourth economic revolution" or "Industry 4.0"), telecom operators will experience significant changes. These changes will be reflected in all segments - from technical, organizational, service, marketing, sales to the segment of customer access. Previous research has shown that there is no single model on the market and in use with precise metrics for analysis and evaluation of telecom operators and a model that would clearly help in making some key business decisions and that could be used in practice. The aim of this research is to create a modular model, based on professional experience but also on previous scientific research, which will be easy to use in telecom operators in order to optimize business.

Keywords: Analysis, Business model, Industry 4.0, Techno-economic model, Telecom operators

Introduction

All existing analysis models (Techno-economic analysis, SWOT analysis, PESTLE analysis, Porter's Five Forces, Ansoff matrix and BCG matrix) and frames (eTOM framework within which were analyzed: TAM framework and SID framework then TNA framework, TOE framework and ITIL framework) that have been researched and analyzed in the past period have not been adjusted for such changes. Their applications are quite subjective and incomplete for the analysis of business, business processes and the potential of individual telecom operators. All these models of analysis generally have basic frameworks set within themselves but no details within individual fields or entities, so that people (persons) doing analyzes based on all these models are left a lot of freedom in performing these analyzes, which brings a great deal of subjectivism to the results obtained. In addition, these results are mostly descriptive and as such are not accurate. The changes that are coming and which will affect all business segments, and especially the ICT segment, need to be identified and analyzed, and in accordance with these analyzes to act in order to adapt companies to new situations. This is especially emphasized in the segment of mobile telecommunications because mobile telecom operators will be particularly affected by these changes.

It is this last statement about telecommunitions that leads to the key motivation for this work - telecom operators have a huge chance in the coming period for instance n the fourth economic revolution and after, to be "key players" in the new ICT market but on the other hand there are significant threats large global companies such as Google, Alibaba, Facebook or Amazon, which will also try to enter this market segment and take a large part of the ICT market, ie in translation - users and money. Therefore, the development of such a modular model based on fields (entities) and defined items within them is important in order for existing modern telecom operators to adapt to emerging changes and maintain significant market shares and together with the aforementioned large global companies find a way to maximize emerging changes. in the field of ICT, all in the interest of faster and better progress and development of economies in the world.

Review of previous research

So far, much research has been conducted on different models of analysis in the ICT segment. These researches were both scientific and professional and a large number of them were done jointly, ie analyzes and researches were conducted by scientists and professionals in order to facilitate and accelerate the development of this segment, which will be the basis for all other industries. It is possible to find a large number of scientific and professional papers and analyzes that have been done around the world. Only some of them will be mentioned here. eTOM (Enhanced Telecom Operations Map) Frameworks is a structural business process model that covers all aspects of the activities of service providers in the telecommunications segment. It is a set of documents that serve to create business processes "from end to end" in telecom operators and which can serve as an aid in creating business transformations, but eTOM is not a specific model for analysis of predefined key items and assessment of telecom operators. eTOM essentially enables the creation of better models for business processes in telecom operators. Thus, in the paper (Korzachenko & Getman, 2010), based on the results of the analysis, it was concluded that the use of eTOM model is recommended for companies to model business processes because it is a highly valuable business model intended for companies providing any technological services, including ICT. Accordingly, this model is also recommended for the telecommunications segment, ie for telecom operators. Telecom operators face different challenges every day and look for solutions to them. This is certainly intensifying in this period and will be even more significant in the coming years. The analysis in (Benhina et al., 2013) provides a methodology for creating a data market for telecom operators (Telco Data Mart) as one of the basic components of business intelligence (BI, Business Intelligence) on a step-by-step basis, using the eTOM model. The paper (Chang, 2011) also focuses on business processes in telecom operators based on the eTOM model. The conclusion is that if telecom operators know how to evaluate their new processes whether the existing processes are optimal or not, they are gaining a powerful weapon in the fight against increasingly fierce competition. The paper also suggests that simulation and optimization techniques are recommended to assess the adoption of new business processes.

New technologies are leading to the rapid development of telecommunications, and new and higher-quality high-speed devices are replacing existing devices. Telecom operators are obliged to offer new and advanced services and must know how to solve the requirements of companies (users). Therefore, it is necessary to have a system in telecom operators that can collect the needs and requirements of users and after their analysis provide an efficient and affordable solution for the same. (Mireskandari et al., 2016) Here is described and explained one such solution management system (SMS = Solution Management System) whose task is to meet the current requirements of business (B2B) users and increase the satisfaction of these users and is based on the eTOM framework. Existing network management systems and communication services are not fully operational meet customer requirements in next-generation information and telecommunications services dictated by the company's business processes. Open Digital Architecture (ODA) can greatly simplify and automate major business processes using distributed computing and management logic, enabling the implementation of services on a set of network nodes. This paper (Mochalov et al., 2013) develops a model of distributed operating management system for new generation information and communication networks that evaluates the efficiency of operational activities of telecom operators and is based on the TM Forum framework. The paper (Czarnecki et al., 2913) also states that the telecommunications market is experiencing significant and rapid changes. Accordingly, in this paper, the option of the eTOM reference model is extended through process reference flows in which knowledge about processes in telecommunications companies is generalized. The paper (Nassiri & Farzi, 2016) presents the use of the eTOM model in the financial sector, in the ICT segment. The example shows how collecting information about customers and analyzing their needs and requirements can significantly improve the quality of service and offer. Further in the paper (Tcukanova et al., 2019), the standardization of the eTOM model and the adaptation of the model for the needs of the domestic (Russian) telecommunications market are given. Five main conclusions are listed, emphasizing that the need to standardize the requirements for OSS / BSS information in systems in the (Russian) telecommunications market. The literature under number (TM Forum, 2004) (ITU-T, 2007) is a presentation of documents of the TM Forum and the ITU-T organization, ie a presentation of documents for standardization of the eTOM framework (model) in front of the TM Forum, which was later accepted by the ITU-T.

The SID (Shared Information and Data Model) analysis model covers all the information needed to apply use cases based on eTOM procedures (ITU-T M.3050.x) which means that the SID covers a large part of the required information for the service (emphasis is on telecom services) operators). (Reilly, 2011) (ITU-T, 2008). However, SID is still evolving and the documents available today cover a significant part of the basic information of service providers, but do not cover all of them. The SID analysis model is independent of implementation, with a focus on information, ie what information is and what its relationship is, and not on how it is implemented and used. SID primarily refers to service provider companies (telecom operators) but also to other companies in the telecommunications segment, ie service integrators (SI), independent software vendors (ISVs) and network equipment manufacturers (NEPs). In other words, with the Common Information / Data (SID) model, the TeleManagement Forum (TM Forum) has developed a common language for companies operating in the telecommunications industry. Thus, the paper (Mochalov et al., 2019) presents an efficient design of distributed operating systems for the management of next generation telecommunications systems and also defines a flexible, software-defined and cost-effective architecture for the management of telecommunications network and service systems based on the SID framework (model). Another paper from the literature (Benhimal et al., 2013) suggests the use of a step-by-step methodology to design a business intelligence solution in telecom, using current telecom standards and frameworks with an emphasis on the Data Mart component. One of the advantages presented in the paper are the analyzes made to align the three frameworks, ie for eTOM, SID and Business Metrics. These mappings made it possible to extend the SID box with the attributes required to calculate KPI items.

The TAM (Technology Acceptance Model) was introduced by Fred Davis in 1986 for his doctoral proposal. (Harryanto et al., 2018) The Technology Acceptance Model (TAM) is considered to be one of the best frameworks for understanding technology adoption and technology solutions that can be extended and adapted to different items in different situations. (Belanche et al., 2012). The TAM model is specifically adapted to model the acceptance of information systems or technologies by users. (Lai, 2017; Konl&Eydgahi, 2017). The aim of TAM is to explain the general determinants of computer acceptance that lead to the explanation of user behavior in a wide range of computer technologies intended for end users and user populations. The basic TAM model included and tested two specific beliefs: Perceived Usefulness (PU) and Perceived Ease of Use (PEU). To date, several new versions of the TAM model have been developed and perfected (Srivastava & Dewan, 2015; Ghazizadeli & Lee, 2012). It should be noted that combined uses of TAM and T-O-E frames can also be found in the works. (Awa & Ukoha, 2012). The proposed model in this paper helps TAM and T-O-E frameworks exploit the enormous potential by integrating these two frameworks (models) so that it can be better utilized to cope with the technical orientation of the TAM framework. The proposed relationships of this new construction bring an original upgrade of the TAM and T-O-E models in order to promote and facilitate the adoption of these models by IT.
The TNA (Training Needs Assessment) has five steps in order to need to assess staff training. These five steps are:

- Identifying problems and needs
- Determining the design of the needs assessment
- Data collection
- Data analysis
- Providing feedback.

It can be concluded that the "Training Needs Assessment" (TNA) method is to determine whether there is a need for training and, if so, what training is needed to fill the gap. TNA seeks to accurately determine the levels of the current situation in the country or company, targeted research, interview, observation, secondary (other) data and / or conducting a workshop. The gap between current and desired status may indicate problems whose interpretation can then translate into the need for training (Md.Som et al,, 2016; Haselip et al., 2019).

TOE Frameworks (Technological - Organizational - Environmental) is an application-based framework for perspective research at the organization level. The TOE framework proposes three main aspects to explore the factors that influence how an individual organization accepts innovations based on new technologies and their dimensions and characteristics (Hoti, 2015). The technological context includes the features and usefulness and innovation provided by technology, the organizational context contains internal items in the company / organization such as management level, employees, products and services ;, while the environmental context includes business

issues and items such as competition and business partners. Thus, the study (Chui-Yu et al., 2017) analyzes three aspects of the TOE framework, i.e., technological, organizational, and environmental contexts that have a positive impact on the adoption of broadband mobile applications. In particular, the technological-organizational-environmental framework (TOE) is widely used in examining the factors influencing the adoption of ICT technologies (Nur Syahida et al., 2013). Future research on the TOE framework may have a number of directions. Perhaps most obviously, the TOE framework can still be used for empirical research (Baker, 2011). As new technologies evolve, the need to understand the adoption of innovation in organizations can be recognized. The TOE framework can provide insight into such a thing to both professionals and scientists. Thus, the continuation of empirical work is one future direction of research of the TOE framework. As the TOE framework incorporates the environment, it enables and facilitates the adoption of innovations within the enterprise (Oliveira&Fraga, 2011). The TOE framework also has a solid theoretical foundation, consistent empirical support, and application potential to facilitate the adoption of ICT change in the firm.

ITIL Frameworks (Information Technology Infrastructure Library) is a set of efficient, interconnected delivery and support processes for IT services. The ITIL framework enables and defines a common language for the analysis of IT services through all IT departments within the company and with customers / users. In short, the ITIL framework provides a complete, integrated view of the IT process. Thus, the paper (Himi et al., 2011) proposes an approach that combines the values and advantages of the ITIL methodology and the value chain within the company ("value chain"). The proposed approach and analogies helped to develop the processes specified by ITIL and apply them to the links in the value chain structure. This paper focused on the main stages of the value chain within the company. Information technology (IT) management is an important part of a company's information technology development. A case study (Yandri et al., 2019) discusses how to customize IT services using the Information Technology Infrastructure (ITIL) framework and managing service level measurement (SLM) using the Fuzzy ITIL (FITIL) approach. This paper results in an appropriate model for measuring IT service management using a “fuzzy” approach. A similar approach to using the "fuzzy" model is shown in the paper under number (Teja et al., 2019) in the literature. ITIL can be used to measure the quality of service excellence and to improve quality control, service level, efficiency, effectiveness and cost estimation and the like within the company. In addition, it is applied in the segments of control over business and management processes (Christiantova & Andry, 2018). The literature (ITIL ver 1.0, 2007) (Overview of ITIL 2011, 2011) provides an introduction and overview for the 2007 and 2011 ITIL frameworks, respectively.

Classical TEA analyzes (Tahon et al., 2014) as well as many other analyzes such as SWOT, PESTLE and other analyzes that have been processed and analyzed (in the Qualification paper) are significantly limited, inaccurate and significantly subjective and depend on people using these models. Techno-economic analyzes have a wide range of applications in telecommunications from applications for estimating investments and costs in optical networks (Wang et al. 2010), in Ethernet networks (Wang et al., 2017), in many mobile networks and systems (4G and 5G), new generation systems (NFV), for the analysis of the application of new services all the way to the analysis of number portability (Rizal & Muayyadi, 2013).

These existing models of analysis (Technical-Economic Analysis, Business Analysis, Cost Analysis and many other analysis models) have been used significantly in the past but are still used significantly in theory and practice for the changes that follow but their application is quite subjective. The changes that are coming and which will affect all business segments, and especially the ICT segment, need to be identified and analyzed, and in accordance with these analyzes to act in order to adapt companies to new situations. For example, in (Phillipson et al., 2013), a model was analyzed that calculated the effect of using different technologies in access networks on a market basis according to revenues, costs and profits. A method for calculating the user's outflow rate (churn) has also been introduced. It was concluded that when introducing FttH, operators are limited by budget, labor costs and user requirements (needs). That techno-economic analyzes can also be used in the introduction of NFV-based (Network Function Virtualization) is shown in the paper in the literature (Askari et al., 2019). A techno-economic analysis and different NFV deployment strategies for service chain support (SC = Service Chain) are presented, taking into account different NFV node implementations and maintenance contracts (SLAs) for the actual topology of the optical metro network and with traffic assumptions. For the traffic considered, the results show that a properly chosen

accommodation strategy can reduce service delivery costs by up to 16% or 23%, respectively, according to different implementations of NFV nodes. The applications of techno-economic analysis in 5G systems are presented in (Neokosmidis et al., 2019; Olighton et al., 2019). The emphasis in both papers is on investment and implementation costs and system profitability, which clearly shows that TEA is applied in new generation systems and that such research actual. All this is a logical sequence after TEA was applied to fourth generation mobile systems (4G) systems (Duan et al., 2013; Duan et al., 2015). Techno-economic analyzes are also used to estimate and calculate complex investments in telecommunications (Tsilipanos et al., 2015). This paper presents an analysis of complex investments in telecommunications and problem analysis using system concepts (SoS = System of System Approach). The literature also lists items (Monath et al., 2015; Al Debei et al., 2015; Nenickova, 2013) in order to show that different models of Business Analysis and Cost Analysis are used in the telecommunications segment and that this research is current and interesting for professionals and scientists around the world.

At the end of the bibliography Jurčić and Jurčić (2013), Jurčić and Gotovac (2016), Gotovac et al. (2016), Jurčić et al. (2018), Papakonstantinidis and Jurčić (2018) and Jurčić (2019) a list of papers is given describing part of the previous research in this area and emphasis is placed on certain contributions as well as the fact that the new approach will in the development of this model can be applied in some branches of business, such as tourism or "smart cities". All of the above and analyzed indicate that there is currently great interest in the world for research and progress in this segment. That is why the goal of the existing research and dissertation is to contribute to this part of telecommunications through the development of a modular model that will give value for certain items at its outputs based on defined fields and items within them that will be unambiguously described and defined and their interactions. Based on the obtained values, it will be significantly easier to make individual business decisions and thus optimize the operations of a particular telecom operator.

Hypotheses

The telecommunications segment has been subject to major changes in recent years and these changes will be even greater in the coming years and even decades. Telecom operators have already started significant transformations - it is not just a classic digital transformation but a complete transformation, starting from organizational, technical, sales, transformation of access to customers, transformation in the overall development of products and services, transformation in public presentation (transition to digital platforms) and the like. Thus, telecommunications markets around the world will experience huge changes in the coming period. And these changes will run through the entire business of all telecom operators. What is crucial to point out is the fact that it is not only telecom operators that compete with each other. In the coming period, telecom operators will have many other competitors. As in any of the previous economic revolutions, many companies will lose in importance or disappear completely if they do not adapt to change, and some completely new ones will emerge and even become leaders in emerging environments. Roughly, such an outcome is already foreseen in the fourth economic revolution. Global players like Google, Amazon, Alibaba or Facebook are largely taking a significant share of the market to telecom operators. On the other hand, telecom operators are also engaged in some business activities that are not their primary business, such as the sale of electricity, advertising and the like.

All previous analyzes and various analysis models that have been created and developed for this purpose and used in telecommunications markets and telecom operators in order to optimize business and optimize business and strategic decision-making, are largely general and subjective and as such quite subject to subjectivity. the assessor, ie the persons doing the assessment. It often happens that different professionals evaluate a company and its environment completely differently (using the same model) and consequently make wrong decisions and make wrong business and strategic moves. Therefore, the aim of this dissertation is to develop a new and original modular model for analysis, based on experiential methods and based on scientific and professional analyzes and research conducted to date - of course taking the good and positive from existing models and research frameworks and adding the new based on research and planned analyzes, which would make this model acceptable and useful in everyday use in telecom operators.

The aim is, based on analysis and research, to define the relevant fields, items in them and the associated mathematical equations that describe these items, as well as feedback between fields and individual items and to define outputs to minimize subjectivity and human influence on analysis. The obtained results, ie their ranges, will be unambiguously defined and will provide key indicators relevant to the business determinants of an individual telecom operator.

MAIN HYPOTHESIS: By developing a modular model for analysis of telecom operators, based on defined fields / entities and defined items for analysis within fields / entities, it is possible to make an objective quantitative assessment of individual segments of telecom operators but also telecom operators as a whole for better and more efficient telecom operations. operators.

Second hypothesis: This model will enable a partial qualitative and quantitative comparison between telecom operators in the same country but also operators operating in different countries on the network quality segment, ie mobile signal quality and supply quality (products) as well as customer satisfaction based on these items.

Description and methodologies of scientific research

This research used scientific survey methods, research of world scientific and professional literature, and research of different structures and organizations of telecom operators in order to define the field / model entity but also the items within the field. Research will also be conducted on the organizations, functioning and operation of telecom operators in order to precisely define the procedures and ways of obtaining certain input data for different fields / entities. Of course, research on network quality, ie signal quality by mobile signal measurement procedures, will also be conducted, as well as research on product offers at different telecom operators in order to obtain a relevant framework for comparing differently created and defined products at different telecom operators. In accordance with the defined criteria in the observed fields, a description will be made and the sampling criteria will be denounced, and mathematical equations describing these stems will be given. Each sampling will be defined and everything will be done according to the defined rules. Ultimately, research will be conducted on new technologies that will be crucial in the Fourth Economic Revolution, but also after that period, and which will significantly affect the transformation of telecom operators into Telekom 4.0 operators. These technologies are primarily:

- Fifth generation of mobile networks (5G),
- Internet of Things (IoT / IIoT / IoE),
- Over The Top Applications (OTT)
- Cloud Services,
- Artificial Intelligence (AI)
- and many others.

Scientific contributions that will be presented in this paper are:

- Development of a new modular model of telecom operators with which it will be possible to objectively and more easily optimize the adoption of certain key and strategic technological and business decisions.
- Application of the model in optimizing signal coverage and quality of accessibility to users.

Layout and description of CTE Model

In the research so far, a result has been obtained that defines the basic items to be analyzed and the areas in which these items are distributed. Of course, in further research it will be possible (and before the final result and model layout) to change the layout of the area as well as the number of areas but the basic items (job description) will remain according to the current description (with possible minor corrections). The eight key areas in this analysis, which have been detected in the analyzes conducted so far (although in the final form there may be small / slight deviations from this proposal, all in line with future research and analysis), are:

- Signal coverage and user accessibility
- Degree of technological and IT development
- Product development
- Service development
- Sales activities and customer care
- Personnel care (training,,) - HR processes
- Political, economic, legal and regulatory environment
- Brand quality and presence and recognition in the media

An overview of the areas distributed in the three levels of the model and a description of the items (jobs) that are crucial for the analysis of telecom operators and that are crucial for future transformation are shown in the following Table 1.

Table 1: Overview of the "CTE Model"

	CTE Model			
Technical Level (TL)	Signal coverage and user accessibility		Assessment of technological and IT development	
Business Level (BL)	Products Development	Services Development	Sales and customer care	Human Resources (HR)
Environmental Level (EL)	Political, financial, regulatory and legal environment		Brand quality and public presence	

In this paper, the usefulness of this model for reliable decision-making of certain business and even strategic decisions will be explained on the example of the field "Signal coverage and user accessibility". At the beginning, it is important to point out that the items to be analyzed will be defined in each area. It is important to note that these items will change over time as telecoms change and as technology advances and evolves. This paper will present items that are now detected as key in this observed area and that will be key in the next few years but over time these items will change and adapt with the development of technology and human needs. It is also important to point out that the results of such an analysis will be a presentation of user experience that will enable telecom managers to make reliable decisions on increasing the quality of accessibility to users and improving the user experience of a particular telecom. The following items are currently detected in this area:

Mobile part:

- Quality of access to mobile data in urban areas (outdoors),
- Quality of access to mobile data in special parts of urban areas - areas of mass gatherings (eg shopping malls, stations, bus stations, railway stations, halls and stadiums,
- Quality of access to mobile data in rural areas,
- Quality of access to mobile data on roads: highways and main state roads,
- Quality of access to mobile data on roads: regional roads and local roads,

Fixed part:

- Transmission fiber optic systems at the state level, fiber optic systems at the level of interconnections between urban ones settlements, and the quality and value of the capacity of fiber optic systems,
- Percentage of connection of homes (houses, flats, apartments,…) with fiber optic cables - FTTH (Fiber to the Home),
- Percentage of connections of factories, business facilities, incubators with fiber optic cables - FTTBus,
- Local loop shortening - number of households (houses, flats, apartments, SME companies) less than 900 meters from the last telecom connection point (RSS) - Item related to the efficiency of the copper network,
- Quality of protection of the primary transmission system and all transmission systems to the end points in the event of failure of the entire system or part of it.

Each of these items will be defined by a mathematical equation and sampling will be clarified i.e. it will be defined how, when, where, in what way and how many times during the day and night samples should be taken. In addition, the method of calculating the factors listed in individual equations will be described, which means that each equation will be defined to reduce the impact of the "human factor", ie so that each item in each area and the overall model would be an objective representation of the telecom operator.

The example of the mathematical equations for calculating the first item "Quality of access to mobile data in urban areas (outdoor)" will be given as follows (equation 1):

$$MD_{UA} = \left(\frac{AvgADD \cdot F_{DL}}{RefADD} + \frac{AvgADU \cdot F_{UL}}{RefADU} + \frac{RefDY \cdot F_{DY}}{AvgDY}\right) \cdot 0.1$$

Where:

MD_{UA} = Mobile Data in Urban Areas
AvgADD represents Average Access to Mobile Data Download calculated as:

$$AvgADD = \frac{1}{N}\sum_{i=1}^{N} ADD_i$$

RefADD represents Referent Download Access Speed (this value (this value changes according to the development of mobile systems),
AvgADU represents Average Access to Mobile Data Upload calculated as:

$$AvgADU = \frac{1}{N}\sum_{i=1}^{N} ADU_i$$

RefADU represents Referent Upload Access Speed (this value changes according to the development of mobile systems),
RefDEL represents Referent delay of sampling (this value changes according to the development of mobile systems),
AvgDEL represents Average delay calculated as:

$$AvgDEL = \frac{1}{N}\sum_{i=1}^{N} DEL_i$$

F_{DL} represent Factor that defines download importance,
F_{UL} represents Factor that defines upload importance,
F_{DY} represents Factor that defines delay importance,
N represents Number of samples,
0,1 represents maximum worth of this item.
It is important to note that:

$$F_{DL} + F_{UL} + F_{DY} = 1$$

The same equation form (1) applies to the second to fifth items noting that the methods and numbers of sampling and the F factors are different.

An example of two different mobile telecom operators analysis in CTE Model

How will look like results in tabular and graphical presentations? Here are shown results of two imaginary mobile operators whose total field value is the same but individual items are different. Although, final amounts are the same, from the table and from graphics is visible that these two operators are different and have different advantages and disadvantages. This analysis will help to scientists, managers and/or analysts (eg those who perform dubious recording of an operator) during a scientific or professional analysis of a telecom operator.

Table 2. Results of two different mobile telecom operators (comparison)

	Whole Amount	Item 1	It 2	It 3	It 4	It 5	It 6	It 7	It 8	It 9	It 10
MO1	0,6	0,07	0,04	0,08	0,06	0,05	0,03	0,09	0,08	0,06	0,04
MO2	0,6	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06

Analysis of Figure 2 will show all important differencies between these two mobile oepartors and all their advantages and disadvantages. It is important that all results are mathematically defined and based on scientific and professional researches during several years.

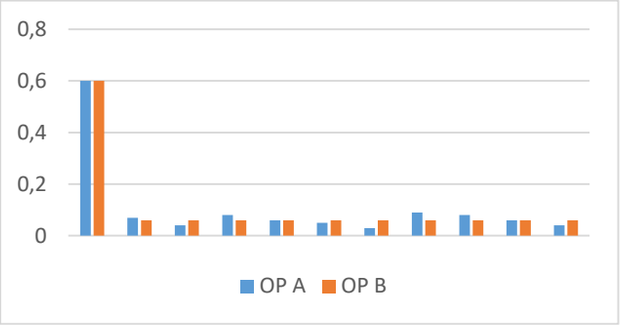

Figure 1: Graphical presentation of previous results together with whole amount of field and all items in the field

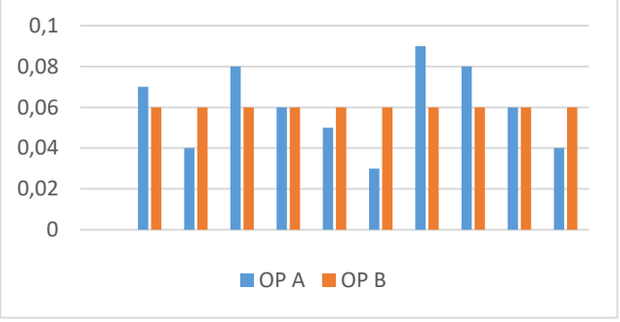

Figure 2: Graphical presentation of previous results without whole amount of field

An example of implementation of measuring data

In this part will be presented results of measuring data signal of one mobile operator in Bosna and Herzegovina and will be shown results according to equations (2). This is an example because only ten measurements have been done: six on the main road intersections in the town, three of them among the high buildings and on at the main bus station. For any relevant conclusions should be done all measurements according to the rules of this field and it should be calculated all ten equations. However, this will be just an indicator of how to count individual items and how to use results. In Table 3 are given results of measurements.

Table 3: Results of download and upload access rate

No.	FO (latency - ms))	FO (DL- Mb/s))	FO (UL - Mb/s))
1	60	8,27	1,396
2	55	10,02	2,625
3	56	13,884	2,935
4	57	7,653	2,504
5	229	8,759	0,898
6	77	1,799	0,131
7	76	2,882	0,233
8	56	3,862	0
9	60	6,845	0,636
10	59	6,881	1,923
Average	78,5	7,0855	1,3281

These results should be included in equation 2. As the second, it is necessary to calculate F_{DL} and F_{UL}. The business and private parts need to be calculated and applied to both factors. For this purpose, a short survey of 100 private users and 20 business users of the First operator (FO) was conducted. The results were as follows: 61% of private users stated that "download" is more important than "upload" and 39% decided for "upload". In the business segment, the ratio was approximately 50:50. It is important to note that the maximum download speed of all measurements for all three operators was obtained from the first operator and is Max ADD = 13,884 Mbps, which is the amount for Max ADU obtained from the Second operator (SO) and is MaxADU = 3,585 Mbps. Subsequently, the amount at the level of monthly income from business and private users with the first operator was taken into account – these data were taken as weighting factors of influence of private and business users. This ratio is 57% of whole income amount for private users and 43% of whole income amount for business users. Applying this data to the data obtained through user research and user habits yields the final results for the factors F_{DL} and F_{UL}: F_{DL} = 0,61*0,57 + 0,43*0,50 = 0,3477 + 0,195 * 0,5627 and F_{UL} = 0,39*0,57 + 0,43*0,50 = 0,4373. After including all the measurement results obtained and calculating the above factors, the final result for this item is 0,0451436667.

This result indicates some weaknesses in the signal quality of the first operator, and the table also shows the inconsistency in the coverage of the city, since the signal in the city center varies significantly in all measured segments. It also shows to management and experts where it is necessary to act to improve this result (through the results in the table and the overall result). More precise measurements need to be made for this item in the city for more accurate conclusions, and make measurements for all other items in the C&A field to produce usable, accurate and high quality results. This was just an indication of how this analysis can be effectively used for telecom operators.

Conclusion

The CTE Model is defined by three levels, 14 pre-defined segments that are joined into eight (8) areas. Each area / segment have defined items but they will be under review every two – three years or even more often, depending on the assessment of the development of the ICT sector. All items are defined by mathematical equations or in any other unique way. The CTE Model is flexible, robust and modular model of analysis. The modular model means that it can be applied as a complete model for the analysis of the potential of telecom operators, but also only individual areas or only individual parts from certain areas can be used for analysis. Flexible and robust model mean that this model can be used to compare two or more telecom operators but also to analyse the potential of a particular telecom operator for different services.

This new model will help professionals and scientists regarding analysis in mobile telecommunication segment – from simple analysis, comparison analysis two or more mobile telecom operators and different techno-economic analysis to very complicated analysis even in due diligence analysis of different mobile telecom operators.

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Analysis of models for software reliability

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Abstract: Software efficiency indicators play a key role in its optimization. Various ways are available to ensure software optimization. One of the key indicators of software is its reliability. Reliability of software (SR) is the features of the features to accomplish certain functions, and they are kept in certain boundaries under definite circumstances. Non-denial and recoverability of software define its reliability. In article Software reliability models show the form of a random process, as it periodically determines the behavior of software failures. The article uses the VIKOR (VIsekriterijumska optimizacija i KOmpromisno Resenje) method for the development of an algorithm to increase software reliability. The VIKOR method is used for different areas. Some sources provide information on the application of the VIKOR method. This method is developed for a multi-criteria decision making or analysis of multi-criteria decision. The alternatives here are ranked and the one closest to the so-called ideal compromise is determined. As a result of the author's research, six important criteria for software reliability are identified and alternatives are used. The fuzzy VIKOR method is used for multi-criteria evaluation of software. The work done is considered to be novel, and the advantage is that the selected criteria have not yet been used for this type of task, which positively changes its efficiency. The experiments perform positive results.

Keywords: Characteristics, Criteria, Efficiency, Optimization, Software, VIKOR method

Introduction

Various technologies and methods are applied when developing high quality software systems. Different ways are available for creating optimal software. In previous articles (Mahmudova, 2020), an algorithm was developed to select the best software using the TOPSIS [5] and AHP methods [6] to optimize the software, and good outcomes are obtained as a result of experiments. Software efficiency (SE) (ISO / IEC standard 25010: 2011 (state standard R ISO / MEK 25010-2015) determines the quality model of the product, and eight top-level characteristics are as follows.

The efficiency characteristics of software are:

1. Functionality;
2. Productivity;
3. Compliance;
4. Ease of use;
5. Reliability;
6. Security;
7. Accompanying;
8. Mobility.

As noted, reliability is one of the key performance characteristics of software. Reliability of software (SR) is the features of the features to accomplish certain functions, and they are kept in certain boundaries under definite

circumstances. In other words, the reliability of a program is the probability that software will work without any failure for a certain period of time. The reliability of the software is determined by its non-denial and recoverability [8]. There may be important factors that affect the reliability of software. The reliability of software is its ability to maintain its functioning in the course of data processing on computer.

Software reliability criteria:

1. Software accuracy;
2. Software recovery;
3. Improvement;
4. Algorithm selection;
5. Software reserve;
6. Software monitoring and testing.

Software accuracy refers to its compliance with the specifications. One of the important features of software reliability is that it can be restored due to errors and consequences in the program. Recovery after a software failure is the ability to correct the program text, correct the data, and make changes to the organization of the computation process. The recovery capability of software can be assessed by the average time it takes to troubleshoot a program and restore it to working condition. Software recovery depends on several factors: the complexity of the structure of software complex, the algorithmic language in which software is developed, the style of programming, the quality of software documents, and so on. Causes of software failure and the main causes of direct software failure lie in tie followings:

1. errors hidden in software itself;
2. falsification of used input data;
3. user error;
4. device failure on which the computing process is performed.

The American National Standards Institute (ANSI) defines the reliability of software as: the probability that a program will run flawlessly over a period of time in a given environment. It is difficult to get the reliability of the program, because the high complexity of the program does not allow it. The following information should be considered to improve the reliability of software:

- Computer's configuration;
- Performance and reliability, for example, how software responses when a button is pressed, how many problems it encounters while software is running, how fast the data is sent over the network;
- Most commonly used tools in software program.

The development of an algorithm for software reliability is one of the foremost issues. There are three main types of algorithms used to solve different types of problems on a computer:

- Linear algorithms;
- Branching algorithms;
- Periodic algorithms.

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Methodology

Software reliability models

Software reliability models show random process forms, as it periodically determines the behavior of software failures. Models of software reliability appeared when people tried to understand its features, such as why the software is faulty and so on. People have tried to quantify the reliability of software [7].
Since the early 1970s, there have been created more than 200 software reliability models. However the question about how to assess the reliability of software remains unresolved.
The software reliability models are sown in Table 1.

Table 1: Software reliability models (Neufelder, 2017)

Model	Inputs Number	Industry supported	Effort required to use the model	Relative accuracy	Year developed/ Last updated
Industry tables	1	Several	Quick	Varies	1992, 2015
CMMI® tables	1	Any	Quick	Low at low CMMi®	1997, 2012
Shortcut model	23	Any	Moderate	Medium	1993, 2012
Full-scale model	94-299	Any	Detailed	Medium-High	1993, 2012
Metric based models	Varies	Any	Varies	Varies	NA
Historical data	A minimum of 2	Any	Detailed	High	NA
Rayleigh model	3	Any	Moderate	Medium	NA
RADC TR-92-52	43-222	Aircraft	Detailed	Obsolete	1978, 1992
Neufelder model	156	Any	Detailed	Medium to high	2015

Reliability determines the end result of software. During fierce competition, any software should not only provide the necessary functionality, but also provide some additional benefits to end users. Developing software is a tedious and time-consuming process, like an experiment. Thus, ensuring the reliability of software should be the primary goal of the appropriate model specified, adopted, and selected by the organization listed above. One of the methods of ensuring the reliability of the software is the Vikor method.

Literature review

Some tasks in which the VIKOR method is applied are reviewed below.

1. Compromise VIKOR method is used in linear programming task. Real decision-making problems often involve the consideration of many opposing goals. MCD is an experimental basis in relevant fields. [3] examines the problem of fuzzy MCD, in which all parameters are fuzzy, and offers a solution using the multi-criterion VIKOR method. The offered method seeks to find a fuzzy effective solution to the problem by minimizing the distance from ideal and anti-ideal solutions. Applying this method may disclose effective boundary for this issue. The applicability of the proposed method is shown in the example and the application is generalized to the investment problem. Both examples demonstrate the usefulness of this method.
2. Vahdani, Salimi and Mousavi (2015) suggests a method based on the VIKOR method as a compromise method to solve extensive nonlinear programming tasks. The proposed method was first introduced to solve extensive nonlinear programming in a fuzzy environment. This problem involves fuzzy ratios in both objective functions and constraints. In this method, the aggregate function based on the LP metric approaches the "ideal" solution based on a special "proximity" dimension. The solution process consists of two stages. The first uses the decomposition algorithm to reduce the q-dimensional space to a one-dimensional space. Then, to solve the problem, multi-purpose identical nonlinear programming is obtained from each fuzzy nonlinear model. The

second one solves the problem of large-scale single-purpose nonlinear programming to find the final solution. An illustrative example is provided to substantiate the proposed method.

3. Being introduced as a Multi-Attribute Decision Making (MADM) method, the VIKOR method resolves decision-making issues through separate and contradictory criteria. It seeks to list, select the number of alternatives on the basis of a certain "proximity" metric to an "ideal" solution. A multi-criteria method developed for compromise sorting is based on l-p metric applied in the compromise programming method as an aggregate function. This study extends the VIKOR method to resolve extended non-linear programming tasks with block-angle structure. This approach applies Dantzig-Wolfe fragmentation algorithm along with the Y-dimensional target area reduced to a one-dimensional area by expanding the concepts of the VIKOR method to make decisions in a sustainable environment. Finally, the paper presents an example to demonstrate and explain the foremost outcomes obtained in this study (Heydari, Sayadi & Shahanaghi, 2010).
4. The VIKOR and TOPSIS multi-criteria decision methods are based on a set of aggregate functions that represent the "ideal proximity" arising from compromise programming. The VIKOR uses linear normalization, while the TOPSIS uses vector normalization in order to exclude criteria function units. VIKOR's compromise ranking method determines the maximum "group benefit" for the "majority" and a compromise solution for the "competitor". The TOPSIS method defines the solution at the shortest distance to the ideal solution and the longest distance to the negative ideal solution, however it cannot take into account the relative importance of these distances. Opricovic (2011) explains a comparative analysis of these two methods in an example and demonstrates some differences and similarities.
5. Emission problems have obliged energy organisations to apply cleaner energy sources such as renewable and hydroelectric technologies. Nevertheless, the optimal use of reservoirs has been highlighted in recent decades due to water insufficiency in many areas. In this regard, Simab, Javadi and Nezhad (2018) offers a multi-purpose model for short-term hydrothermal planning issue when pumped storage technology is available. It uses VIKOR method to solve the task. The effectiveness of the proposed model is tested by comparing the results obtained with four sample studies using different methods.
6. The linguistic ambiguity of a particular fuzzy set derived from linguistic terms may represent the qualitative preferences of decision-makers, as well as their uncertainties and hesitations. In this study, a new VIKOR method is used to solve multi-criterion decision tasks. The paper analyzes an evaluation sample of a smart transport system to demonstrate the effectiveness and expediency of the proposed method (Dong, Yuan & Wan, 2017).
7. Digital control machines are used for high-precision, repetitive, complex and dangerous production operations. However, there are several decision-making criteria to be considered when choosing the right one. Fuzzy VIKOR-based multi-criteria group decision-making method offered to solve the problem in the work. Triangular fuzzy numbers denote the linguistic variables, which replicate decision-makers' preferences related to weights of criterion significance and evaluation of their effectiveness. This study develops two algorithms based on a fuzzy linguistic approach. It proposes a common method based on these two algorithms and the VIKOR method (Wu, Ahmad & Xu, 2016).
8. Alguliyev, Aliguliyev and Mahmudova (2015) uses a modified fuzzy VIKOR method for multi-criteria assessment of information culture of individuals. The VIKOR method is considered more proper for resolving the individual selection problem. A modified fuzzy VIKOR method developed in the paper ranks the alternatives. It presents comparative analysis of the outcomes of fuzzy and modified fuzzy VIKOR methods. Experience shows that the proposed modified fuzzy VIKOR method has a number of benefits over the conventional fuzzy VIKOR method. The presented model is efficient in terms of computational complexity.

About the VIKOR method

Different methods are used to determine the reliability of software. One of them is the VIKOR method. Brief information about this method is given below. The VIKOR method is a multi-criteria decision (MCD) or multi-criteria decision analysis method. It categorizes alternatives, identifies the one closest to the so-called compromise ideal. A compromise solution was first proposed in 1973 by Po-Lung Yu and Milan Green.

It was stated that a compromise was acceptable, initially offered by Seraphim Opricovic for conflict resolution problem solving and diverse (different sections) criteria, that the decision-maker wanted the solution closest to the

ideal and evaluated all alternatives based on defined criteria. The method evaluates the alternatives, identifies a solution called compromise that is closest to the ideal (Opricovic & Gwo-Hshiung, 2007).

Sayadi offered main ideas about VIKOR in his thesis in 1979, and information on its application was published in 1980. The name VIKOR originated from the Serbian language in 1990: Multi-value and Optimization of Compromise solution (VIseKriterijumska Optimizacija I Kompromisno Resenje, Vikor). In 1998, real expressions were introduced. The VIKOR method was internationally recognized in the document adopted in 2004 (Sayadi., Heydari & Shahanaghi, 2009). As a result, a compromise solution can be provided by those who make decisions, as it provides the maximum utility of the majority and the minimum failure of the individual competitor. Measures are integrated for a compromise solution, which is the basis of an agreement recognised by mutual concessions.

Conclusion

The fuzzy VIKOR method is designed for the solution of task in fuzzy environment. Here, both criteria and weights may be fuzzy. To control uncertain numerical quantities, triangular fuzzy numbers are applied. Fuzzy VIKOR is based on fuzzy work that characterizes and combines the length of an ideal solution alternative. Fuzzy operations and fuzzy ranking procedures play a key role in the development of fuzzy VIKOR algorithm. Applying this method, the reliability of software can be achieved.

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Theme 4:

Natural and health science (HHS)

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Scoping review: Adherence in TB journey, its challenges and sustainability

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Abstract: This systematic scoping review proposed examining issues connected to TB medication non-adherence among TB patients over a long time in South Africa. Wide electronic databases and online digital libraries were searched, including medical informatics (Google Scholar, PubMed Central, Web of Science and MEDLINE) by means of the keywords: 'TB medication non-adherence, TB non-adherence and interventions, digital health strategy to end TB, program, management of TB, control, and sustainability to medication'. Various studies envisioned to address TB medication non-adherence in developing nations and South Africa among TB help seekers from 2010 to date were incorporated in data extraction. Twenty-eight innovative articles were altogether reviewed. Articles not written in English were all excluded. Factors that contributed to non-adherence were identified and discussed. Those factors linked with TB medication non-adherence were socioeconomic factors: patients-health care facilities, stigmatization, distance to facilities, poverty, lack of social support, and poor workers' communication. Behavioural factors include smoking, getting improved some weeks into medication, drugs, improper communication on TB treatment are problems linked with non-adherence alongside additional factors. Digital interventions like the DOT, SMS, and Video reminders were identified, and the sustainability approach to long-term TB medication adherence during the TB journey was mentioned. Some digital interventions have been in use but have various limitations therefore, an innovative intervention that will be patient-centred and sustained over a long period of time to support the End TB goal is suggested in South Africa and sub-Sahara Africa.

Keywords: Iceberg theory, Long-term, Non-adherence to medication, Sustained support, TB journey, TB patients

Introduction

Tuberculosis (TB) is a contagious disease that has been recognized by mankind for thousands of years. Although curable, it remains a reality affecting the lives of many hackathon patients, their relatives and is still a significant challenge in public health care (WHO, 2017). The adherence to medication regimens has been identified as one of the most significant challenges in addressing the spread and reoccurrence in and amongst the risk population (WHO, 2015, 2017). According to WHO, 1.5 million individuals have died from tuberculosis (including 214 000 people with HIV) in 2020. TB is the world's 13th biggest cause of mortality and the second leading infectious killer (behind HIV/AIDS). Also, an anticipated 10 million people globally will have contracted TB. There are 5.6 million men, 3.3 million women, and 1.1 million children in the country. Tuberculosis is seen in all countries and in all age groups. TB, on the other hand, is both treatable and

avoidable (Migliori et al., 2020). In the year 2020, the 30 nations with the highest TB burden would account for 86% of new TB cases. China, Indonesia, the Philippines, Pakistan, Nigeria, Bangladesh, and South Africa account for two-thirds of the total (Migliori et al., 2020). Moreover, TB occurrence is decreasing at a rate of roughly 2% per year globally, with a total reduction of 11% between 2015 and 2020. This was more than halfway to the End TB Strategy's goal of a 20% reduction in TB cases between 2015 and 2020(Migliori et al., 2020). According to the most recent national TB patient cost survey statistics, nearly one in every two TB-affected households faces costs that exceed 20% of their household income. By 2020, the entire planet has not reached the goal of 0% TB patients and their families incurring devastating losses as a result of the disease. Thus, support in low- and middle-income countries (LMICs), which accounted for 98 percent of recorded tuberculosis cases, is far insufficient. In 2020, spending was US$ 5.3 billion, only around half (41%) of the global objective (Migliori et al., 2020). One of the United Nations Sustainable Development Goals is to end the tuberculosis epidemic by 2030. (SDGs).

In South Africa for year 2019, the World Health Organization (WHO) predicted that 360,000 cases of active tuberculosis will be diagnosed. This equates to a rate of 615 per 100,000 people(Migliori et al., 2020). Based on South Africa statistics in 2017, the first national tuberculosis analysis and reporting began, with evaluation results received in 2020. The survey revealed that the number of persons living with tuberculosis in South Africa is significantly higher than previously estimated. It also revealed that many persons with tuberculosis are undiagnosed and untreated (SA survey, 2021). Around 80% of South Africa's population is infected with tuberculosis bacteria, the vast number of which have latent TB instead of active TB disease. The age group 30-39 years old living within suburbs and rural villages had the highest incidence of primary infection, estimated at 88 percent (Hopkins, Doherty, & Gray, 2018)(SANAC, 2021). Tuberculosis is the top cause of death in South Africa. In 2019, 58,000 individuals died from tuberculosis. It's anticipated that 36,000 of them were HIV-positive (Migliori et al., 2020).

Kanabus argued that there are many control programme for TB designed by WHO, not only has the disease remained uncontrolled, but it is rather having a huge challenge of nonadherence to medication leading to drug resistant cases(Curto, Einav, Finkelstein, Levin, & Bhattacharya, 2019; Kanabus, 2017). Factors contributing to medication nonadherence in South Africa include socioeconomic factors, Behavioral factors, Patient related factors,Healthcare system problem,treatment omplexity, Lack of knowledge of the disease and treatment (Tola et al., 2015). Controlling tuberculosis is crucial (DiStefano & Schmidt, 2016). Meanwhile, appropriate adherence treatment is needed in controlling TB, impediments to adherence varied and substantial. Health establishes an emergent field with promises to deal with such barriers. Hence, there will be an improvement in individual and population health and the health system's effectiveness (DiStefano & Schmidt, 2016). Medication non-adherence is a costly, multifaceted, and common issue that causes meagre treatment results and absorbs healthcare funds in developing countries. Moreover, non-adherence is hard to measure precisely, and solutions to alleviate it have not been successful (Dayer, Heldenbrand, Anderson, Gubbins, & Martin, 2013). The article adds to the importance of policymaking in developing nations, also necessary for education improvement, enlightenment or awareness development on the effect of TB non-adherence in our communities and the global world, most notably in the world of digital intervention and sustainable development goals (SDGs). This systemized scoping review aims to answer the research question on how the existing literature can help to constitute a framework for sustained adherence to medication over a long term to support the End TB goal.

Factors Disrupting Adherence in TB patients

Several epidemiological research works have discovered links to adherence, often investigating the issue from a biomedical viewpoint. The framework of TB patients has sometimes been expressed as patients receiving treatment are expected to obey instructions of the health care staff. Non-adherence occurs when patients do not follow the rules of medication. This method shows why the behavioural factor is multifaceted and is

determined by many issues involving patient health beliefs, socio-cultural background, and individual illness experience (WHO, 2003, 2017).

Patient-related issues - Age, gender and ethnicity are associated with various backgrounds such as beliefs and knowledge on issues. Adequate knowledge about TB and accepting the efficacy of the medication often determines whether the patient will adhere to medication or not. Also, cultural belief supports using traditional treatment against allopathic medicine. Some TB patients have altered mental states triggered by abuse, psychological stress, and depression that could play a part in non-adherence behaviours. Numerous patients' access to the health provider is mainly based on distance and unavailability of transportation alongside their health condition. A study revealed that even though the aim was for a DOT devotee to stop over at the health seekers home rather than the patient trekking to the devotee's house. This showed difficulty for TB patients with severe symptoms. Another study noted that admission to health services improved in cities than in rural areas. Patients and health providers admitted that non-adherence occurred once the distance from patients' homes was too far from the closest clinic. Patients' whose homes are closer to the hospital would frequently attend. The time needed to show for DOT often affect the capability to focus on other daily activities. In other studies, patients believed that private physicians were more reachable (da Silva Garrido et al., 2012; Habteyes Hailu, Azar & Shojaeizadeh, 2015; Ifebunandu & Ukwaja, 2012; Maruza et al., 2011; Naidoo et al., 2013; Yao et al., 2011).

Structural and economic issues – TB typically affects people who are difficult to access, such as the poor, the homeless, and the unemployed. Ineffective economic support and unsafe living environments are added factors that bring about an adverse situation for non-adherence in TB patients. Numerous studies specified that having TB had a negative effect on work (Munro et al., 2007). Studies advised that patients could not disclose their TB status for fear of job loss. Further work-related matters comprised trouble in getting sick-leave for treatment; fear of requesting cash to procure TB medications, along with fear of dismissal or losing a job (Munro et al., 2007). Struggles from work and treatment, with the concealed costs of treatment, leading to expenditures surpassing incomes may well lead people into poverty (Gust et al., 2011; Habteyes Hailu et al., 2015; Maruza et al., 2011; Naidoo et al., 2013; Tadesse, Demissie, Berhane, Kebede, & Abebe, 2013).

Health care delivery problem – The clinical organization of services such as poor communication, lack of expertise, inflexibility in the operating hours are linked with a patient support system that affects medication adherence. Most ambulances that serve as health care support for TB patients might lack the skills necessary for long-term supervision strategy with patients. Therefore, self-management is not enabled, and medication follow-up is irregular. Difficulties arising from healthcare facilities comprised of queues, long waiting times, inconvenient appointment times, lack of privacy and the poor maintenance of hospitals. Many studies described that patients had stress in getting into health facilities for treatment because of inconvenient operating hours and staff absence. Patients and healthcare workers listed poor TB medication accessibility at healthcare centres (Munro et al., 2007). For instance, one study stated that some health care staff traded TB medications that could be offered free of charge (Habteyes Hailu et al., 2015; Kebede & Wabe, 2012; Tachfouti et al., 2013; Vijay et al., 2010).

Behavioural issues – Lack of patient satisfaction from the health provider is an important factor in non-adherence. Proper relationships are challenging to build where health care workers are overworked, lack knowledge about TB, staff are not adequately supervised in their duties which happens in nations with a high TB burden. The relationship created by patients with the treatment worker may affect adherence. Several articles showed that poor workers' tracking and ill-treatment, including rebuking a patient for being absent during his/her appointments, caused non-adherence. In disparity, further studies observed the optimistic influence of improved patient-provider contact on adherence (Habteyes Hailu et al., 2015; Kulkarni et al., 2013; Naidoo et al., 2013; Sendagire, Van der Loeff, Kambugu, Konde-Lule, & Cobelens, 2012; Tachfouti et al., 2013).

Treatment complexity – Many medications need to be taken. However, their venomousness and added side-effects linked with the use might limit the continuation of medication. The altered mental state of patients can affect medication adherence. Asymptomatic patients are more likely not to adhere to treatment (WHO, 2003, 2017). Some studies emphasized how treatment demands might influence patient approaches concerning the treatment and their behaviour towards adherence. Patients may become tired of administering medicines (Allen, 2006; Gleissberg, 2001; San Sebastian & Bothamley, 2000), suspend medication based on lengthened treatment (Allen, 2006; Matebesi, 2004; Watkins, Rouse, & Plant, 2004), the number of pills (Jaiswal et al., 2003), or fear of drugs or painful injections (Pushpananthan, Walley & Wright, 2000) as identified by both patients and providers (Hailu et al., 2015; Munro et al., 2007; Muture et al., 2011).

Knowledge, towards TB treatment -The named researchers (Garrido et al., 2012; Naidoo et al., 2013; Tadesse et al., 2013; Tola et al., 2015) focused on the effect that patients' knowledge of treatment, duration of treatment and the subsequent result that avoidance had on treatment adherence. Patients and adherence adapted poorly to the lengthening time of treatment, and these are regarded to be enabled where patients are made to understand the reason for finishing treatment procedures. From the result gathered from a study on adherence to prophylaxis, it was described that non-adherence is common with patients who had less knowledge on TB as a deadly disease but are more mindful of its likely contrary effects caused by its treatment. Patients' cultural beliefs about treatment efficiency, both negative (Munro et al., 2007) and positive, might influence adherence. TB patients often ask questions on the effectiveness of the drugs or assume that injections can cure them and query the rationality of diagnostic tests that are not well-thought-of as classy enough for a disease so dangerous as TB (Munro et al., 2007). Belief in medication efficacy is linked to patients' assurance in the medical system in certain instances, public-based treatment strategies improved self-confidence in members of the community that TB has a cure (Munro et al., 2007). Another study highlighted that patients choose to see traditional healers when there are not enough knowledge on the treatment provided (Amuha, Kutyabami, Kitutu, Odoi-Adome, & Kalyango, 2009; Bagchi, Ambe, & Sathiakumar, 2010; Castelnuovo, 2010; Cramm, Finkenflügel, Møller, & Nieboer, 2010; Elbireer, Guwatudde, Mudiope, Nabbuye - Sekandi, & Manabe, 2011; Gebremariam, Bjune & Frich, 2010; Hasker et al., 2010; Widjanarko, Gompelman, Dijkers, & van der Werf, 2009; Xu et al., 2009).

Understanding of disease and awareness of wellness – Previous studies from our findings stated that health-seekers halted medication because they felt being healed or due to a reduction in symptoms (Munro et al., 2007). Certain studies showed that patients who could feel worse than before medication or have seen no development in their health state might interject treatment. A research work carried out in The Gambia stated that immigrants came to the country to obtain TB treatment and reverted as soon as they improved (Harper, Ahmadu, Ogden, McAdam, & Lienhardt, 2003). Lack of understanding and awareness of wellness process could be connected to patients' commencements of recovery and the aetiology of TB. Medication non-adherence was reported according to observations on TB as an illness; some did not accept that they had been infected, they only sought for cure on the TB signs and terminated treatment by the time it reduced (Ayisi et al., 2011; Elbireer et al., 2011; Gebremariam et al., 2010; Hasker et al., 2010; Kittikraisak et al., 2009; Sagbakken, Frich, & Bjune, 2008; Vijay et al., 2010).

Factor type characterizes the classification of prompting issues based on comparing related factors as seen in the previous studies. This mode of grouping allows the formation of a category, sometimes in a pyramid, to help separate the terms. Factors that serve as barriers to adherence to TB medication can be described in Table 1 below.

Table 1: Factors that serve as barriers to adherence to TB medication

References	Socioeconomic	Behavioral	Health system problem	Condition and Therapy	Analytical result
Hasker et al 2010	Lack of food, homelessness, transportation problem, Joblessness, stigma related,	No knowledge on TB, Fear of stigma, lack of motivation	Poor communication, unfriendly staff, uneducated staff		Lack of basic amenities leads to socioeconomic factor, knowledge and stigma affect behavior of patients.
Sagbakken et al., 2008	Lack of food, Joblessness, lack of social support,	Lack of adequate knowledge, no motivation,			Social amenities, knowledge and motivation are needed for adherence
Naidoo et al., 2013	Lack of food, transportation problem, low education, age, gender, joblessness, stigma related	Lack of knowledge, alcohol consumption, lack of exercise, smoking of cigarette, psychological stress	Untrained staff, unfriendly health workers		Basic amenities, social network, stigma, and knowledge is required to support adherence
Gebremariam et al., 2010	Lack of food Finance, homelessness, low education, joblessness, Lack of social support, stigmatization,	Lack of Knowledge, fear of stigma, lack of motivation			Social support and fear of stigmatization, belief also affect adherence
Amuha et al., 2009	Lack of food	No belief, no motivation, drug abuse	Poor communication, Unavailability of a drug, no proper appointment time		Belief, knowledge, and social support is required
Tadesse et al., 2013	Lack of food, financial issues, basic amenities, Employment problem, stigma related,		Distance from healthcare centers, transport cost, lack of communication,		Finance, fear of stigma are components of factors
Muture et al., 2011	Lack of food, financial issues, location, low education, joblessness, stigma related,	Fear of stigma, lack of self-efficacy, abuse of substance, smoking of cigarette, wrong diet, lack of exercise	Drug unavailability poor communication, unconducive appointment time, uneducated staff, unfriendly health workers		Basic amenities Fear of stigma Social network, Adequate health facilities
Maruza et al 2011	Lack of food, low education, age, gender,	Alcohol consumption, abuse of drug, smoking, wrong diet, lack of exercise			Demographic, and lack of social support
Kittikraisak et al., 2009	Lack of food, income class	Lack of motivation, self-efficacy, & belief			Knowledge and belief
Gust et al., 2011	Financial issues, gender, age,	Alcohol and drug abuse	Transport to health centers, unfriendly health workers		Finances, and Lifestyle
Kulkarni et al., 2013	Financial issues, low education, age, joblessness,	Lack of TB knowledge, smoking of cigarettes, wrong diet, drug abuse	Lack of Social network, distance problem		Basic amenities, knowledge, and no social support
Bagchi et al 2010	Finance, transportation problem, basic amenities, Joblessness,	Fear of stigma, alcohol consumption, drug abuse, wrong diet, lack of exercise	Distance from healthcare centers		Stigma related, Social network and finances
Cramm et al., 2010	Income class, Low education,	Fear of stigma, alcohol consumption,			Lifestyle, low education

Kebedee & Wabe (2012)	Financial issues, Transportation problem,	Lack of knowledge, lack of motivation	Unfavorable appointment time, poor communication from staff to patients, unfriendly staff		Lack of Basic amenities
Garrido et al 2012	Finance, low education,	Lack of TB knowledge, alcohol consumption, drug abuse	Transportation to health centers		Knowledge level, social support
Elbireer et al., 2011	Income class, homelessness, knowledge, joblessness, stigma related, lack of social network,	Lack of TB knowledge, fear of stigma,	No proper communication to patients, lack of health education for staff, transport cost		Basic amenities, Finances and untrained health workers
Widjanarko et al., 2009		Fear of stigma, lack of motivation,	Unfavorable appointment time, poor communication, no proper health education,		No health education, stigma related
Yao et al., 2011	Homelessness, Basic amenities, low education,	Lack of motivation,			Belief, Basic amenities
Tachfouti et al., 2013	Low education, gender, age	Lack of knowledge, no motivation, belief, lack of exercise, wrong diet, drug abuse	Transportation cost		Lifestyle, belief, finances
Vijay et al., 2010	Low education, Unemployment	Lack of TB knowledge, fear of stigma, lack of motivation, drug abuse	Unfavorable appointment time, long queue, untrained staff, unfriendly health workers		No knowledge, lifestyle, Lack of skilled staff
Xu et al., 2009	Knowledge, stigma related,	Fear of stigma, lack of motivation,	Lack of adequate support from health workers		
Ifebunandu & Kingsley (2012)	Age, gender,		Transportation cost, distance from health care centers		
Castelnuovo 2010	Psychological, Social network,	Lack of motivation, no belief			Psychological issues, belief
Ayisi et al., 2011	Poverty	Lack of motivation, drug abuse, alcohol consumption, smoking, lack of exercise	Lack of expertise, Transport cost		
Sendagire et al., 2012		Lack of belief, no motivation, alcohol consumption,	Lack of expertise		
Munro et al., 2007	Adverse side effect on work, Age, gender, ethnicity, social amenities	Stigma related issue, lack of supervision at work	Untrained staff, Unfriendly staff Distance to health facilities	Altered mental state, Complex treatment dosage, Asymptomatic patients, adverse side effects	Side effects on work and health, belief, stigma related
Habteyes et al., 2015	Age, gender, ethnicity	Lack of patient satisfaction	Healthcare delivery problem	Complex treatment dosage, Asymptomatic patients, adverse side effects	Knowledge, belief
Matebesi, 2004	Homelessness	Fear of stigma		Lengthen treatment, adverse side effect	
Allen, 2006	Unemployed, poverty			Lengthen treatment, adverse side effect	
Watkins et al., 2004	Homelessness, Poverty,			Too long treatment period,	Basic amenities

	unemployment			
Pushpananthan et al., 2000.	Poverty, Joblessness	Lack of flexibility in appointment time	Fear of drugs, Painful injections	Psychological related
Jaiswal et al 2003	Poverty, unemployment		Too much medication to take	

Table 1 shows the factors that lead to non-adherence in TB patients. The researcher analyzed the factors based on components and elements that eventually resulted in the above factors. The components and elements were observed by other researchers as the components of medication non-adherence.

Methodology

This section expounds in using a systematized literature review approach or procedure to carry out a scoping review on TB medication non-adherence in a long-term patient journey. According to Fink, a literature review is defined as an unambiguous, systematized, and dependable approach of evaluating, identifying, and synthesizing the current completed and documented work carried out by scholars, practitioners, and researchers (Fink, 2019). Moreover, this involves carefully collecting data by evaluating, identifying, and synthesizing (Fink, 2019), which impacts the integrity of work done (Hart, 2018; Jahoor, 2019). This definition shows that following a systematic approach while doing a scoping review will be efficient (Colquhoun et al., 2014). As posited by Colquhoun et al., a scoping review is a way of knowledge synthesizing that reports an exploratory research question intended to map vital concepts, kinds of evidence, and gaps in related research to a definite field through systematically selecting, searching and synthesizing previous understanding. This review describes the building of a theoretical framework to guide succeeding research (Okoli & Schabram, 2010). Relevant articles in the subject of study were collected and investigated by a systematic literature review. The systematic method aided the purpose of this research process (Seuring & Müller, 2008) that helps in contributing to current literature (Okoli & Schabram, 2010).

The systematic scoping review was facilitated by accessing an academic library that supports several online databases and a digital library in medical informatics and software engineering. The multidisciplinary academic databases used are Wiley Online Library, IEEE Xplore, Web of Science, PubMed, Science Direct, Scopus, Springer, Google Scholar, ACM, and expert referrals. Health-related databases searched include Embase, BMC, MEDLINE, and Global health. Keywords and phrases used in data retrieval are 'TB medication non-adherence, 'TB non-adherence and interventions', digital health strategy to end TB, program, management of TB, control, and sustainability to medication. In addition, the researcher incorporated studies that investigated non-adherence to precautionary or therapeutic TB treatments that explained the perception of health-seekers and health care providers. Publications only written in English were considered in this study from 2000 to December 2020; articles that define the programs, procedures, or interventions in TB medication non-adherence control from public health perception aim to decrease the occurrence death rate. Exclusion criteria are: (1) Policy/Strategy papers the likes of bulletin items and magazines are disqualified from this study; (2) articles relating to biological, clinical, and epidemiological non-interventional research work; (3) articles that do not relate to TB are all exempted. The search was modified to include studies carried out in South Africa and other developing nations to suggest the current state of the research literature on non-adherence and intervention.

Data analysis and selection

A systematized review is a reiterative approach that presents a steady flow of information in a flow chart, as shown below:

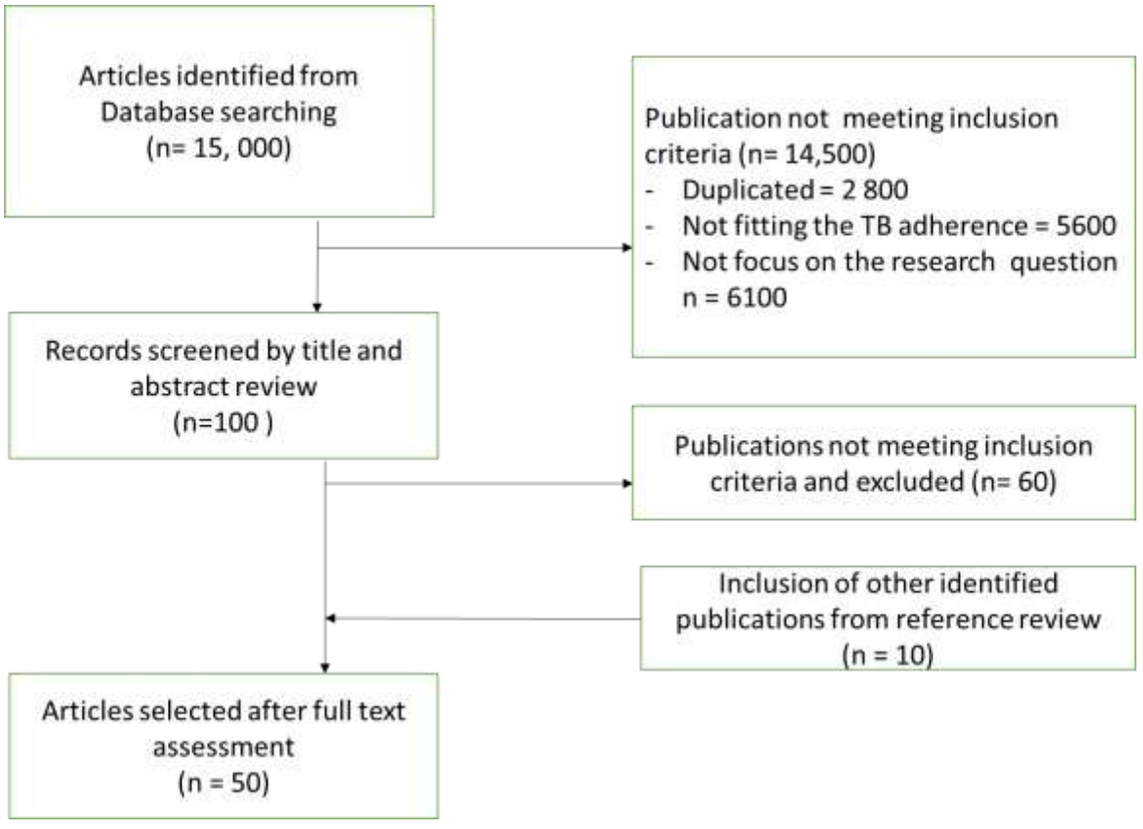

Figure 7: Number of articles used during this systematic review

The twenty-eight articles feature TB non-adherence from a global perspective, studies from South Africa and other developing nations and articles focusing on long term care.

TB Patient pathway

A disease such as TB requires a long-term treatment that cannot be measured just by refining diagnosis and treatment adherence in healthcare centers. TB needs a vigorous facility through which private and public health centers work together to support each other. A health system is required to alert patients with suggestive TB symptoms (Identify presumptive TB patient). Such a system would have efficient mechanisms at hand to ensure early detection (diagnose TB patients), treatment instigation (Enroll TB patients), and completion with adequate referrals to professionals in the right sector, as described in Figure 1. Information needs to be provided to patients' families clearly to understand the process and risk involved in non-adherence so that a better outcome is achieved(Bhattacharya Chakravarty et al., 2019). This initial stage is the awareness state to prepare the potential patient for treatment, but patients do not understand the details of what the medication period entails. Therefore, the long-term medication phase is not properly managed by the patients.

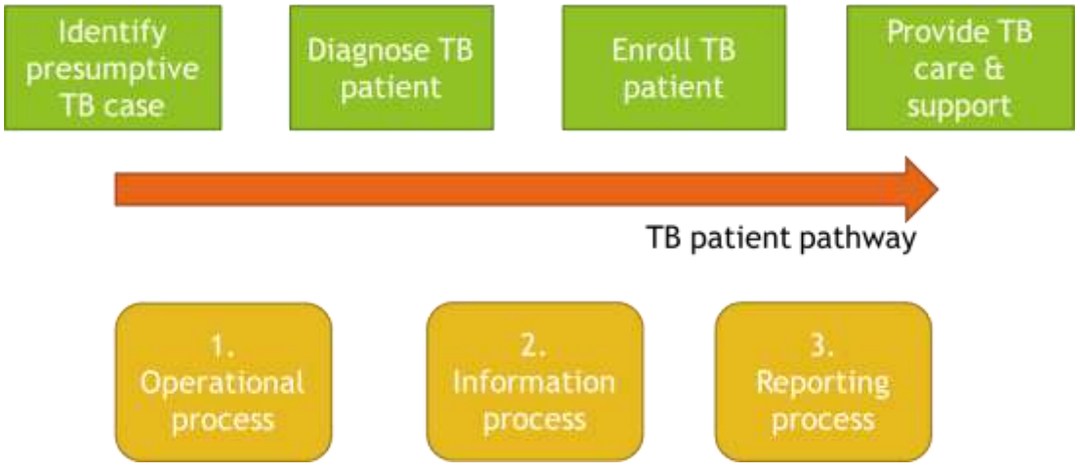

Figure 8: TB patient Journey (Adapted from WHO 2017).

TB patient pathway aid patients during the detection phase of TB symptoms, but the care and support needed while on medication is beyond the pathway illustrated above. Therefore, this paper will use iceberg theory to analyze the behavioural pattern that affects the patient in adhering to medication over a long period of time.

The Icebery theory

The iceberg theory, according to Hemingway, is defined as the real intent of a writer not being noticeable from the surface, but the real part of the work is under the surface. The iceberg approach allows people who read to perceive the meaning from Hemingway's basic understanding. He further observed that the iceberg is one-eighth above the surface while the seven-eighth is below (Darzikola, 2013). Little of the circumstances around the iceberg is seen on the surface, but many other issues/ reasons are hidden underneath the iceberg that should be explored. Green suggests a socio-environmental model of health advancement where health and its security are construed in the context of the environmental system (Green & Marshall, 2005). Also, Hanson alongside other researchers. propose the injury iceberg adapted in this scoping review to analyze the factors affecting adherence to long-term medication in TB patients. Three dimensions/factors to the system are specified:

- The individual and their attitude.
- The physical environmental factor
- The societal, environmental factor.

The components and elements that constitute the factors are now discussed:

The intra-personal component is related to the individualities, skills, knowledge, experiences in life, behaviors, and attitude show how they relate in the society and environment (Hanson et al., 2005).

The **inter-personal** components refer to the direct physical environment and the social networks where the person lives the family, spouses, friends, and colleagues (Hanson et al., 2005).

The **organizational** components are the institutions surrounding the TB patients. Mostly, these are work-related places with goals and objectives to achieve and influence TB patients. These are the health facilities, clinics, private and public hospitals inclusive, and health caregivers, doctors, and nurses (Hanson et al., 2005).

A **community** consists of functional and structural terms. Its geographical and political borders define a community. A community could share cultural, demographic, ethnic, and social features in its functional state with its members. I have a sense of belonging and identity in norms and communication (Green, 2005; Hanson et al., 2005).

A **society** is a larger environment, being referred to as political borders, having the capacity to allocate resources, control the development of facilities to improve the lives of members of their community (Hanson et al., 2005).

The individual factor referring to the tip of the iceberg is just a part of the factors with components and various elements affecting adherence in TB patients. These factors could be the most visible components, but vital determining factors of their behaviour and environmental danger are concealed under the watermark. The

underlining factors unseen are more complex, and they are hard to change. Attempting to solve this factor alone (individual behaviour) would not yield a sustained outcome. Hanson and other researchers acknowledged that behavioural and health change is tough and probably unsuccessful when other social and cultural factors affect such change(Hanson et al., 2005). The socio-environmental factor emphasized the individual, the social and the physical environment. Each factor is built on deeper components and elements that contribute to non-adherence to medication in the long term. For adherence to TB patients, more attention needs to be paid to the components and elemental issues facing TB patients (Physical and societal environmental factors), as shown in Figure 2.

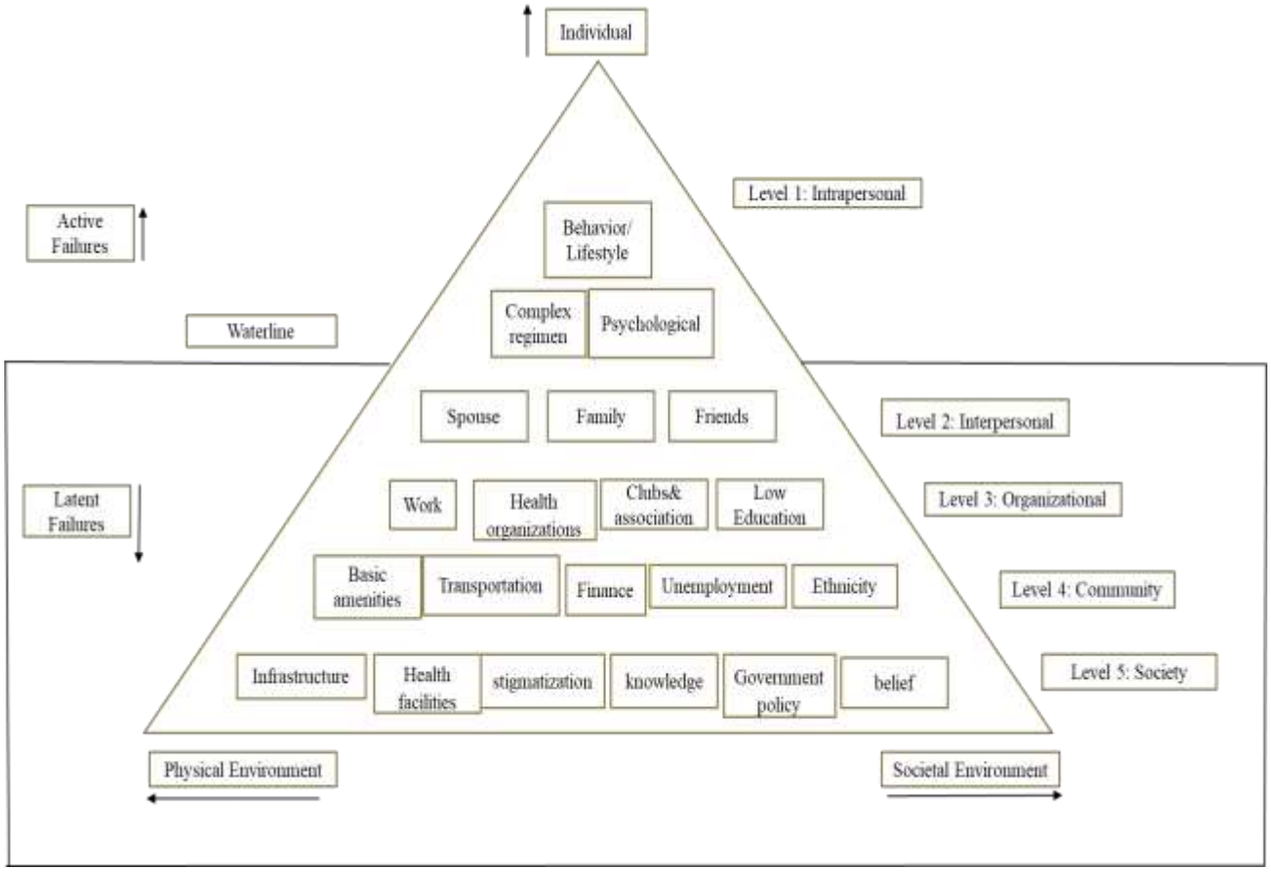

Figure 2: Application of iceberg injury in medication adherence for TB patients (Adapted from Hanson et al., 2005)

The iceberg theory explains the levels of components and their associated elements on how it affects adherence in TB patient behaviour.

Result and discussion

From the review findings, it was discovered that adherence to long term medication in TB patients is affected by many factors identified as Socioeconomic, Behavioural, patient-related, health facility-related and complex therapy/regimen. These factors are further affected by other components from patients' background, knowledge, and social status, and societal components also constitute non-adherence in TB patients. Stigma related issues made TB patients afraid, patients life experience is a major contributing factor too, poverty, joblessness, financial problem, and unfriendly health workers. According to the Iceberg theory, all factors would be unidentified by the behavioural pattern of patients but by carefully analyzing what underlining factors are and start by identifying each and then provide a solution that would be sustained. TB patient pathway has observed the initial phase of identifying a potential patient and initiating the treatment process for such individuals. TB care and support is the reality after the initial discovery, and the treatment period will last about six months which is a long time for patients to be on daily medication. Treatment adherence should be maintained for the patient to be cured to avoid the disease developing into a more complex drug resistance situation. Understanding how these factors interconnect over a period is significant for improving the research programme on discovering sustained health interventions.

This article has helped to search previous literature on various factors that affect treatment adherence and what more needs to be done for sustained adherence to medication over a long term to support the End TB goal.

Conclusion

In conclusion, this article assessed the level of adherence in TB patients receiving medication for a long-term period. Although previous literature highlighted factors affecting medication adherence, this review revealed additional components and elements that constitute more to patients' behaviour to non-adherence. Hence, to provide sustained support to TB patient medication adherence, the components and elements that result in non-adherence behaviour should not be overlooked. A sustained intervention can only be effective when strategies are developed to address these factors from the foundation and not only issues that appear through individual behaviour.

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Studies towards the development of potential antibiotics from the leaves and stem bark extracts of *Pterocarpus Osun*

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Abstract: *Pterocarpus osun* is a leguminous tree that belongs to the family *Fabaceae*. *P. osun* is an ingredient used in traditional therapy for the treatment of sickle cell disorder, diarrhea, dysentery, and management of freshly severed umbilical cord to prevent infections. The goal of this study was to look at some of these old assertions. Hexane, ethyl acetate, and methanol were used to extract the leaf and stem bark of *P.osun*. The antioxidant capacity of the extracts was determined using the 2, 2-Diphenyl-1- PicrylHydrazyl DPPH scavenging technique. Standard procedures were used to screen the extracts for secondary metabolites and antibacterial activity. The DPPH scavenging activities of all the fractions compared favorably well with the ascorbic acid used as standard. Highest activity (of 85.0%) for the extracts was recorded at 0.0625mg/mL for the methanol stem bark extract and the least activity (62.7%) for ethyl acetate leaf extract at a concentration of 1.0mg/ml. Terpenes, cardiac glycoside, saponins, steroids, alkaloids, tannins, and flavonoids are some of the phytochemicals detected in the extracts. Four of the tested organisms were sensitive to all the extracts while four others were resistant. The inhibitory zones were measured between 18mm and 29mm. For the crude and crude fractions, the extracts were evaluated for their minimum inhibitory concentration (MIC) and minimal bacteria/fungicidal concentrations (MBC/MFC) at 2.5mg/mL and 0.5mg/mL, respectively. The findings of these investigations suggest that the plant could be used as a supplemental medicine source. In future medication development projects, more chemical analysis for chemical ingredients is required.

Keywords: Antimicrobial, DPPH, Fabaceae, *Pterocarpus osun*, Secondary metabolites

Introduction

One of the most significant breakthroughs of natural products and medicinal chemistry in recent decades has been the investigation of new antibiotic sources. However, it is important not to take these success stories for granted, as pathogenic organisms appear to be fighting back, and scientists are fighting a never-ending battle with drug-resistant microbes. Bacterial infections continue to be a major cause of death in impoverished countries around the world. According to the World Health Organization (WHO), tuberculosis (TB) killed around two million people in 2002, and about two million children died of respiratory diseases in 2000.Approximately two million children died of respiratory illnesses, with Africa and Asia accounting for 70% of these deaths. In the industrialized world, deaths from multiple-resistant Staphylococcus aureus (MRSA) infections are becoming more common among the elderly (WHO, 2014).

Literature review

Different plant organs, including leaves, stem bark, root, and root bark, have long been used as traditional medicine due to their healing properties. The therapeutic properties of plant organs are due to bioactive substances found within them. Alkaloids, tannins, flavonoids, saponins, and phenols are among the most important bioactive secondary metabolites (Shihabudeen *et al,* 2010). In different plants, their quantity may differ, and the organs of a plant produce therapeutic characteristics that are unique to that plant. Because of their antibacterial and antioxidant actions, phytochemical potential, low toxicity, and potential to be a good alternative to synthetic medications, interest in the study of many medicinal plants has risen dramatically in recent decades (Chew *et al,* 2012). Natural products are unquestionably used as sources of a vast number of antibiotic isolates for the treatment and control of infectious pathogens (Shriram *et al*, 2018). The efficiency and cost of many antibiotic medications have been drastically lowered as a result of the rise of multidrug-resistant (MDR) bacteria (Pitout, 2008; Van *et al,* 2017; Falcone *et al*, 2016). According to the Centers for Disease Control and Prevention (CDC), at least two million people in the United States suffer serious bacterial illnesses each year that are resistant to one or more antibiotics used to treat them. Antibiotic resistance has a significant economic cost in terms of both direct health care and productivity. Because to poor or complete lack of surveillance systems, poor laboratory diagnostics, and lack of access to effective antimicrobials due to budgetary constraints, the issue is especially urgent in low-income regions of the world.To avoid an increase in mortality and negative economic consequences in the years ahead, urgent and effective intervention in the search for novel medications is essential (Solomon *et al*, 2014; Rather*et al*, 2017; Shehadeh *et al*, 2016; Courvalin *et al*, 2016; Sharland *et al,* 2015; Raoult *et al*, 2016; Morehead *et al,* 2018 and Dhami N, 2013). As a result of this, as well as the introduction of new diseases such as Lassa fever, Ebola, and Covid-19, the need for a novel antibiotic derived from natural products has become critical in overcoming the health issues posed by multidrug-resistant microbes (Bakal *et al,* 2017). Several studies have found that medicinal plants contain bioactive phytochemicals that are used as a starting point for the production of antibiotics used in disease therapy (Rahman *et al,* 2007). Aside from their physiological qualities and uses in plants, medicinal plants have been documented to have antioxidant, antimalaria, antibacterial, and other effects.

In the culinary, pharmaceutical, cosmetic, and agricultural industries, many physiologically active chemicals have been identified and employed (Osbourn *et al*, 2009; Mierziak *et al*, 2014; Takshak *et al* 2018). As a result, studying medicinal plants and their natural bioactive principles has become critical in order to maximize the potential value of natural goods. Traditional medicine has employed the stem bark of Pterocarpus osun to treat diarrhea, dysentery, and gastrointestinal ailments. The leaves of the *Pterocarpus* plant are used as a febrifuge, and the bark is used as a tonic. To make cough medicine, the grated root is combined with tobacco. It's also been proven to help with fever (Hutchinson *et al,* 1958). The leaves have insect repellent properties as well. A tribe in Senegal/Guinea, Africa, uses it as a pesticide to safeguard their crops. The tree could be used as a honey producer because bees are drawn to the blossoms. P. santalinoids is edible when cooked, although it is reported to be intoxicating when not. In addition, the seeds are considered to be intoxicating (Sandrine *et al,* 1983; Gill, 1992). The powdered stem protects the freshly severed umbilical chord against infection. Rheumatism, eczema, gonorrhea, candidiasis, and acne have all been treated with it in traditional medicine (Upholf, 1959). Traditional treatments for sickle-cell disease and amenorrhea (Upholf, 1959; Krumbeigel, 1948) include the stem as a component. The heartwood, bark, and roots are ground into a paste and applied to the skin as a cosmetic (Krumbeigel, 1948). The antioxidant activity as well as the depigmenting action have been documented (Krumbeigel, 1948). The wood contains red pigments of the santarubin and santalin that can be used as histology stains, according to studies (Krumbeigel, 1948; Osuagwu, 2008). The contents of proximate and vitamins have previously been published (Osuagwu, 2008) Because of the present global issue of rising antibiotic resistance in microorganisms, determining the antibacterial activity of various medicinal plants is of particular interest these days. Drug resistance in pathogenic bacteria is thought to be rising as a result of the indiscriminate use of commercial antimicrobial medicines. Antimicrobial resistance poses a growing challenge to the prevention and treatment of infections caused by bacteria, parasites, viruses, and fungi. As a result, identifying chemicals that can be exploited to generate novel treatments with improved antibacterial characteristics is critical.

Methodology

The Sheda Science and Technology Complex (SHESTCO) biological garden, Kwali area council of the Federal Capital Territory (FCT), Abuja, Nigeria, provided fresh leaves and stem bark of P.osun. With herbarium number NIPRD/H/7251, the plant was validated at the National Institute of Pharmaceutical Research and Development (NIPRD), FCT, Abuja. After two weeks of air drying, the materials were crushed in a hammer mill. For later usage,

the powdered samples were stored in plastic bags. All of the reagents that were utilized were of analytical grade. Redistilled solvents were used. The plant materials were extracted in stages using n-hexane, ethyl acetate, as well as methanol and cold maceration for 72 hours. A rotary evaporator was used to concentrate the extracts after they were filtered. The extracts were air-dried before being weighed and recorded.

Phytochemical screening

The extracts' fractions from the stem bark and leaves of *P.osun* were screened for their phytochemical constituents using standard methods (Sofowora, 1993; Trease and Evans, 2002; Harbone, 1973; Debela, 2002) .

Antioxidant activities

The antioxidant and free radical scavenging capacity of *P.osun* extracts were evaluated using a modified version of the standard DPPH (2, 2-diphenyl-1-picryhydroxyl) test (Brand-Williams, 1995). The coloring of the 2, 2-diphenyl-1-picryhydroxyl radical in methanol is involved. The absorbance was measured at 517nm after 30 minutes of incubation in the dark against a blank solution at the following concentrations (1.0, 0.5, 0.25, 0.125, and 0.0625mg/mL). The same concentrations of vitamin C (1.0, 0.5, 0.25, 0.125, and 0.0625 mg/mL) were employed as a standard. The capacity to scavenge radicals was determined using the following formula:

$$\text{Inhibition percent} = \frac{A_b - A_s}{A_b} \times \frac{100}{1}$$

Where, A_b = absorbance of the blank solution, As = absorbance of the sample

Antimicrobial screening

Pathogenic microbes (*Methicillin Resist Staph aureus, Vancomycin Resist Enterococci, Escherichia Coli, Vibrio Cholerea, Salmonella Typhi, Helicobacter Pylori, Campylobacter Jejuni, Candida Tropicalis, Candida albica, Candida Krusei*) obtained from the department of medical microbiology Ahmadu Bello university were used to determine the antimicrobial activities of the extracts of *P.osun* crude. (Sparfloxacin, ciprofloxacin, and fluconazole were employed as control antibiotics. The extracts were screened using the diffusion method with Mueller Hinton agar as the bacteria' growth medium. The medium had been prepared by sterilizing it at 121 degree Celsius15 minutes later, it was put into sterile Petri plates and allowed to cool and solidify. The sterilized medium was planted with 0.1ml of the test microorganisms' standard inoculums. A sterile swab was used to disseminate each inoculum equally across the surface of the media, and a well was cut in the center of each inoculated medium with a standard cork borer of 6mm diameter. The extract was dissolved in 0.1 ml of water at concentrations of 20 mg/mL for crude methanol leaf (CML), and crude methanol stam bark (CMB), and 5 mg/ml (for crude fractions hexane leaf (HL), hexane stem bark (HB), ethyl acetate leaf (EL), ethyl acetate stem bark (EB), methanol leaf (ML), and and methanol stem bark (MB) and then injected into the well on the inoculation medium. After a 24-hour incubation period at 37°C, the plates of the media were examined for the inhibited zones.

Inhibition Concentration Minimum (MIC)

Using the broth dilution procedure, the extract's minimum inhibitor concentration (MIC) was measured. Mueller Hinton broth was made, and 10ml was poured into test tubes. The broths were sterilized at 121°C for 15 minutes, and then allowed to cool. The solution was calculated using McFarland's turbidity standard scale number 0.5. The test microorganism was injected and cultured at 37°C for 6 hours after the normal saline was produced and 10ml poured into a sterile test tube. The test microbe was diluted in normal saline until it became as turbid as Mc-scale Farland's by visual comparison; at this point, the test microbe has a concensus. The crude methanol extracts of leaf and stem bark were serially diluted two times in sterile broth to generate concentrations of 20 mg/mL, 10 mg/ml, 5 mg/ml, 2.5 mg/mL, and 1.25 mg/mL (CML and CMB). Hexane crude fractions of leaf and stem bark (HL, HB), ethyl acetate leaf and stem bark (EL, EB), and methanol crude fractions of leaf and stem bark (5mg/mL, 2.5mg/mL, 1.25mg/mL, 0.65mg/mL, 0.31mg/mL (ML and MB). The initial concentrations were achieved by dissolving 0.2g and 0.05g of extracts in 10mL of sterile broth, respectively. After obtaining various quantities of the extract in sterile broth, 0.1mL of the test microbe in normal saline was found to be the most effective.

Results

Table 1: Phytochemical screening

Phytochemicals	HB	HL	EB	EL	MB	ML
Alkaloids	+	+	+	+	+	+
Flavonoids	+	+	+	+	+	+
Tannins	-	-	-	-	+	+
Phenols	-	-	-	-	+	+
cardiac glycoside	+	+	+	+	+	+
Saponins	-	-	+	+	+	+
Steroids	+	-	+	-	+	+
Terpenoids	+	+	+	+	+	+

Key: ML- methanol leaf extract, MB- methanol stem bark extract, EL- ethyl acetate leaf extract, EB- ethyl acetate stem bark extract, HL - hexane leaf extract, HB- hexane stem bark extract.

Table 2: Antioxidants activities (DPPH method)

conc (mg/mL)	ASA %	ML %	MB %	EL %	EB %	HL %	HB %
1.00	79.03	79.31	80.22	60.71	77.89	76.27	84.58
0.50	77.82	82.56	82.45	65.38	82.15	80.73	83.16
0.25	79.40	83.47	83.37	71.40	84.79	83.57	82.45
0.125	79.77	83.27	81.34	80.22	83.77	81.74	81.74
0.0625	81.24	83.87	85.00	80.12	84.18	83.67	81.54

Key: ASA - ascorbic acid, ML- methanol leaf extract, MB- methanol stem bark extract, EL- ethyl acetate leaf extract, EB- ethyl acetate stem bark extract, HL- hexane leaf extract, HB- hexane stem bark extract.

Table 3: Qualitative antimicrobial activities of leaves and stem bark against the test organisms

Test organism	CML	CMB	HL	HB	EL	EB	ML	MB	SX	CX	FZ
Methicillin resist staph aureus	S	R	S	R	S	R	S	R	S	R	R
S. aureus	S	S	S	S	S	S	S	S	R	S	R
Vancomycin resist enterococci	R	R	R	R	R	R	R	R	S	R	R
E. coli	S	S	S	S	S	S	S	S	R	S	R
V.cholerea	R	R	R	R	R	R	R	R	R	S	R
Salmonella typhi	S	S	S	S	S	S	S	S	R	S	R
Helicobacter pylori	S	S	S	S	S	S	S	S	R	S	R
Campylobacter Jejuni	R	R	R	R	R	R	R	R	S	R	R
Candida tropicalis	S	S	R	R	S	S	S	S	R	R	R
Candida albica	R	R	R	R	R	R	R	R	R	R	S
Candida krusei	R	S	R	R	R	R	R	R	R	R	S

key: S= Sensitive; R =Resistant; SX = Sparfloxacin; CX = Ciprofloxacin; FZ =Fluconazole ML = methanol leaf extract, MB = methanol stem bark extract, EL = ethyl acetate leaf extract, EB = ethyl acetate stem bark extract, HL = hexane leaf extract, HB = hexane stem bark extract, CML = Crude Methanol extract and CMB = Crude methanol stem bark extract

Table 4: Zones of inhibition (mm) of extracts against test and control microorganisms

Test organism	CML	CMB	HL	HB	HL	EB	ML	MB	SX	CX	FZ
Methicillin resist staph aureus	20	0	18	0	27	0	23	0	30	0	0
Staphylococcus aureus	22	18	23	20	29	25	26	23	0	29	0
Vancomycin resist enterococci	0	0	0	0	0	0	0	0	32	0	0
Escherichia coli	21	20	21	22	26	28	24	25	0	37	0
Vibro cholerea	0	0	0	0	0	0	0	0	0	29	0
Salmonella typhi	18	20	23	20	25	24	24	24	0	39	0
Helicobacter pylori	21	19	22	24	27	26	25	24	0	30	0
Campylobacter jejuni	0	0	0		0	0	0	0	31	0	0
Candida tropicalis	18	20	0	0	24	25	23	22	0	0	32
Candida albicans	0	0	0	0	0	0	0	0	0	0	32
Candida krusei	0	19	0	0	0	0	0	0	0	0	34

Table 5: Minimum Inhibitory Concentration of extracts against the test microorganisms (mg/ml)

Test organism	**CML**	**CMB**	**HL**	**HB**	**EL**	**EB**	**ML**	**MB**
Methicillin resist Staph aureus	20.0	-	5.0	-	2.5	-	2.5	-
Staphylococcus aureus	20.0	20.0	2.5	5.0	1.5	2.5	2.5	5.0
Vancomycin resist enterococci	-	-	-	-	-	-	-	-
Escherichia coli	20.0	20.0	5.0	5.0	2.5	1.25	2.5	2.5
Vibrio cholerea	-	-	-	-	-	-	-	-
Salmonella typhi	20.0	20.0	2.5	5.0	2.5	2.5	2.5	2.5
Helicobacter pylori	20.0	20.0	5.0	2.5	2.5	2.5	2.5	2.5
Campylobacter jejuni	-	-	-	-	-	-	-	-
Candida tropicalis	20.0	20.0	-	-	2.5	2.5	5.0	5.0
Candida albicans	-	-	-	-	-	-	-	-
Candida krusei	-	20.0	-	-	-	-	-	-

Table 6: Minimum Bacterial/Fungi Concentration of extracts against the test microorganisms (mg/ml)

Test organism	**CML**	**CMB**	**HL**	**HB**	**EL**	**EB**	**ML**	**MB**
Methicillin resist Staph aureus	20.0	-	5.0	-	2.5	-	2.5	-
Staphylococcus aureus	20.0	20.0	2.5	5.0	1.5	2.5	2.5	5.0
Vancomycin resist enterococci	-	-	-	-	-	-	-	-
Escherichia coli	20.0	20.0	5.0	5.0	2.5	1.25	2.5	2.5
Vibrio cholerea	-	-	-	-	-	-	-	-
Salmonella typhi	20.0	20.0	2.5	5.0	2.5	2.5	2.5	2.5
Helicobacter pylori	20.0	20.0	5.0	2.5	2.5	2.5	2.5	2.5
Campylobacter jejuni	-	-	-	-	-	-	-	-
Candida tropicalis	20.0	20.0	-	-	2.5	2.5	5.0	5.0
Candida albicans	-	-	-	-	-	-	-	-
Candida krusei	-	20.0	-	-	-	-	-	-

Figure 1: Zones of inhibition for extract EL

Figure 2: Zones of inhibition for extract EB

Figure 3: Zones of inhibition for extract HB

Figure 4: Zones of inhibition for extract HL

Figure 5: Zones of inhibition for extract CMB

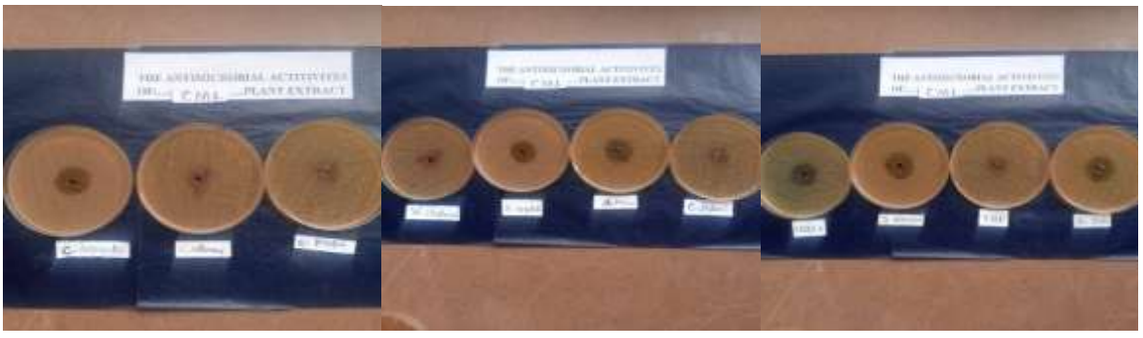

Figure 6: Zones of inhibition for extract CML

Figure 7: Zones of inhibition for extract ML

Figure 8: Zones of inhibition for extract MB

Discussion

The phytochemical screening results (Table 1) of the stem bark and leaves of *P. osun*show that of alkaloids, flavonoids, cardiac glycoside, and terpenoids are present in all the six extracts tested. Saponins were also noted in all except in the hexane extracts. The presence of these secondary metabolites lends credence to the traditional claimed uses of the plant organs. Flavonoids are known to prevent damages caused by free radicals in the body and for the treatment of diarrhea (Dweck *et al.*, 2002; Schuier *et al.*, 2005), fever, and pain. They are known also as spasm-inhibitors and anti-cancer agents. The phenols and flavonoids compounds are important antioxidants, antimicrobial, antiallergic, anti-inflammatory, and anticancer agents. They play useful roles in reproduction and growth. They give protection against harmful pathogenic microbes and predators (Rice-Evans *et al., 1996;* Enechi *et al., 2016)*. Tannins play a useful role in promoting wound healing. Tannins are also known to act as free radical scavengers (Polterait, 1997). Alkaloids act as stimulants, pain relievers, and tranquilizers. It's used in curing hypertension. Alkaloids are organic and natural ingredients that contain nitrogen and are also physiologically active together with sedative and analgesic roles. Alkaloids are found useful in reducing stress and depression symptoms. Alkaloids compounds tend to be poisonous when taken in a large quantity due to their stimulatory activities, resulting in excitation associated with cell and nerve disorders (Jisika *et al.*, 2010; Obochi, 2006). Saponins are terpenoids or steroidal glycosides known as important phytoconstituent with various medicinal properties such as antiallergy, totoxic, antitumor, antiviral, immunomodulating, antihepatotoxic, and antifungal effects (Musa *et al.*, 2011). Saponins are found very useful in veterinary vaccines because of their activity as an adjuvant; they assist in

the improvement of the immune response. Many saponins are useful in intracellular histochemistry staining permitting antibody access to intracellular protein molecules.

The result of the antioxidant capacity measurement by the DPPH (Table 3) shows that the plant is very rich in the scavenging of free radicals. All the extracts gave incredibly high activities that compare favourably with the ascorbic acid used as standard. The stem bark extract of methanol has the highest activity (85%) and the least activity (60.71%) recorded for ethyl acetate leaf extract. Plant extracts may have antioxidant action due to the presence of phenolic chemicals, polyphenols, flavonoids, or tannins. This is in agreement with the study conducted by Nahak and Sahu (Nahak, 2010). The *in-vitro* antimicrobial studies revealed that *Staphylococcus aureus, Salmonella typhi, Helicobacter pylori, Escherichia coli* are sensitive to all the extracts, while *Vancomycin resist enterococci*, *Campylobacter jejuni*, and *Candida albica* are resistant to the extracts (Table 3). The zones of inhibition of the extracts displayed in Table 4 revealed increased antimicrobial activities of the extracts from the crude to the semi-pure (crude fractions). This is a clear indication of the great possibility of increased activities when pure compounds are isolated. From the table, antimicrobial activity is lowest in hexane crude fractions and highest in ethyl acetate. The activities in leaf fractions are noted to be slightly higher than those of the stem-bark. These activities compare very favourably with the standard antibiotic drugs used as control.

Conclusion

Results of both phytochemical screening, antioxidant capacity measurement, and the antimicrobial activities of this research work on *Pterocarpus osun* support the indigenous claims on the plant's usage and also suggests that when the plant is fully investigated, new antibiotics drugs can be developed from it. As seen in the result of the antimicrobial test, the solvent-based serial extracts showed higher antimicrobial activities than the crude because of the higher purity or separation of the constituents. This gives a high hope that active principles when isolated will be a lead to the discovery of new drugs.

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Influence of Anti-Open Defecation Campaigns on the Residents of Owo Local Government Area, Ondo State

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Abstract: This study looks at the influence of anti-open defecation campaigns on Owo residents. This study relies on persuasion communication theory as the theoretical framework. The survey method was used to gather quantitative data while the questionnaire was used as the instrument of data collection. A total number of four hundred respondents were carefully selected using multi-stage sampling and 400 questionnaire copies were administered and retrieved. Quantitative data were analysed using descriptive statistics and Chi-square at P=0.05 level of significance. The findings of the study revealed that the majority of the respondents are aware of anti-open defecation campaigns and this is reflected in their knowledge of the variants of the campaign on radio and outdoor materials. Also, it is found that respondents' attitudes to and practices of open-defecation have been influenced significantly. This is reflected in their involvement in keeping their environment clean to live healthy, keeping a better society, and involving in safe sanitation. This was further confirmed by the Chi-square analyses as a significant relationship between exposure to anti-open defecation campaigns and respondents' attitude and practice of open defecation was established at p>0.05. It was, therefore, recommended that the government should continue to partner with concerned agencies to campaign against open defecation so as to reduce the practice of open defecation effectively in Ondo State, Nigeria.

Keywords: Anti-open defecation campaigns, Campaigns, Open defecation, Owo residents

Introduction

People have continued to face severe health risks such as diarrhea, typhoid, cholera, viral infections, and infectious illnesses as a result of open defecation. Nigeria has a long way to go in terms of cleanliness. Nigeria Demographic and Health Survey (NDHS) (2003) revealed that approximately 18% of Nigerian households used improved sanitation facilities such as flush toilets or VIPs, while over 56% used traditional pit latrines, unimproved sanitation facilities, shared latrines, and 26% had no access to sanitation facilities, forcing them to defecate in the open. In rural regions, almost one-third of families practiced open defecation. Open defecation is defined as the practice of going out in fields, shrubs drain, open bodies of water, and other similar places to defecate. People do this behaviour because they do not have easy access to a toilet or because of traditional cultural customs. Open defecation is a personal as well as a public health issue. This is analogous to other environmental issues, such as greenhouse gas emissions, which can only be resolved if the majority of the population participates in climate-protective behaviour, such as reducing individual energy use. Activating societal norms that encourage pro-environmental behaviours, such as avoiding littering in public areas, saving domestic energy, and sustainably utilising clean water sources, assists individuals in acting ecologically. The practice of open defecation is thought to contribute significantly to the worldwide burden of diarrhea and enteric parasite infection in children under the age of five. People must have access to and use improved sanitation facilities to minimise open defecation, which is defined as facilities that prevent human waste from re-entering the environment.

In 2010, it was projected that 47 percent of the world's population lacked proper sanitation (Drinking Water Sanitation and Hygiene (WASH), 2016). India alone is responsible for one-third of all persons without proper sanitation (814 million), over 60% of those who practise open defecation (626 million) and one-quarter of all diarrheal illness mortality among children under the age of five (WASH, 2016). Every year, nine million people die as a result of environmental pollution. Unsafe sanitation, especially open defecation, is a major cause of faecal contamination of bodies of water and the transmission of faecal germs. Open defecation was performed by 892 million people in 2015, with Sub-Saharan Africa having the highest prevalence (WHO & UNICEF, 2017). In Ghana, 31 percent of the rural population performed open defecation in 2015 (UNICEF, 2017). According to a recent comprehensive study, improving access to clean sanitation facilities may decrease diarrheal illnesses by 16% (Wolf *et al.*, 2014). However, preventing open defecation may only slightly decrease a single person's or household's diarrhoea risk in a faecally contaminated environment (Jung, Hum, Lou & Cheng, 2017). Nigeria, with a population of over 46 million people, is one of the countries in the world with the greatest rate of open defecation. The practice has harmed the population, especially children, in terms of health and education, and has contributed to the country's failure to meet the Millennium Development Goals (MDG) (NDHS, 2013). In 2015, 46 million individuals defecated in the open. An additional 56 million individuals are expected to be added during the following 10 years. Improving public access to sanitation services in a rapidly urbanising globe is a critical, but difficult, a problem for governments, international development organisations, urban planners, and sanitation practitioners. Aimed with the knowledge that inadequate sanitary hygiene often leads to illnesses such as cholera and other infections, the Ondo state government started anti-open defecation campaigns in 2019 in collaboration with UNICEF to create a healthier and better society. Given the backdrop, it is pertinent to evaluate the influence of anti-open defecation campaigns on the residents of Owo local government, where this phenomenon is prevalent. This paper uses standard deviation approach to analyze the volatility of returns of BIMB within the periods of 2010 till 2016. The main reason to evaluate the performance of BIMB is because BIMB is the first Islamic bank established in Malaysia. Besides that, BIMB is the first full-fledged Islamic banking system used a sharia contract such as *mudhrabah*, *musharakah*, *ijarah* and many more.

Statement of the problem

Significant health hazards are associated with open defecation, including fatalities from diarrhoea, cholera, and typhoid (Adepoju, 2019). Nigeria established its action plan against open defecation in 2016, intending to eliminate open defecation by 2025. To promote a healthier and better society, the Ondo State government, via the ministry of health, partnered with UNICEF to conduct anti-open defecation campaigns in 2019. There have been a lot of studies that have looked at anti-open defecation efforts, but none have looked into media impact. For example, Saleem, Burdett and Heaslip (2019) performed a comprehensive assessment of the available literature on the consequences of open defecation and social effects connected with open defecation, while Jain, Wagner, Snell-Rood, and Ray (2020) studied open defecation in Rural Bihar, India. Using concepts from social epidemiology and political ecology, they examined the structural determinants of latrine ownership and use. Alom, Ogah and Dogo (2020) examined public awareness and understanding of anti-open defecation campaign methods in Benue State. While previous studies focused on the impact, determinants of open defecation on individuals and public awareness/knowledge of campaign approaches, this study examines whether media anti-open defecation campaigns influenced knowledge, attitude and practice of open defecation in OWO local government, Ondo State.

Research questions

Based on the research, it is hoped that this study would answer the following questions:

1. To what extent are Owo residents aware of anti-open defecation campaigns?
2. To what extent have the anti-open defecation campaigns influenced the attitude of Owo residents?
3. To what extent have the anti-open defecation campaigns changed the practices of open defecation among OWO residents?

Hypothesis

HO1: Exposure to anti-open defecation has not significantly influenced the attitude of Owo residents to the practice of open defecation.

HO2: Exposure to anti-open defecation has not significantly influenced the practice of open defecation among Owo residents.

Literature review

The habit of going out in fields, bushes, forests, open bodies of water, and other open locations to defecate rather than using the toilet" is referred to as "open defecation" (UNICEF, 2017). Environmental sanitation is considered to be the greatest significant medical development since 1840 and that better sanitation lowers cholera, worm

infestation, diarrhea, pneumonia, and starvation, among other illnesses that affect millions of people (Langergrabera & Muellegger, cited in Mariwaha, 2011). Different individuals have understood and utilised the word "sanitation" in various ways. The World Summit for Children, which established objectives for child survival, development, and protection, recognised access to There are many explanations why open defecation has remained unchecked in developing nations, especially in rural; it can be intentional or semi-voluntary, but in most cases, it is attributable to a shortage of or restricted access to different options (i.e., modern toilets) and a lack of a clean, safe and attractive toilet at the time of embarking on the act due to filthy, dark or fouled conditions (Atkinson, 2016).

Environmental communication is essentially about disseminating knowledge about the environment. It is the deliberate use of communication processes to promote successful policy formulation and project execution aimed at environmental sustainability. The media have a major impact on the environmental debate. Their breadth, reach and coverage makes them unavoidable outlets in any attempt to teach and educate people about critical problems such as the environment. As a result of this scenario, the media has become an important instrument in increasing public awareness about environmental issues. Individuals get a lot of their environmental knowledge from the media. The media is responsible for a large percentage of the public's understanding of environmental issues. He claims that much of what people learn about issues such as the greenhouse effect, global climate change, ozone depletion, water, and air pollution, and other environmental threats come from the media (or from others who have heard it from the media) because our firsthand knowledge of the state of the environment is likely to be limited. Indeed, it has been suggested that for many people, the media is their only source of information on environmental issues. In their study titled "Open Defecation: A Behaviour Change Communication Challenge; India on the Move," Gupta and Agarwal (2017) discovered that a significant number of children in India, approximately 61 million, representing 48 percent of children under the age of five, continue to suffer from moderate or severe stunting, which results in long-term cognitive deficits, poor school attendance and performance, fewer years of education, and fewer years of life. They claim that this is because the faecal bacteria that children ingest make them sick and prevent them from reaching their full developmental potential. They also said that a lack of sanitation encourages the spread of diarrheal infections, which are a leading cause of infant death worldwide.

Furthermore, in a study titled "Health and social impacts of open defecation on women: a systematic review," Saleem, Burdett and Heaslip (2019) conducted a systematic review of the published literature related to the implications of open defecation that went beyond the scope of addressing health outcomes by also investigating social outcomes associated with open defecation. The review identified four overarching themes: the health consequences of open defecation, the increased risk of sexual exploitation, threats to women's privacy and dignity and the psychosocial stressors associated with open defecation, all of which present a serious situation of poor sanitation in rural communities of Lower-Middle Income Countries (LMICs). According to the findings of the review, open defecation worsens women's health and has long-term negative effects on their psychological well-being. Jain, Wagner, Snell-Rood and Ray (2020) investigated open defecation in rural Bihar, India, during the Swachh Bharat Abhiyan: Agency, Accountability, and Anger. In rural Bihar, they used ethnographic approaches to explore people's attitudes about open defecation and latrine use, as well as the socioeconomic and political factors that influence these attitudes. They discovered that, despite academics' frequent emphasis on rural populations' proclivity for open defecation, their findings demonstrated that people were aware of its many risks. They also discovered that while sanitation research and''behaviour change.''campaigns frequently conflate the unwillingness to adopt latrines with a preference for open defecation, this is an incorrect conflation; and (ii) a subsidy can assist (some) households in constructing latrines, but the amount of the subsidy and how it is disbursed are critical to its usefulness.

Furthermore, Alom, Ogah and Dogo (2020) evaluated public awareness and understanding of anti-open defecation campaign tactics in Benue State. The Situation Awareness Theory of communication served as the foundation for the project. In a study of 400 respondents from the state's three zones, a questionnaire was utilised to gather data. The study sought to evaluate the level of public knowledge and comprehension of measures used in Benue State's campaign against open defecation. This study revealed an adequate level of awareness of Benue State's anti-open defecation effort. The study also assesses the level of community knowledge about the strategies used in the anti-open defecation campaign in Benue State. The most often used approach identified is the use of leaflets, posters, and signboards (50 percent). Other campaign techniques revealed to project the state's open defecation-free status include the use of opinion leaders, town criers, and health experts' word-of-mouth campaigns (22%), as well as radio, television, and newspaper ads (21 percent). The lowest rated medium was social media/blogging (6 percent). According to the findings, community compliance is extremely excellent but not exceptional. While previous studies focused on the impact, determinants of open defecation on individuals, and public awareness/knowledge of campaign approaches, this study examines whether anti-open defecation campaigns influenced knowledge, attitude, and practise of open defecation in OWO local government, Ondo State.

Theoretical foundation

The persuasive communication theory proposed by Carl I. Hovland in 1940 was used in this research. Hovland proposed in 1940 that persuasion is the "changing of one's attitude by absorbing new knowledge." Persuasion is defined as "human communication aimed at influencing others by altering their beliefs, values, or attitude" (Simon, 1976: 21). According to Asemah et al. (2012: 347), persuasion is a systematic and skilled approach to raising awareness to influence or strengthen ideas, attitudes, beliefs, or values for a more favourable end. Persuasion may be defined as the skillful presenting of ideas and messages to diverse audiences to obtain the desired effect. Communication is required for persuasion. It is the capacity to persuade someone to change their mind, attitude, belief, habits, or behaviour. In other words, it is the capacity to persuade others to perceive things from your point of view. The communication process, according to persuasive communication theory, consists of three phrase models: Communication-Attitude-Behaviour. For communication, information is given to people of Owo for them to be aware of the health issues associated with open defecation, through anti-open defecation campaigns. Once the people of Owo are aware of the campaign, the campaigner may concentrate on changing attitudes that encourage open defecation. In this section, the researcher observes people of Owo see whether the information gained has influenced their attitudes about open defecation. A change in attitude is expected to translate to changes in practice against open defecation. The researcher investigates if the attitude of Owo residents has affected their practice to discontinue the practice of open defecation.

Methodology

The survey method was used for this study. According to Lockesh (as cited in Atuah, 2020), survey studies are undertaken to gather comprehensive descriptions of existing phenomena to use data to justify present circumstances and practices or to develop more intelligent strategies for changing them... This research technique is appropriate for this study because it allows for the assessment of Owo people's knowledge, attitude and practice about hygienic methods of excretal disposal as promoted by anti-open defecation campaigns in Ondo State. The population for this research consists of Owo residents, which is projected to be 300,000 in 2016. The sample size is made up of 399 residents of Owo. This was arrived at through the Taro Yamane sample size formula. To properly pick Owo residents into the sample size, a multistage sampling technique was used. In the first stage, Owo local government areas were divided into thirteen districts, from which three districts (Ijebu, Iloro, and Igboro) were chosen using purposive sampling. These districts were chosen due to the high prevalence of open defecation in certain areas. The districts were further stratified into streets in the second stage, and three streets from each district were chosen at random, giving nine streets. In the last step, 133 respondents from the three districts were chosen using a disproportionate quota and available samplings. The questionnaire was used to gather data and the data were presented, analysed and interpreted, using frequency data and Chi-square.

Data presentation and analysis

Table 1: Responses on the Level of Awareness of Anti-Open Defecation Campaigns in Owo

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	170	42.5	42.5	42.5
	Agree	128	32.0	32.0	74.5
	Undecided		1.5	1.5	76.0
	Disagree	64	16.0	16.0	90.5
	Strongly Disagree	32	8.0	8.0	100.0
	Total	**400**	**100.0**	**100.0**	

Field Survey: 2021

The data above show that majority of the respondents are aware of anti-open defecation campaigns in their environment.

Table 2: Exposure to Radio Anti-Open Defecation Campaigns

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	126	31.5	31.5	31.5
	Agree	154	38.5	38.5	70.0
	Undecided	17	4.3	4.3	74.3
	Disagree	66	16.5	16.5	90.8
	Strongly Disagree	37	9.3	9.3	100.0
	Total	**400**	**100.0**	**100.0**	

Field Survey: 2021

The data above show that majority of the respondents agreed that have been exposed to anti-open defecation campaigns on radio. 126 (31.5%) and 154 (38.5%) agreed to have heard about anti-open defecation jingles on the radio.

Table 3: Exposure to Outdoor Anti-Open Defecation Campaigns

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	109	27.3	27.3	27.3
	Agree	119	29.8	29.8	57.0
	Undecided	32	8.0	8.0	65.0
	Disagree	95	23.8	23.8	88.8
	Strongly Disagree	45	11.3	11.3	100.0
	Total	**400**	**100.0**	**100.0**	

Field Survey: 2021

The data above show that majority of the respondents agreed that they have come across anti-open defecation campaigns outdoor materials. 109 (27.3%) and 119 (27.3%) have come across anti-open defecation campaigns outdoor materials.

Table 4: Anti-Open Defecation is Primitive

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	136	34.0	34.0	34.0
	Agree	81	20.3	20.3	54.3
	Undecided	17	4.3	4.3	58.5
	Disagree	94	23.5	23.5	82.0
	Strongly Disagree	72	18.0	18.0	100.0
	Total	**400**	**100.0**	**100.0**	

Field Survey: 2021

The data above show that majority of the respondents strongly agreed that defecation in the open is primitive. About six in every ten respondents sees it this way.

Table 5: Anti-Open Defecation Act not dignifying

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	201	50.2	50.2	50.2
	Agree	98	24.5	24.5	74.8
	Undecided	19	4.8	4.8	79.5
	Disagree	46	11.5	11.5	91.0
	Strongly Disagree	36	9.0	9.0	100.0
	Total	**400**	**100.0**	**100.0**	

Field Survey: 2021

The data above show that majority of the respondents strongly agreed that they see open defecation as an act not dignifying. Seven in every ten respondents sees it this way.

Table 6: My Disposition to Open Defecation is favourable

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	176	44.0	44.0	44.0
	Agree	131	32.8	32.8	76.8
	Undecided	22	5.5	5.5	82.3
	Disagree	39	9.8	9.8	92.1
	Strongly Disagree	32	8.0	8.0	100.0
	Total	**400**	**100.0**	**100.0**	

Field Survey: 2021

The above data show that majority of the respondents agree that they are not favorably disposed to open defecation. That is, seven out of every ten respondents agree that they are not favorably disposed to open defecation.

Table 7: Involvement in keeping Environment Clean

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	310	77.5	77.5	77.5
	Agree	77	19.3	19.3	96.8
	Undecided	2	.5	.5	97.3
	Disagree	6	1.5	1.5	98.8

	Strongly Disagree	5	1.3	1.3	100.0
	Total	**400**	**100.0**	**100.0**	

Field Survey: 2021

The data above show that majority of the respondents strongly agreed that they must be involved in keeping my environment clean. That is, nine out of every ten respondents agree that they involve in keeping their environment clean through the practice of hygienic defecation.

Table 8: I still defecate in the Open

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	44	11.0	11.0	11.0
	Agree	29	7.2	7.2	18.3
	Undecided	19	4.8	4.8	23.0
	Disagree	166	41.5	41.5	64.5
	Strongly Disagree	142	35.5	35.5	100.0
	Total	**400**	**100.0**	**100.0**	

Field Survey: 2021

The data above show that majority of the respondents disagreed that they still engage in open defecation. Seven in every 10 respondents disagree that they engage in open defecation.

Table 9: Responses on using Alternative Means to Defecate

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	93	23.3	23.3	23.3
	Agree	81	20.3	20.3	43.5
	Undecided	19	4.8	4.8	48.3
	Disagree	115	28.7	28.7	77.0
	Strongly Disagree	92	23.0	23.0	100.0
	Total	**400**	**100.0**	**100.0**	

Field Survey: 2021

The data above show that half of the respondents disagreed that they make use of alternative means to defecate whenever they don't have access to modern sanitary facilities; about 45% agreed that make use of alternative means to defecate whenever they don't have access to modern sanitary facilities.

Table 10: Shows the Responses on whether Respondents still defecate in Bushes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	64	16.0	16.0	16.0
	Agree	58	14.5	14.5	30.5
	Undecided	25	6.3	6.3	36.8
	Disagree	141	35.3	35.3	72.1
	Strongly Disagree	112	28.0	28.0	100.0
	Total	**400**	**100.0**	**100.0**	

Field Survey: 2021

The data above show that majority of the respondents do not agree with the statement that they defecate in bushes since they don't have a latrine: six of every ten respondents so disagreed. However, three of every ten respondents agree that they defecate in bushes because they cannot access laterin.

HO1: Exposure to Anti-Open Defecation Campaigns has not significantly influenced the Attitude of Owo residents to the practice of open defecation.

Table 11: Chi-Square Test One

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	27.550[a]	16	.036
Likelihood Ratio	26.303	16	.050
Linear-by-Linear Association	2.024	1	.155
N of Valid Cases	400		

4 cells (16.0%) have an expected count of less than 5. The minimum expected count is 1.06. This test indicates that there is a statistically significant relationship between exposure to anti-open defecation campaigns and the attitude of Owo residents to the practice at p>0.05. Since the P-value of .036 is less than 0.05, the hypothesis that "Exposure to anti-open defecation has not significantly influenced the attitude of Owo residents to the practice of open defecation" is not true and hereby rejected.

HO2: Exposure to anti-open defecation has not significantly influenced the practice of open defecation among Owo residents.

Table 12: Chi-Square Test Two

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	33.470[a]	16	.006
Likelihood Ratio	35.664	16	.003
Linear-by-Linear Association	5.013	1	.025
N of Valid Cases	400		

a. 16 cells (64.0%) have an expected count of less than 5. The minimum expected count is .13. This test indicates that there is a statistically significant relationship between exposure to anti-open defecation campaigns and the practice of open defecation among Owo residents at p>0.05. Since the P-value of .006 is less than 0.05, the hypothesis that "Exposure to anti-open defecation campaigns has not significantly influenced the practice of open defecation among Owo residents" is not true and hereby rejected.

Result and discussion

The result of data analyses indicates that respondents are aware of anti-open defecation campaigns in their community. This means that the majority of Owo people have been exposed to anti-open defecation jingles on the radio and outdoor campaign materials. This evidence can be seen in tables 2 and 3 of research question 1, which showed that the majority of respondents heard and saw anti-open defecation campaigns on radio and outdoor outlets. This result is confirmed by USAID (2013), which claims that the media helps to improve individual understanding and promote changes in attitudes and practices. The media has been helpful in national development by raising knowledge of the possibilities for progress. It is a given fact, as shown in the data, that the anti-open defecation campaign in Ondo state achieved its goal of raising awareness, which is a prerequisite for behavioural change. This conclusion is corroborated by Alom, Ogah & Dogo (2020) who found that there was appropriate awareness of the anti-open defecation programme in Benue State. This signifies that the chosen Benue community has been adequately educated as a result of the State's effort against open defecation. There are also signs (albeit not conclusive) that a small percentage of the populace (3%) is still unaware of the dangers of open defecation campaigns. Substantial exposure to the campaign targeting attitudinal transformation must have occurred before a change in attitude may be accomplished. This is what Hovland (1940), in persuasion theory, discussed as communication. Awareness must first be created before concentrating on attitudes.

According to the statistics provided in tables 4, 5 and 6, anti-open defecation campaigns have affected the attitudes of Owo people to a fair degree. According to the findings, the majority of respondents agreed that defecating in public is primitive. Similarly, the majority of respondents felt that open defecation is demeaning conduct. This demonstrates that the campaign was successful in changing their minds. This shift in Owo people's attitudes is explained by persuasion communication theory, which states that persuasion is the altering of one's attitude as a result of obtaining new information. The necessity for and methods for, changing people's beliefs, values and attitudes regarding open defecation are discussed in persuasion theory. A carefully grafted message has a propensity of altering people's attitudes. To a fair degree, the campaigns have therefore managed to alter Owo people's attitudes to open defecation practices. Also, there is a statistically significant connection between exposure to anti-open defecation campaigns and Owo residents' attitudes at P=0.05. This demonstrates that the anti-open defecation campaign has influenced Owo residents' attitudes. Hovland (1940) in persuasion theory posited that communication must come before the attitudinal change and this is what has played out in the study. Exposure to anti-open defecation campaigns has led to a shift in Owo residents' attitude to the open defecation practices.

Also, analysis shows that anti-open defecation efforts have aided in the reduction of open defecation among Owo people. The campaigns have influenced the people of Owo in reducing the practice of open defecation by urging them to use safe sanitary facilities rather than being involved in practices of open defecation in their community. This is

reflected in their decision to become engaged in keeping their surroundings clean to live in a better and healthier society. According to this finding, Alom *et al.* (2020) observed that 61 respondents (15%) confirmed that the compliance to open defecation free status is outstanding, and more than 1/2 of the respondents (63 percent, 250 respondents) scored the level of compliance as very good, indicating that the open defecation campaign is affecting behavioural change in achieving an open defecation free status. This could be because the campaigns exposed Owo people to the illnesses that open defecation causes if the habits are not stopped. This is consistent with Gupta & Agarwal (2017), who claim that open defecation may cause severe health problems such as diarrhea, cholera, and other infectious illnesses due to improper disposal of human waste. In line with this, a change in attitude through persuasive communication, according to Hovland (1940), must result in a change in practices, in this case, of open defecation.

Conclusion

According to the results, Owo residents have been exposed to anti-open defecation jingles on the radio and outdoor campaign materials. The campaigns have influenced Owo residents' attitudes about open defecation to some extent since there is a statistically significant relationship between exposure to anti-open defecation campaigns and Owo residents' attitudes at P=0.05. This shows that the anti-open defecation campaign has influenced the attitudes of the Owo people. This shift in attitude toward open defecation has resulted in a drop in open defecation practice since there is a statistically significant relationship between exposure to anti-open defecation campaigns and a decrease in Owo people's open defecation practice at P=0.05.

Recommendation

To effectively fight the issue of open defecation in Ondo State and based on the study findings, it is recommended that the Ondo state government should continue to intensify its campaign efforts against open defecation as its activities over the last two years are yielding meaningful results.

Funding

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Resource co-management: Incorporating traditional ecological knowledge into resource management frameworks

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Abstract: Resource management is facilitated through various bureaucratized government agencies, which exercise policy that attempts to balance competing economic, political, and conservation interests. These agencies abide by Western ideology and Western science, which have failed to preserve ecological health and adequately represent the interests of local indigenous populations that have depended on said resources. As a result of this failure and a growth in legal requirements to consult indigenous people about the usage of land and resources, much attention has been concentrated on indigenous resources management techniques, which are inextricably linked to their ways of knowing. A review of literature on the subject revealed that TEK, when adequately included in the resource management process, is essential for the regeneration of ecological health. Still, its implementation and attempted integration have been abysmal. Therefore, the study recommends that TEK must be given the utmost respect as a cultural and spiritual belief system to be adequately incorporated. Furthermore, TEK holders must be in control of TEK and ultimately have the ability to make decisions concerning its use, productive and equivalent collaboration between Western management and TEK throughout the entire process of resource management must be adopted – as both systems are crucial to ecological regeneration, and legal mechanisms must be employed to mandate the involvement and protection of TEK to redress power imbalances so that inclusion does not rest on the goodwill of, or perceived benefit to, existing resource management agencies.

Keywords: Traditional ecological knowledge, Resource management, Indigenous people, Western ethics/science

Introduction

Traditional Ecological Knowledge has been refined for thousands of years, with each indigenous group having its own distinct version, as TEK, is impacted significantly by the local environment it is created in. It is transmitted orally, and through field-based experience, each generation applies its philosophy to contemporary realities and flexibly adds information that fits the overall ethical requirements (Dudgeon & Berkes 2003; Mason et al., 2012; Hoagland 2017; Adom, 2016). TEK holds that humans are an equivalent part of the natural world around them, treating plants, animals, and landforms, as extensions of their kinship network rather than as simply existing for human exploitation (Pierotti and Wildcat 2000; Donoghue et al., 2010). Another crucial aspect of TEK is that all parts of the natural environment are seen as connected to one another, impacting each other through complex feedback loops (Pierotti and Wildcat 2000). Through careful observation, theorization, and testing of feedbacks in their local environment for millennia, indigenous people accrued diverse knowledge that allowed them to form

practices and techniques that would enable all parts of the environment to thrive while supporting a human population (Hoagland 2017; Mason et al., 2012; Gomez-Baggethun, 2013). Over time, these practices were instilled in indigenous cultures and belief systems in the form of rules and norms that dictate how one acts and thinks about the world (Adom, 2021). Holding this wealth of knowledge within a spiritual and cultural worldview validates its use to indigenous people while framing the way it must be applied (Berkes 2017; Pierotti & Wildcat 2000). Its effectiveness in stewarding the natural environment, and therefore, its value to ecological conservation, is shown by its ability to maintain a stable population in a flourishing environment for thousands of years (Berkes 2017: 4). For example, a marked decline in ecological health began in North America only after European colonization and the introduction of Western ethics and science as dominant authorities over resource management (Posey 2001; Gomez-Baggethun et al. 2013). Therefore, TEK's differing philosophy, diverse and extensive deposit of ecological knowledge, and holistic approach have much to offer in preserving local environments if it is allowed to participate in the resource management process. However, there are many misconceptions about TEK and its synergy with the popular, Western ethics in resource management. Therefore, this short review of related literature was aimed at explaining and comparing TEK to Western Ethics in resource management to chart a new path for a co-management between the seemingly contrary resource management strategies.

Traditional Ecological Knowledge versus Western Ethics in Resource Management

Traditional Ecological Knowledge and the Western ethics in resource management that is pervasive in contemporary Western societies diverge fundamentally in the way they validate ecological knowledge and in how they think of humans in relation to the natural world. In regard to knowledge, the Western ethic relies wholeheartedly on positivism, which posits that knowledge is only useful if it has been through the gauntlet of the scientific method. This method makes theories based on observations and test theories in ways that can be quantified, only being satisfied if the same result is achieved through repetitive testing in isolated settings (Dudgeon & Berkes 2003; Hoagland 2017). Furthermore, findings must be thoroughly documented and further validated by other specialized professionals in the same field studied by the experiment (Mason et al. 2012; Hoagland 2017). Though this method is highly similar to how TEK generates its knowledge – through observing, theorizing, and testing – they are starkly different in how they bank this information and how they validate its use. As a result of TEK being validated through cultural and spiritual backing and not empirically proven studies, western science tends to relegate it to the level of pseudoscience and mysticism (Pierotti & Wildcat, 2000; Mason et al., 2012; Adom 2018). Ethically, the Western view is anthropocentric, separating humans from the natural world and placing them above it. Thus, resources exist solely for human use and may be exploited (Dudgeon & Berkes 2003; Posey 2001). This fundamental differentiation is the root by which followers of TEK and the Western ethic respectively conceptualize the environment and its resources, explaining why their approaches to resource management and understanding of their duty to the environment – and its duty to them – is so different. Despite its shortcomings, Western science has contributed significantly to most fields, including resource management – creating innovative technological advances and valuable insights (Hoagland 2017). As such, equal collaboration is the most desirable outcome for the best possible resource management, as applying one form of knowledge without the other would not be as effective as using both (Hoagland, 2017; Mason et al., 2012).

Pierotti and Wildcat (2000) state that Western resource management has rigid, unflinching philosophical thoughts about the environment and its resources. This, they argue, comes from Western ethical behavior itself being "derived from unchanging ideas" (Pierotti & Wildcat, 2000:1339). They contrast this with a glowing review of TEK, giving an extensive explanation of its flexibility, multidisciplinary nature, and vast bank of knowledge. The authors argue that the bank of knowledge is useful in terms of adding to that possessed by the existing science, it being multidisciplinary (due to its holistic outlook) makes it easier to incorporate in various disciplines, and its flexibility could influence its thinking to be more adaptable (Pierotti & Wildcat, 2000).

Pierotti and Wildcat (2000) provide an appropriate description of TEK and the benefits it could have to resource management; however, how it proposes to incorporate TEK into existing schemes leaves much to be desired. The failing here is that Pierotti and Wildcat state that resource management agencies should analyze TEK and incorporate it into their ethics and their scientific database. As explained by the authors' contemporaries and successors, this is not a desirable path forward. First, agencies have proven that they cannot simply study TEK and

incorporate its philosophy into their established way of thinking, picking and choosing favorable aspects as they please. Second, the knowledge stored within TEK cannot be broken up into desirable scientific disciplines; doing so robs it of its holism and separates it from its cultural and spiritual elements, without which the knowledge cannot be appropriately applied (Houde 2007; Nadasdy 1999) (Donoghue et al. 2010; Berkes 2017). Most complications in applying TEK to resource management have been derived from the stance taken by Pierotti and Wildcat, as without the cultural and spiritual understanding that was previously attached to the knowledge, it can be applied erroneously and ineffectively. Applying it as such can encourage further ecological degradation and is disrespectful to holders of TEK, as their belief system is being torn apart, manipulated, and exploited (Posey 2001; Mason et al. 2012; Nadasdy 1999). One example of this can be found with the Yukon Fish and Wildlife Management Board and its attempt to manage a sheep population around the Kluane First Nation's reserve. When asked to share TEK, the local indigenous population gladly did so, explaining that the Board's mandate that only matured male sheep could be hunted could lead to further complications, as without male role models, young sheep could not develop properly. Resource managers either disregarded this information or could not prove it, meaning it could not be implemented, and instead asked holders of TEK for specific figures of where and when they saw sheep, so they might be used as data to monitor the population. The sheep population promptly declined, harming the overall ecosystem and limiting the resources that local populations had subsisted off of (Nadasdy 1999).

According to Nadasdy (1999), Western resource management and TEK cannot be properly integrated, and that collaborative workshops, academic research, and interest organizations have not been useful due to the power imbalance between the two, allowing resource management agencies to subversively frustrate successful integration. Furthermore, due to a lack of belief in "the existence and efficacy of traditional knowledge" within agencies and their being long-institutionalized bureaucracies that derive their very existence from their being seen as the most qualified body to manage resources, actors within government agencies are hesitant to include TEK in a meaningful way (Nadasdy 1999). As a result, TEK is treated simply as a source of data to be compartmentalized and distilled to fit into western resource management (Nadasdy, 1999). As pointed out earlier, doing so causes TEK to lose its meaning and effectiveness. In conclusion, Nadasdy states that TEK cannot be integrated with Western resource management structures, and therefore, effective resource management can only be achieved once complete autonomy and control over resources and all development are given to local indigenous communities (Nadasdy, 1999).

Through studying the actions – rather than words – of resource management agencies, Nadasdy (1999) masterfully explains the issues that integration of knowledge has faced due to power imbalances within the colonial structures that govern resource management. His proposed framework provides TEK holders with maximum agency – allotting complete control and the ability to draw on Western science when it pleases (Nadasdy, 1999). However, Nadasdy's framework lacks an appreciation for the benefits of equivalent collaboration for ecological purposes – which seeks to draw on the resources of two valuable forms of knowledge to restore Western societies' declining ecological health in a way that neither way of knowing could do alone. Despite Western management being the cause of this degradation, globalized forces continue to degrade local environments to an unprecedented point, where TEK alone may be unable to restore them. Though Nadasdy is correct that integration of TEK into Western management schemes is undesirable, his solution reaches too far in that it relegates Western management to having no decision-making capacity, revoking agency, and thus making it unable to fully contribute to the collaborative process. In 2010, Donoghue and colleagues studied ten indigenous-government agency collaborations to find the most effective format for a collaboration between the two parties. The study revealed that beneficial collaborations had transparency, the sharing of resources, flexible government agencies, the sharing of information, and, most importantly, equivalent decision-making authority (Donoghue et al., 2010). Indeed, the study found that for indigenous people to be comfortable with full usage of TEK in conservation efforts, they had to hold significant control over the entire operation, as if this was not offered, the risk of the information being disrespected or misused was too high (Donoghue et al., 2010). As a result, the study recommended that indigenous people be given equivalent autonomy to agencies, having an active role in creating the structure of the collaborative mechanism itself, "defining goals, developing the collaborative processes, and outlining roles and responsibilities" (Donoghue et al., 2010: 34). Such a conclusion was reached because agencies cannot understand TEK and its objectives well enough to outline the collaborative process in a way that TEK holders would be comfortable with, derailing the process before it began (Donoghue et al., 2010).

Furthermore, Donoghue et al. (2010) acknowledge the inability of agencies to garner a comprehensive and enough understanding of all that TEK encompasses to implement it properly. The path they point forward, allowing TEK holders more autonomy over the integration process, is promising as it departs from past frameworks that simply look to study TEK and have agencies use it as they see fit, which has proven to be ineffective and harmful. However, the solution provided is too simple in that it does not give credence to the fact that all parties are not acting in good faith and do not earnestly believe that TEK holders should be allowed into the resource management process as an equivalent stakeholder. Rather, the authors function under the assumption that agency bureaucrats and scientists are actively looking to fully incorporate TEK into their resource management framework, acknowledging that their approach is inherently flawed. Unfortunately, doing so fails to acknowledge the political aspect of the resource management world, which Western ideals hold hegemonic control over, and the unwillingness of some actors – entrenched in their worldview – to accept the error in their ways and merit of TEK. As such, these actors often actively hinder the inclusion of TEK into existing schemes through their actions, despite their public rhetoric.

Darrel Posey's chapter in *Indigenous Traditions and Ecology* adds an important voice to the discussions surrounding TEK and resource management. Specifically, Posey (2001) highlights concerns about indigenous intellectual property rights, appropriation, and misapplication of TEK. He draws on the Western-colonial propensity to appropriate "materials, ideas, expressions of culture – and even human genes" from Indigenous communities as incredibly harmful to indigenous communities and an indication of how the integration of TEK into Western conservation, or potentially the commodification of this knowledge for profit, could develop (Posey, 2001: 3). The author points out that this is especially likely, considering the noticeable lack of collective intellectual property coverage TEK is subjected to by international law (Posey 2001:13). Furthermore, the appropriation of TEK is especially harmful because it is not simply pragmatic resource management. Instead, it is deeply spiritual; therefore, its misuse outside of indigenous control is "not only disrespectful to local culture but a violation of religious principles and human rights" (Posey, 2001: 21). To avoid the complete alienation of TEK by Western conservation and Western commodification, Posey recommends shoring up intellectual property laws and provides a list of rights created through collaboration with the International Society for Ethnobiology and indigenous people. The list featured acknowledging rights to self-determination, active participation in any project that might take place using TEK, respect for the culture and spirituality of indigenous groups, and a requirement of informed consent prior to launching projects (Posey 2001: 18-21)

Posey's contextualization of TEK within historical and contemporary colonial dispossession and disrespect, as well as its harmful impact on indigenous people, is essential to comprehending the hesitance of some indigenous people to allow access to TEK and the risk involved with doing so. His emphasis on the respect that must be given to TEK and its holders is also significant, as it is truly a way of life with spiritual importance and needs to be respected as such. The potential protections, made through a collaborative effort on the side of TEK and Western interests and listed by Posey, have the ability to prevent the exploitation or bastardization of TEK due to it being ripped from the hands of its creators and used harmfully or ineffectively. However, the flaw with this solution is that it offers little control over the initiation of programs to indigenous people, as it posits that Western interests are to come to TEK holders with plans, which they would then have equitable input towards throughout the remainder of the process (Posey 2001:18-21). Doing so denies TEK holders the ability to create their own sweeping initiatives from the point of inception, a disservice to indigenous people as they would not have the desired level of control over programs and to the environment as it would not see the full benefits of TEK.

The contribution of Traditional Ecological Knowledge to natural resource management.

Over the last few decades, researchers in diverse bodies of theory such as ecologists, anthropologists, and other interest groups have begun placing more value on non-scientific knowledge systems in natural resource management (Boersema 2009). These kinds of knowledge systems include Traditional Ecological Knowledge. Despite debates surrounding the usefulness of Traditional Ecological Knowledge in managing natural resources in modern times, its importance cannot be overemphasized. TEK is an important way of knowing that has the potential to play a central role in natural resource management and conservation (Asante 2015; Adom 2016; Awuah-Nyamekye 2013). Indigenous communities have historically depended on TEK to guide their relationship and interaction with the natural environment (Berkes 2017). Turner et al. (2000:1275) rightly observe that TEK "is acknowledged as having

fundamental importance in the management of local resources, in the husbanding of the world's biodiversity, and in providing locally valid models for sustainable living." The importance of TEK is seen in the increasing recognition of the value of TEK as it applies to diverse forms of environmental crises among indigenous and non-indigenous peoples and communities.

Among some Indigenous communities, TEK takes the form of taboos and totems, traditional protected areas, customs and rituals, and rules and regulations (Boafo et al. 2016). This diverse form of TEK enjoins community members to relate to their natural environment in a more environmentally friendly manner, which has aided in protecting and conserving biodiversity. For example, TEK in the form of taboos and totems forbids people partially or entirely from using part or whole of specific plant and animal species. This serves as an essential management approach for reducing the overexploitation of endangered plant and animal species (Boafo et al. 2016; Asante 2015). In a similar vein, TEK in the form of traditional protected areas provides grounds for communities and individuals to safeguard and conserve defined sites of their local landscape. These may include sacred groves or forests, uncultivated land, riverbanks, and wildlife sanctuaries (Adom & Boamah 2020; Millar 2004). These zones are protected because of their distinct and unique contribution to the economic, social, religious, cultural, and ecological worth or benefit of communities and individuals (Boafo et al. 2016; Adom & Boamah 2020). For example, Asante (2020) found that the Twendurase mystical sacred grove shelters two important medicinal plants—Nyamedua (Alstonia boonei) and African myrrh (Combretum spp.)— for the treatment of measles and ulcers, respectively. The grove also protects several rare plants valuable for food and other economic uses, which might otherwise have disappeared from the local landscape.

Conclusion

As many societies' ecological health continues to decline, adopting different approaches to managing the health of natural environments becomes increasingly important. This is because pre-existing structures that are used to manage the environment have been unsuccessful on their own and require re-orientation. The field of resource management is one such place and could yield significant benefits if entrenched government agencies were to enter collaborative partnerships with TEK holders in their local environments. This is because TEK's way of viewing the world, resource management techniques, and massive store of knowledge have proven effective at cultivating healthy ecosystems. However, reaching an arrangement that benefits the environment as well as the interests of TEK holders has been exceptionally challenging. After reviewing available literature concerning TEK implementation, we have reached several conclusions regarding its inclusion. First, TEK is not simply a resource management strategy; it must be treated with the utmost respect as a complex cosmology with spiritual and cultural importance. Second, no specific information or philosophical aspects can be alienated from the overall cosmology, as its meaning and usefulness are lost when it is not understood within the context of the entire bank of information and philosophy. Third, to ensure that TEK is respected and used effectively for resource management, it is imperative that TEK is employed and controlled by its knowledge holders. Fourth, to most effectively protect indigenous control of TEK and benefit from Western science simultaneously, TEK and Western management must collaborate. To facilitate this collaboration, both entities must be given equivalent authority over decision making throughout the entire process. Fifth, due to the existence of power imbalances in the face of competing ideologies and objectives, TEK holders must be protected by comprehensive laws and regulations that force Western management to allow TEK access to equal representation concerning resource management and protect them from harmful appropriation and misuse. Doing so would force management agencies to form equal partnerships with TEK holders rather than depending on their willfully deciding to do so. If the above recommendations are employed, TEK and Western management could effectively work together to regenerate healthy ecosystems in a manner that is ultimately beneficial to all parties.

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Institutionalizing the Protection of Lesbian Gay Bisexual Transgender Rights in the Public and Private Secondary Schools of Dumaguete City, Philippines

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Abstract: The investigation explored the extent of policy implementation among public and private Junior High School administrators and other policy implementers of the Philippine Department of Education Order Number . 32, series of 2017 in the City of Dumaguete. To obtain the needed data, the researcher came up with the research questions focused on the respondents' profile and their extent of knowledge, attitude, perceived capability, and involvement, serving as important exploratory variables. The theories on planned behavior, curriculum, and policy implementation served as the study's backbone. Then, the researcher utilized the mixed methods of descriptive quantitative and qualitative data analysis. Findings reveal that public school respondents were more knowledgeable on the provisions of the policy. On the attitude, both groups of respondents tended to accept the diversity of the LGBT community. There was a significant difference (probability value = 0.020) in the overall extent of compliance with the GAD policy among the three groups of respondents. There was a significant relationship (probability value = 0.002) between the attitudes toward LGBT and the overall extent of compliance. There was a significant correlation (probability value = 0.000) between the respondents' involvement and compliance to implement the policy. There was a significant association (probability value = 0.000) between the respondents' capability and overall extent of compliance to implement the policy. Lastly, there was a significant difference (probability value = 0.003) between private and public schools regarding the overall extent of compliance to implement the policy. Hence, the respondents in the private schools were less compliant on the implementation of the Philippine Department of Education Order Number 32 series of 2017. From the study results, the researcher recommended that protection of LGBT rights be institutionalized in the junior high schools in Dumaguete City since the respondents' extent of compliance was not sufficient to assure protection of the LGBT sector in the schools. Thus, the writer presents the research output, A Proposed Three-Year Action Plan, 2019-2021.

Keywords: Institutionalizing protection, Public & Private Schools, Rights of Lesbian Gay Bisexual Transgender

Introduction

Everyone strives for respect and equality as basic needs in society. The world wide human rights declaration (1948) disclosed that every human being is born free and has equal dignity and rights. This declaration has also recognized the inherent dignity of human beings are foundation of freedom, justice, and peace of the world. It further declares the universality of human rights, that is, to be enjoyed by all people, whoever they are or wherever they live. These rights include civil and political rights, like the right to life, liberty, free speech, and privacy. The aforementioned

declaration further includes economic, social, and cultural rights, like the right to health, social security, and education (Australian Human Rights Commission, n.d.). Despite this universal declaration, the global Lesbian Gay Bisexual Transgender (LGBT) sector continuously strives to get equal footing in terms of the rights above with the other members of the society. The LGBT communities are up in every street and everywhere, voicing their sentiments of the unrelenting disrespect and inequalities they have been experiencing, in schools, workplace, or even in the community where they live. The kind of respect and equality longed for is far from the reality as this sector of society has been facing challenging and hostile situations every day. Unsurprisingly, authorities from countries within the range of influence by the United Nations have not been pushing much on this declaration or issue; moreover, the LGBT communities just experience minimal effort to address or lessen their anxieties. This apparent indifference is because member countries of the United Nations consider homosexuality as not moral, if not illegal (Orlandi, 2016).

According to Hutt (2018), the claim on the rights of the LGBT sector has made progress in the past years only in some parts of the world. But worldwide, there are only a few provisions of protection for the LGBT against gender or racial discrimination. At the forefront of education, UNESCO has joined the list of the United Nations organizations advocating for the gender issues in an attempt to address concerns of the LGBT communities relative to bullying, inequalities, and disrespect. The report, "Come Out in the Open," written by Muñoz (2016) and published online at the UNESCO news, informs that students who do not confirm their sexuality are the minority group, and they become vulnerable in educational settings. Previously, Orlandi (2016) urged that school personnel have to provide children with non-judgmental and accurate information on gender identity and preferences through information campaigns and partnerships with civil society and the wider school community. Further, the Rights of the Child Convention (1989) also recognizes the rights of LGBT children, though neither the children's convention nor any UN human rights treaty mentions the issue. More so with junior high school students who are to conform to how society expects of him/her to behave or follow his/her gender preference. Studies addressing the issue of LGBT rights protection in schools have not yet fully explored the problem. Inequality still prevails even in some countries with constitutions that provide protection based on sexual orientation. Murdock and Bolch (in Kosciw, Greytak, Diaz, & Barkiewicz, 2010) assert that research on the LGBT sector has not given more attention to the negative consequences of an unresponsive school climate towards access to education and learning. Further, Barron and Stephens' study (2012) informed that despite awareness of verbal and physical homophobic bullying in their schools, 90% of teachers indicated no mention of gay and lesbian-related bullying in their school's bullying policy.

In the study of Goodhand's (2014), its findings confirm the need for strategic practices that interrupt and confront homophobia through federal building social capital, policies, professional development, inclusive curricula, and a call for social justice leaders within schools, colleges, universites or any educational system. Moreover, Jones (2016) found that despite international policies covering LGBT rights as well as protection in one's sexual orientation, key institutions, such as the Australian Educational System, still implement local policies. Among the eight states in Australia, only two states have duly implemented the policy in protecting the LGBT sector. In the Philippines, the approval of Gender and Development (GAD) law ushered the Department of Education Order Number 32 series of 2017 known as Gender Responsive Basic Education Policy, which was released June 29, 2017 (DepEd). This policy provides opportunities for LGBT students to enjoy security and safety against violence and discrimination. Under this policy, principals, teachers, and GAD focal persons in Basic Education are to integrate respect for the rights of LGBT students. In this context, this study explored the extent of policy implementation among principals and other policy implementers of DepEd Order No. 32, s 2017, and determined explanatory variables for the said phenomenon. Data gathered will validate the proposed framework that aims to institutionalize the policy implementation given the kind of environmental conditions the respondent schools are presently experiencing.

The problems posted in the study

This investigation intended to explore the factors that explain the extent of principals, teachers, and GAD focal person's response to the furtherance of LGBT rights in their respective schools and to develop an intervening gender and development framework that will eventually institutionalize the promotion of LGBT rights in the secondary schools. This study explored answers of the following:

1. What is the respondent's profile in terms of:
   - **1.1.** age;
   - **1.2.** gender preference;
   - **1.3.** religion;

1.4. educational attainment; and
1.5. position held in school?

2. What is the extent of the respondents' knowledge on the Philippine Gender Responsive Policy for Basic Education provisions?
3. What is the respondents' attitude towards the LGBT sector?
4. What is the respondents' level of compliance in implementing the Philippine Department of Educationn Order Number 32, series of 2017,vis-a-vis:
4.1. promoting gender equality involving teachers, students as well as the non-teaching personnel;
4.2. reflecting non-discriminatory attitude as embedded in the learning materials, support services, curriculum, methodologies as well as teaching processes;
4.3. addressing gender dimension in information exchange, planning, design as well as delivery of service;
4.4. allocating tasks related to LGBT rights protection to the different subunits of the school understudy; and
5. What is the level of perceived capability of the respondents to integrate into their lessons and school activities the promotion of LGBT rights as stipulated in the Department of Education Order Number 32, series of 2017?
6. What is the extent of involvement of the respondent teachers and GAD Focal Persons on the provisions of DepEd Order No. 32 s, 2017?
7. Is there a significant difference in the level of compliance to implement the provisions of DepEd Order No. 32 s, 2017among the principal, teachers, and the GAD Focal persons?
8. Is there a significant relationship between the extent of policy compliance and:
8.1. extent of knowledge and attitude towards LGBT rights promotion;
8.2. extent of involvement to implement the policy; and
8.3. extent of the perceived capability to integrate into the lessons and school activities to promote LGBT rights?
9. Is there a significant difference in the policy compliance of the Basic Responsive Education Policy between public and private secondary schools in Dumaguete City?
10. What implementation model can be designed to institutionalize the promotion of LGBT rights protection in Basic Education?

Literature review

The study anchored on three theories as follows: (1) Icek Ajzen's (2006) Theory of Planned Behavior, (2) The Curriculum Theory developed by John F. Bobbit (1918) and Werrett W. Charter (1923), and (3) Policy Implementation Theory advanced by Pressman and Wildavsky (1973). The researcher gives a brief description of each theory and the variables used in this present study. Ajzen (2006) explained that the **theory of planned behavior** deals with human behavior guided by three kinds of considerations: beliefs about the possible consequences of the behavior (behavior beliefs), beliefs about the normative expectations of others (normative beliefs), and beliefs about the presence of factors that may facilitate or impede the performance of the behavior (control beliefs). Attitude toward the behavior, subjective norm, and perceived behavioral control all together leads to the formation of a behavioral intention. However, in the actual execution of the behavior, the perceived behavioral control is considered, and the intention, to substitute for the actual behavioral control of such behavior.

Ajzen further stated that in his model, there are three categories of background factors: individual, social, and information. Firstly, individual includes personality, mood, emotion, intelligence, values, stereotypes, and experience. Social factors consist of education, age, gender, income, religion, race, ethnicity, culture, and laws. And, information covers knowledge, media, and interventions. The **curriculum theory** began to expand in the USA after the publishing of John F. Bobbit's book, *The Curriculum* (1918) and Werrett W. Charter's book, *Curriculum Construction* (1923). Ralph W. Tyler, often called the father of the curriculum movement, came along with other influential proponents, Bobbit and Werrett. Bobbit wrote in *The Curriculum* (1918: 42): The central theory of curriculum is simple. Human life, however varied, consists of the performance of specific activities. Education that prepares for life prepares definitely and adequately for these specific activities. However numerous and diverse they may be for any social class, they can be discovered. This requires only that one go out into the world of affairs, and discover the particulars of which their affairs consist. These will show the abilities, attitudes, habits, appreciations and forms of knowledge that men need. These will be the objectives of the curriculum. The curriculum will then be a series of experiences that children and youth must have by way of obtaining those objectives.

On the other hand, Wallin (2011) said that curriculum theory is fundamentally concerned with values and other areas such as the historical background, recent views and policy decisions, and perspectives about the future curricula. Also, Pinar (2004) defines the present-day field of curriculum theory as "the effort to understand

curriculum as a symbolic representation." Other proponents view curriculum as "simply a collection of study plans, syllabi, and teaching subjects. The curriculum becomes the outcome of a process involving the political and social factors that can affect the education for the future" (Tedesco, Opertii & Amadio; 2014). Pressman and Wildavsky (1973) asserted that **policy implementation theory** is the actual use of policies by the constituents usually based on written laws, which can be in the form of executive orders or court decisions. These decisions emanate from the top officials to achieve the desired results. Three types of variables affect the achievement of legal objectives throughout this entire process. These variables, according to the proponents, include the manageability of the problem(s) addressed, the ability of the directive to design the implementation process, and the effect of the different political variables on the balance of support for the policy objectives. Meanwhile, O'Toole (2003) defined policy implementation as what develops between establishing an evident intention on the part of the government to do or stop doing something and the outcome of such decisions. Briefly, policy implementation is the connection between the intention and the actual result. Hence, O'Toole's view (2003) relates with Ajzen's theory (2006) regarding intention as a prerequisite of the desired result or behavior.

As part of the policy cycle, policy implementation concerns how governments put policies into effect (Howlett & Ramesh, 2003). Elmore (1978) identified four main ingredients for effective implementation: (1) specified tasks and objectives that accurately reflect the intent of policy; (2) a management plan that allocates tasks and performance standards to subunits; (3) an objective means of measuring subunit performance; and (4) a system of management controls and social sanctions sufficient to hold subordinates accountable for their performance. Failures of implementation are, by definition, lapses of planning, specification, and control (Elmore, 1978). Successful implementation, according to Matland (in Hill & Hupe, 2002), requires compliance with statutes' directives and goals, the achievement of specific success indicators, and improvement in the political climate around a program. In line with this, Giacchino and Kakabadse (2003) cited the successful implementation of public policies on decisive factors. These factors are the decisions taken to locate political responsibility for the initiative, strong project management or team dynamics, and the level of commitment shown to policy initiatives.

Thus, implementation focuses on the process, output, and outcome. It involves a series of decisions and actions directed towards putting a prior authoritative decision into effect. The essential characteristic of the implementation process is the timely and satisfactory performance of specific necessary tasks related to carrying out the law. Also, implementation refers to the output or level of program satisfaction by the beneficiaries. Finally, implementation outcome indicates the measurable change in the larger problem addressed by the program, public law, or judicial decisions (Lester et al., 1995).

Figure 1: shows the schematic diagram of the Theoretical Framework of the study focused on three perspectives.

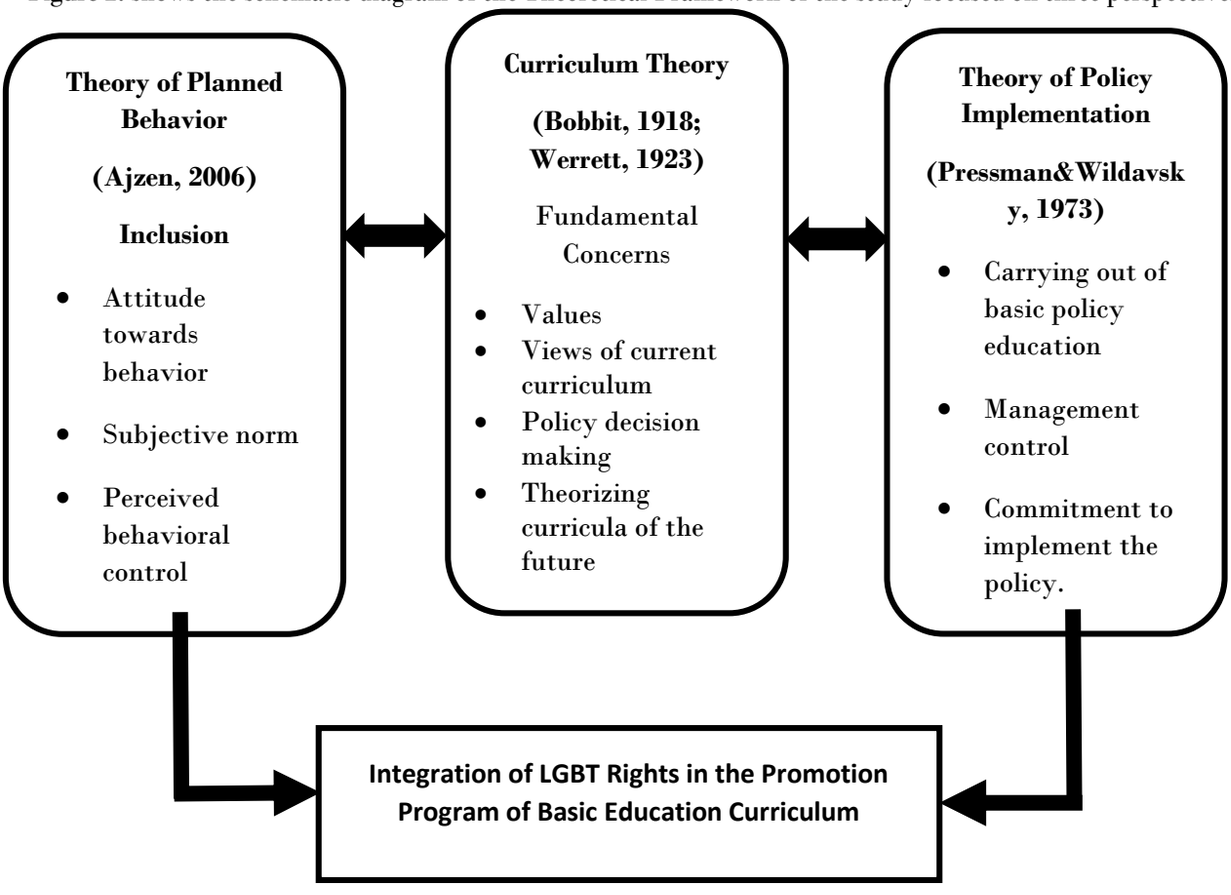

Figure 1: Schematic Diagram of the Theoretical Framework of the Study

Methodology

Research respondents

The respondents were school principals, teachers, and GAD focal persons from the public and private junior high schools in Dumaguete City, Negros Oriental. The teachers included in the study were chosen by proportionate random sampling, and a population of the school principals, GAD focal persons, and teachers served as respondents. Table 1 shows the distribution of participants grouped by high schools and their status.

Table 1: Number of Respondents from Public and Private Junior High Schools of Dumaguete City

Schools	Status	No of Respondents			
		Principal	GAD Focal Person	Teacher	
				Male	Female
1. Camanjac National High School	Public	1	1	6	6
2. Dumaguete City High School	Public	1	1	21	45
3. Hermenigilda Gloria Memorial High School	Public	1	1	1	9
4. Junob National High School	Public	1	1	6	21
5. Negros Oriental High School	Public	1	1	31	97
6. Piapi High School	Public	1	1	13	15
7. RPTM Science High School	Public	1	1	8	24
8. Taclobo National High School	Public	1	1	6	26
9. Cittadini High School	Private	1	1	4	10

10. Collegio de Sta. Catalina, High School	Private	1	1	3	19
11. Don Bosco High School	Private	1	1	11	14
12. Foundation University High School	Private	1	1	9	14
13. Holy Cross High School	Private	1	1	3	9
14. Silliman University High School	Private	1	1	21	34
15. St. Paul University High School	Private	1	1	6	15
Total		**15**	**15**	**143**	**358**

Research environment

The locale of the study is Dumaguete City, Negros Oriental where the junior high schools are located. The following are the fifteen public and private junior high schools included in the study: 1) Dumaguete City, 2) Junob, 3) Hermenegilda F. Gloria 4) Camanjac, 5) Piapi, 6) Ramon Teves Pastor, 7) Taclobo, 8) Negros Oriental, Silliman University, Colegio de Sta. Catalina, 3) Foundation University, 4) St. Paul University, 5) Holy Cross, 6) St. Louis Don Bosco, and 7) Catherina Cittadini. In addition, the Tanjay City Division consists of public and private high schools. The public high school are: 1)Tanjay National High School (TNHS), 2) Tanjay Legislated High School (TLHS), 3) Luca High School (LHS), 4) Tanjay City Science High School (TCSH), 5) Polo High School (PHS), 6) Azagra High School (AHS), and 7) Lourdes Ledesma Del Prado Memorial High School. While the private schools with junior high schools are as follows: 1) Casa Marie Learning Institute (CMLI), 2) Immaculate Heart Academy (IHA), 3) Villaflores College (VC), and 4) Diaz College.

Research instruments

Survey/Questionnaire instrument

The gathering of data followed the three-phase process, namely; 1) collecting data through the use of questionnaires, 2) Key Informant Interviews (KII's), and 3) Focus Group Discussions (FGDs) with the principals, faculty, and GAD focal persons. The researcher pre-tested the survey questionnaire to remove ambiguities before the data gathering commenced and to ensure reliability. *Cronbach Alpha* tested the reliability of the instrument, which generated reliability result of **.963**.

The instrument consisted of two major sections: the extent of implementation of DepEd Order no. 32, s 2017 and extent of the promotion of legal and social rights. Within each of these two sections, there were questions with several subcategories. The faculty and GAD focal persons' questionnaire had the same main parts but with fewer subcategories. Majority of the items were answerable using the Likert-style scale 5 point system. There were open-ended questions that allowed respondents to expand upon their quantitative responses. The questionnaire, which can be answered by about 10 minutes, contained a cover sheet explaining the study's purpose and providing all other information that were necessary to ensure voluntary participation and informed consent.

Research and data gathering procedures

The researcher first met the City Division of School Superintendent to seek permission to meet the school principal or designated representative. The objective was to inform on the purpose of the study, which involved the internal stakeholders, and to discuss the possible dates and time for the gathering, the conduct of the interviews, and the purpose of the data. Then, the principals accomplished the questionnaire at their convenient time. The researcher also interviewed them and they accomplished the instrument longer than the GAD focal persons and teachers. They belong to the top level of the school hierarchy and served as a linkage for DepEd and the other participants.

Finally, the teachers were met as a group to begin the process. The gathering discussed the questionnaires previously distributed. After the interviews, the researcher met the teachers for the focus group discussion.

Statistical treatment

The analysis and interpretation of quantitative data followed after using the appropriate statistical tools. Problem 1 focused on the profile of the respondents and the tools are frequency count, and percentage. And weighted mean for problems 2,3,4,5, and 6. The interpretation used the Likert Scales below:

Extent of attitude and knowledge on the provisions of DepEd Order no. 32, s. 2017

5 – Strongly Agree (SA) 75% - 100% of statement complied with

4 – Agree (A) 51% - 74% of statement complied with
3 – Neutral /Unsure 50%
2 – Disagree (D) 25% - 49% of statement complied with
1 – Strongly Disagree (SD) 0% - 24% of statement complied with

- **Level of compliance in implementing DepEd Order no. 32, s. 2017**

5 – Full Compliance (FC) 81% - 100% of statement complied with

4 – High Compliance (HC) 61% - 80% of statement complied with
3 – Moderate Compliance (MC) 41% - 60% of statement complied with
2 – Less Compliance (LC) 21% - 40% of statement complied with
1 – No Compliance (NC) 0% - 20% of statement complied with

- **Level of perceived capability to integrate LGBT rights stipulated in DepEd Order no. 32, s. 2017**

5 – Extremely Capable (EC) 81% - 100% of statement can be carried out

4 – Very Capable (VC) 61% - 80% of statement can be carried out
3 – Moderately Capable (MC) 41%- 60% of statement can be carried out
2 – Slightly Capable (SC) 21% - 40% of statement can be carried out
1 – Least Capable (LC) 1% - 20% of statement can be carried out

- **Extent of involvement on the provisions of DepEd Order no. 32, s. 2017**

5 –Always Involved (AI) 81% - 100% of statement is performed

4 – Often Involved (OI) 61% - 99% of statement is performed
3 – Sometimes Involved (SI) 41% - 60% of statement is performed
2 – Rarely Involved (RI) 21% - 40% of statement is performed
1 – Never Involved (NI) 0% - 20% of statement is performed

The rest of the problems called for other types of statistical tools. Kruskal–Wallis test was to test the difference in the level of commitment to implement the provision of DepEd Order No. 32 s, of 2017 among the school administrator, teachers and GAD focal person. Multiple regression was for problem 8, while Spearman rank order coefficient of correlation for problem 9. Problem 10, stepwise multiple linear regression was to generate a model that best explains the study outcome variable/phenomenon identified.

Result and discussion

1. **What is the profile of the principal, teacher and GAD focal person respondents relative to their socio-demographic profile?**

Table 1 shows the socio-demographic profile of the respondents. Most of the teachers and GAD focal persons are 20-39 years old, while the principals are predominantly within the age range of 40-65. This finding suggests that, in general, teachers and GAD focal persons are younger than the principals. Moreover, most of the respondents are female across the three groups and Roman Catholic by religious affiliation. On educational attainment, most of the school principals pursued graduate studies or earned units in master or Doctor of Education, and they are either full-fledged principals or assistant principals. On the other hand, most GAD focal persons and teachers earned units in a master's degree. The GAD focal persons are all appointed to that position, while most teachers are within the Teacher 1-3 ranks.

The findings imply that as middle-aged individuals with appropriate educational background and position, they have sufficient exposure to the LGBT issues and can respond positively to the problem in their respective areas. Further, teaching, as a female-dominated profession, is an effective avenue towards values integration and formation, especially with female teachers who are more sensitive to the needs of the LGBT youths in schools. Thus, they serve as role models to the students in exercising equality and mutual respect.

Table 1: Profile of respondents

Age	GAD (%)	Principal (%)	Teacher (%)
20-39	8 (57.14)	4 (28.57)	115 (57.5)
40-65	6 (42.86)	10 (71.43)	85 (42.5)
Total	14 (100.00)	14(100.00)	200 (100)

Mean age	39	46	35
Gender			
Female	13 (92.86)	8 (57.14)	143 (71.5)
Male	1 (7.14)	3 (21.43)	47 (23.5)
LGBT		3 (21.43)	10 (5)
Total	14 (100.00)	14 (100.00)	200 (100.00)
Religion			
Baptist			1 (0.50)
Born Again Christian			2 (1.00)
Christian		1 (7.14)	1 (0.50)
Iglesia ni Cristo			2 (1.00)
Protestant			16 (8.00)
Roman Catholic	14 (100.00)	13 (92.86)	171 (85.50)
Other			7 (3.50)
Total	14 (100.00)	14 (100.00)	200 (100.00)
Educational Attainment			
BS	1 (7.14)	1 (7.14)	60 (30.00)
CAR		3 (21.43)	35 (17.50)
Educ. Units	3 (21.43)	1 (7.14)	17 (8.50)
LI.B			1 (0.50)
MA/MS	1 (7.14)	1 (7.14)	15 (7.50)
MA/MS units	9 (64.29)	4 (28.57)	67 (33.50)
Ed.D		3 (21.43)	
Ph.D			5 (2.50)
Total	14 (100.00)	14 (100.00)	
Position			
Head teacher		2 (14.29)	1 (0.5)
Master Teacher 1			8 (4)
Master Teacher 2			3 (1.5)
Senior Teacher			1 (0.5)
Teacher		1 (7.14)	
Teacher 1			112 (56)
Teacher 2			20 (10)
Teacher 3			55 (27.5)
GAD	14 (100.00)		
Officer in Charge		2 (14.29)	
Assistant Principal		3 (21.43)	
Principal 1		5 (35.71)	

Principal 4		1 (7.14)	
Total	14 (100.00)	14 (100.00)	200 100

2. What is the extent of the principal, teacher and GAD focal person respondents' knowledge of the provisions of GAD policy?

This problem focuses on the GAD focal persons, school principals, and teachers' extent of knowledge of the policy in all government and private owned junior high schools in Dumaguete City, Negros Oriental.

GAD Focal Persons

Table 2.1 focuses on GAD focal persons' extent of knowledge of the policy. The private school respondents rated "moderately agree" (x=3.16), while their public school counterparts rated "agree" (x= 3.43). As shown in the table, the private school respondents agree with the specific policy items except Gender-Responsive Basic Education Center creation or development for LGBT, providing sufficient, efficient, effective and capacity-building responsive activities for the principals in dealing with children in conflict with the law (CICL), supporting policies on instruction, curriculum as well as assessment consistent with the principles of human rights education. In another perspective, the different public school respondents agree with the Gender and Development policy items, except creating a Gender-Responsive Basic Education Center for LGBT in the school, providing responsive, efficient, effective and sufficient capacity-building activities for the principal in dealing with children in conflict with the law (CICL), ensuring that resources for learning procured from internal sources comply with GAD core messages and concepts, supporting policies on instruction, curriculum as well as assessment consistent with the principles of human rights education.

Thus, the GAD focal persons have sufficient knowledge of the GAD policy, but for some items, they vary according to the type of school where they belong. The extent of their knowledge slightly differs as indicated by their average weighted mean.

Table 2.1. Extent of GAD focal persons' knowledge on the provisions of GAD policy.

Items	Private		Public	
	WX	V D	WX	VD
1. Promote awareness of the Philippine Gender Responsive Basic Education Policy (GRBE) issues and concerns in the governance and operations of schools, learning centers, and workplaces.	3.40	A	4.50	SA
2. Conduct continuous capacity-building activities to upgrade personnel on Information and Communications Technology knowledge and skills particularly on development of sex-disaggregated database and other Gender and Development information.	3.40	A	4.13	A
3. Create a Gender Responsive Basic Education Center for LGBT in the school.	2.20	D	2.38	D
3. Conduct effective and efficient capacity building trainings or workshops to ensure that all facilities are safe, functional, adequate, sanitary, gender and culture sensitive, and accessible to Persons with Disabilities (PWDs).	3.60	A	4.13	A
4. Provide sufficient as well as gender responsive capacity-building activities for principals in dealing children in conflict with the law (CICL)	2.40	D	2.13	D
5. Ensure gender-responsive implementation of sports programs and activities.	3.80	A	4.13	A
6. Create information, education, and communication (IEC) materials on issues for learners in need of special attention.	3.60	A	3.75	A
7. Create framework policies and standards for learner support programs and services that integrate GAD core messages and key concepts.	3.40	A	4.00	A
8. Make it certain that learning resources procured from internal sources comply with GAD concepts and core messages.	2.60	MA	2.38	D
9. Sufficient support policies on curriculum, instruction, and assessment are consistent with the principles of human rights education.	2.20	D	2.25	D
10. Encourage or motivate all public and private accrediting institutions or organizations to include gender-equality elements in their accreditation criteria.	3.40	A	4.00	A
11. Incorporate effectively and efficiently GAD core messages and key concepts in the test development process specifically in the table of specifications as integrated in the learning competencies using gender-fair language.	3.40	A	3.75	A
12. Create effective and efficient Lesbian, Gay, Bisexual and Transgender LGBT Desk in Schools.	3.40	A	2.88	MA

13. Create, effectively recommend, and efficiently implement policies for youth development aligned with GRBE in coordination with the National Youth Commission (NYC).	3.20	A	3.50	A
14. Make it certain that all schools, learning centers, and workplaces promote mental health and psychosocial support services aligned with GRBE.	3.40	A	3.50	A
Aggregate	**3.16**	**MA**	**3.43**	**A**

Legend:
5 – Strongly Agree (SA)
4 – Agree (A)
3 – Moderately Agree (MA)
2 – Disagree (D)
1 – Strongly Disagree (SD)

WX: Weighted Mean
VD: Verbal Description

School principals

Table 2.2 presents the school principals' extent of knowledge of the GAD policy. On average, the rating of the private school principals is "moderately agree" (x=3.38). However, they disagree with creating a Basic Education Gender Responsive Center for LGBT in the school, providing adequate and responsive capacity-building activities for the principal in dealing children in conflict with the law (CICL), ensuring that learning resources procured from internal sources comply with GAD concepts and core messages, supporting policies on curriculum, instruction, and assessment consistent with the principles of human rights education, and establishing Lesbian, Gay, Bisexual and Transgender LGBT Desk in Schools.

On the other hand, the public school principals rated "agree" (x=3.60). They strongly disagree with creating a Gender- Responsive Basic Education Center for LGBT in the school, providing adequate and responsive capacity-building activities for the principal in dealing children in conflict with the law (CICL), ensuring that learning resources procured from internal sources comply with GAD concepts and core messages, supporting policies on curriculum, instruction, and assessment consistent with the principles of human rights education, and establishing Lesbian, Gay, Bisexual and Transgender LGBT Desk in Schools.

Both groups have a similar extent of knowledge with the focal persons of the GAD policy. However, the extent of knowledge between the two groups of administrators differs as indicated by the average weighted mean.

Table 2.2. Extent of school principals' knowledge of the provisions on GAD policy

Items	Private		Public	
	WX	V D	WX	VD
1. Promote efficient and effective awareness towards Gender Responsive Basic Education Policy (GRBE) issues and concerns in the governance and operations of schools, learning centers, and workplaces.	4.00	A	4.93	SA
2. Conduct efficient, effective and continuous capacity-building activities to upgrade personnel on Information and Communications Technology knowledge and skills particularly on development of sex-disaggregated database and other GAD information.	3.33	MA	4.75	SA
3. Create a Gender Responsive Basic Education Center for LGBT in the school.	2.33	D	1.50	SD
4. Conduct efficient and effective capacity building activities to ensure that all facilities are safe, functional, adequate, sanitary, gender and culture sensitive, and accessible to Persons with Disabilities (PWDs).	4.17	A	4.82	SA
5.Provide adequate, efficient, effective and responsive capacity-building activities for principals in dealing children in conflict with the law (CICL)	2.17	D	1.57	SD
6. Make it certain that gender-responsive as well as effective and efficient implementation of sports programs and activities.	4.33	SA	4.43	SA
7. Create appropriate information, education, and communication (IEC) materials on issues for learners in need of special attention.	4.17	A	4.57	SA
8. Create appropriate framework policies and standards for learner support programs and services that integrate GAD core messages and key concepts.	4.17	A	4.68	SA
9. Make it certain that learning resources procured from internal sources fully complied with GAD concepts and core messages.	2.50	D	1.32	SD
10. Support absolutely policies on curriculum, instruction, and assessment which are consistent with the established principles of human rights education.	2.50	D	1.25	SD
11. Make it certain that all Philippine public and private accrediting institutions or organizations to include appropriate gender-equality elements in their accreditation criteria.	4.00	A	4.68	SA
12. Include Gender and Development core messages and key concepts in the test development process specifically in the table of specifications as integrated in the learning competencies using gender-fair language.	3.67	A	5.00	SA

13. Establish Lesbian, Gay, Bisexual and Transgender LGBT Desk in Schools.	2.50	D	1.32	SD
14. Formulate, recommend, and implement policies for youth development aligned with GRBE in coordination with the National Youth Commission (NYC).	3.33	MA	4.54	SA
15. Ensure that all schools, learning centers, and workplaces promote mental health and psychosocial support services aligned with GRBE.	3.50	A	4.68	SA
Aggregate	**3.38**	**MA**	**3.60**	**A**

Legend:
5 – Strongly Agree (SA)
4 – Agree (A)
3 – Moderately Agree (MA)
2 – Disagree (D)
1 – Strongly Disagree (SD)

WX: Weighted Mean
VD: Verbal Description

Teachers

Table 2.3 presents the teachers' extent of knowledge of the GAD policy. The private school teachers rated "agree" (x = 3.49). But they do not agree with creating a Gender-Responsive Basic Education Center for LGBT in the school, providing adequate and responsive capacity-building activities for the principal in dealing children in conflict with the law (CICL), ensuring that learning resources procured from internal sources comply with GAD concepts and core messages, supporting policies on curriculum, instruction, and assessment consistent with the principles of human rights education, and establishing Lesbian, Gay, Bisexual and Transgender LGBT Desk in Schools. The public school teachers also rated "agree" (x = 3.41) with the GAD policy. However, they do not agree with creating a Gender-Responsive Basic Education Center for LGBT in the school, providing adequate and responsive capacity-building activities for the principal in dealing children in conflict with the law (CICL), ensuring that learning resources procured from internal sources comply with the GAD concepts and core messages, supporting policies on curriculum, instruction, and assessment consistent with the principles of human rights education, and establishing Lesbian, Gay, Bisexual and Transgender LGBT Desk in Schools.

The teachers reveal a similar extent of knowledge with the school principals and GAD focal persons. The finding confirms the teachers' role, as claimed by Troop and Ladd (2015), to integrate gender sensitivity in the instruction. By doing so, Kosciw, Palmer, Kull, and Greytak (2013) claimed that school-based supports could lower victimization and improve academic outcomes. And these views confirm the previous studies that emphasized school-based supports for LGBT students to have a better school environment and educational outcomes (Goodenow, 2006; Kosciw et al., 2010; Szalacha, 2003).

Table 2.3: Extent of teachers' knowledge on the provisions of GAD policy

Items	Private		Public	
	WX	V D	WX	VD
1. Promote awareness of the Philippine Gender Responsive Basic Education Policy (GRBE) issues and concerns in the governance and operations of schools, learning centers, and workplaces.	4.14	A	4.19	A
2. Conduct effective, efficient and continuous capacity-building activities to upgrade personnel on ICT knowledge and skills particularly on development of sex-disaggregated database and other GAD information.	3.67	A	3.83	A
3. Create a Gender Responsive Basic Education Center for LGBT in the school.	2.82	MA	2.39	D
4. Conduct effective, efficient and continuous capacity building to ensure that all facilities are safe, functional, adequate, sanitary, gender and culture sensitive, and accessible to Persons with Disabilities (PWDs).	4.18	A	4.13	A
5. Provide effective, efficient, continuous and adequate and responsive capacity-building activities for principal in dealing children in conflict with the law (CICL)	2.35	D	2.09	D
6. Make it certain that effective, efficient and continuous gender-responsive implementation of sports programs and activities.	4.12	A	4.10	A
7. Develop information, education, and communication (IEC) materials on issues for learners in need of special attention.	4.06	A	4.12	A
8. Create effective, efficient and continuous framework policies and standards for learner support programs and services that integrate GAD core messages and key concepts.	4.06	A	4.08	A
9. Make it certain that appropriate learning resources procured from internal sources comply with GAD concepts and core messages.	2.39	D	2.06	D
10. Support effective, efficient and appropriate policies on curriculum, instruction, and assessment are consistent with the principles of human rights education.	2.27	D	1.91	D

11. Make it certain that all public and private accrediting institutions or organizations to include gender-equality elements in their accreditation criteria.	3.96	A	3.97	A
12. Include GAD core messages and key concepts in the test development process specifically in the table of specifications as integrated in the learning competencies using gender-fair language.	3.78	A	3.81	A
13. Create an effective, efficient and continuous Lesbian, Gay, Bisexual and Transgender LGBT Desk in Schools.	3.00	MA	2.62	MA
14. Create, recommend, and implement appropriate policies for youth development aligned with GRBE in coordination with the National Youth Commission (NYC).	3.71	A	3.82	A
15. Make it certain that all schools, learning centers, and workplaces promote mental health and psychosocial support services aligned with GRBE.	3.86	A	4.00	A
Aggregate	**3.49**	**A**	**3.41**	**A**

Legend:
5 – Strongly Agree (SA)
4 – Agree (A)
3 – Moderately Agree (MA)
2 – Disagree (D)
1 – Strongly Disagree (SD)

WX: Weighted Mean
VD: Verbal Description

Summary on the extent of knowledge of the principal, teacher and GAD focal person respondents on the GAD policy. The overall extent of knowledge reflects similar findings, as shown in Table 2.4. There is just a slight variation among the three groups of respondents in the private schools. These findings imply that they have adequate knowledge of the policy, as mandated to protect the rights of the LGBT sector.

Table 2.4: Summary on the respondents' extent of knowledge

Items	Private		Public	
	WX	V D	WX	VD
2.0 Extent of knowledge of GAD focal persons	3.16	MA	3.43	A
2.1 Extent of knowledge of the principals	3.38	MA	3.60	A
2.2.Extent of knowledge of the teachers	3.49	A	3.41	A

Legend:
5– Strongly Agree (SA)
4– Agree (A)
3– Moderately Agree (MA)
2– Disagree (D)
*1– Strongly Disagree (*SD)

WX: Weighted Mean
VD: Verbal Description

1. **What is the attitude of the respondents towards the LGBT sector?**

The succeeding tables present the attitude of the respondents on the LGBT sector.

GAD Focal Persons

Table3.1 shows the data from the GAD focal persons' attitude towards the LGBT sector. On average, the respondents in private (x = 4.02) and public schools (x = 3.90) rated "agree". The private school respondents strongly disagree with homosexuality as unnatural and immoral and transgender as strange and sick individuals, while the public school counterparts disagree. The GAD focal persons' attitude implies acceptance of the LGBT sector. Hence, it is evident that with their favorable attitude, they are supportive in institutionalizing gender equality programs in their high schools.

Table 3.1: Attitude of GAD focal persons towards LGBT sector

Items	Private		Public	
	WX	V D	WX	VD
1. Homosexuality is unnatural and immoral. Transgender individuals are strange and sick.	1.50	SD	2.25	D
2. LGBT people should participate in reparative therapy or any other treatment available to them to fix their sexual orientation or gender identity disorder.	2.00	D	3.38	MA
3. We should have compassion for LGBT people. They can't be blamed for how they were born.	4.83	SA	4.75	SA
4. LGBT people did not choose to be the way they are. If they could somehow, they would certainly choose to be heterosexual or identify as a traditional male or female.	4.50	SA	4.00	A
5. Having same-sex attractions and showing non-gender conforming behaviors is a phase that many people go through and most people outgrow.	4.17	A	3.13	MA
6. LGBT people need our support and guidance as they wrestle with the many difficult issues associated with being LGBT.	4.50	SA	4.50	SA
7. I have no problem with LGBT people, but see no need for them to flaunt their sexual orientation or transgender identity publicly.	4.33	SA	3.50	A
8. What LGBT people do in the privacy of their own bedroom is their business.	4.17	A	4.13	A
9. LGBT people deserve the same rights and privileges as everybody else.	4.83	SA	4.63	SA
10. Homophobia and heterosexism is wrong. Society needs to take a stand against anti-gay bias.	4.00	A	3.75	A
11. It takes strength and courage for LGBT people to be themselves in today's world.	4.17	A	3.88	A
12. It is important for me to examine my own attitudes so that I can actively support the struggle for equality that LGBT people have undertaken.	4.17	A	3.88	A
13. There is great value in our human diversity. LGBT people are an important part of that diversity.	4.50	SA	4.50	SA
14. It is important for me to stand up to those individuals who demonstrate homophobic attitudes.	4.17	A	4.00	A
15. LGBT people are an indispensable part of our society. They have contributed much to our world and there is much to be learned from their experiences.	4.50	SA	4.13	A
16. I would be proud to be part of a LGBT or LGBT –ALLY organization, and to openly advocate for the full and equal inclusion of GLBT people at all levels of our society.	4.00	A	4.00	A
Aggregate	**4.02**	**A**	**3.90**	**A**

Legend:

5 – Strongly Agree (SA) *75% - 100% of statement complied with* *WX: Weighted Mean*
4 – Agree (A) *51% - 74% of statement complied with* *VD: Verbal Description*
3 – Moderately Agree (MA) *50%*
2 – Disagree (D) *25% - 49% of statement complied with*
1 – Strongly Disagree (SD) *0% - 24% of statement complied with*

School principals

Table 3.2 shows the principals' attitude towards the LGBT sector. On average, the respondents rated "agree" in private ($x = 4.15$) and public schools ($x = 3.83$). Both groups disagree with homosexuality as unnatural and immoral, and transgender as strange and sick individuals. The finding indicates the principals' positive attitude towards the LGBT sector. This result is consistent with Table 3.1 as revealed by the GAD focal persons, and their positive attitude may contribute to the beneficial implementation of the proposed intervention. This finding seems contrary to the LGBT sector's claim of discrimination in educational institutions. LGBT people argue that schools have the right to create their policies, but the curriculum did not include gender issues. That is why the Department of

Education (2012) issued an order protecting all children from violence, abuse, and exploitation (UNDP, USAID, 2014).

Table 3.2: Attitude of the school principals towards LGBT sector

Items	Private		Public	
	WX	V D	WX	VD
1. Homosexuality is unnatural and immoral. Transgender individuals are strange and sick.	2.33	D	1.50	SD
2. LGBT people should participate in reparative therapy or any other treatment available to them to fix their sexual orientation or gender identity disorder.	2.83	MA	2.63	MA
3. We should have compassion for LGBT people. They can't be blamed for how they were born.	4.17	A	3.50	A
4. LGBT people did not choose to be the way they are. If they could somehow, they would certainly choose to be heterosexual or identify as a traditional male or female.	4.00	A	3.75	A
5. Having same-sex attractions and showing non-gender conforming behaviors is a phase that many people go through and most people outgrow.	3.33	MA	3.13	MA
6. LGBT people need our support and guidance as they wrestle with the many difficult issues associated with being LGBT.	4.33	SA	4.75	SA
7. I have no problem with LGBT people, but see no need for them to flaunt their sexual orientation or transgender identity publicly.	4.50	SA	3.75	A
8. What LGBT people do in the privacy of their own bedroom is their business.	3.50	A	4.38	SA
9. LGBT people deserve the same rights and privileges as everybody else.	4.00	A	4.63	SA
10. Homophobia and heterosexism is wrong. Society needs to take a stand against anti-gay bias.	2.83	MA	2.25	D
11. It takes strength and courage for LGBT people to be themselves in today's world.	4.17	A	4.50	SA
12. It is important for me to examine my own attitudes so that I can actively support the struggle for equality that LGBT people have undertaken.	4.33	SA	4.63	SA
13. There is great value in our human diversity. LGBT people are an important part of that diversity.	4.17	A	4.88	SA
14. It is important for me to stand up to those individuals who demonstrate homophobic attitudes.	3.83	A	4.25	SA
15. LGBT people are an indispensable part of our society. They have contributed much to our world and there is much to be learned from their experiences.	4.17	A	4.75	SA
16. I would be proud to be part of a LGBT or LGBT –ALLY organization, and to openly advocate for the full and equal inclusion of GLBT people at all levels of our society.	3.17	MA	4.00	A
Aggregate	**4.15**	**A**	**3.83**	**A**

Legend:

5 – Strongly Agree (SA) *75% - 100% of statement complied with* *WX: Weighted Mean*
4 – Agree (A) *51% - 74% of statement complied with* *VD: Verbal Description*
3 – Moderately Agree (MA) *50%*
2 – Disagree (D) *25% - 49% of statement complied with*
1 – Strongly Disagree (SD) *0% - 24% of statement complied with*

Teachers

Table 3.3 shows the teachers' attitude towards the LGBT sector. On average, the respondents from the private schools rated "agree" (x = 3.70). However, they disagree with homosexuality as unnatural and immoral, and LGBT people need treatment to fix their sexual orientation or gender identity disorder. Similarly, the public school teachers' rated "agree" (x = 3.82). And they also disagree with homosexuality as unnatural and immoral and needs reparative therapy or treatment.

This finding also indicates a positive attitude among teachers like the GAD focal persons and school principals. It confirms the study conducted by Francis (2012) in Durban, South Africa, that teachers' life orientation influences their teaching of sexuality education and homosexuality, particularly in their classrooms. However, knowledge and attitude may differ from actual practice since the type of school (public or private) determines whether or not policy protections are available.

Table 3.3: Attitude of teachers towards LGBT sector

Items	Private		Public	
	WX	V D	WX	VD
1. Homosexuality is unnatural and immoral. Transgender individuals are strange and sick.	1.96	D	2.09	D
2. LGBT people should participate in reparative therapy or any other treatment available to them to fix their sexual orientation or gender identity disorder.	2.20	D	2.57	D
3. We should have compassion for LGBT people. They can't be blamed for how they were born.	4.16	A	4.22	SA
4. LGBT people did not choose to be the way they are. If they could somehow, they would certainly choose to be heterosexual or identify as a traditional male or female.	3.84	A	3.76	A
5. Having same-sex attractions and showing non-gender conforming behaviors is a phase that many people go through and most people outgrow.	3.37	MA	3.55	A
6. LGBT people need our support and guidance as they wrestle with the many difficult issues associated with being LGBT.	4.39	SA	4.26	SA
7. I have no problem with LGBT people, but see no need for them to flaunt their sexual orientation or transgender identity publicly.	3.65	A	3.96	A
8. What LGBT people do in the privacy of their own bedroom is their business.	3.82	A	4.14	A
9. LGBT people deserve the same rights and privileges as everybody else.	4.41	SA	4.54	SA
10. Homophobia and heterosexism is wrong. Society needs to take a stand against anti-gay bias.	3.18	MA	3.74	A
11. It takes strength and courage for LGBT people to be themselves in today's world.	4.12	A	4.18	A
12. It is important for me to examine my own attitudes so that I can actively support the struggle for equality that LGBT people have undertaken.	4.06	A	4.14	A
13. There is great value in our human diversity. LGBT people are an important part of that diversity.	4.16	A	4.18	A
14. It is important for me to stand up to those individuals who demonstrate homophobic attitudes.	3.92	A	3.88	A
15. LGBT people are an indispensable part of our society. They have contributed much to our world and there is much to be learned from their experiences.	4.22	SA	4.19	A
16. I would be proud to be part of a LGBT or LGBT –ALLY organization, and to openly advocate for the full and equal inclusion of GLBT people at all levels of our society.	3.78	A	3.74	A
Aggregate	**3.70**	**A**	**3.82**	**A**

Legend:

5 – Strongly Agree (SA)	*75% - 100% of statement complied with*	*WX: Weighted Mean*
4 – Agree (A)	*51% - 74% of statement complied with*	*VD: Verbal Description*
3 – Moderately Agree (MA)	*50%*	
2 – Disagree (D)	*25% - 49% of statement complied with*	
1 – Strongly Disagree (SD)	*0% - 24% of statement complied with*	

Table 3.4 shows the summary of the respondents' attitude towards the LGBT sector. The data reveal that both private and public school respondents consistently agree with the items indicating positive attitude towards the LGBT sector. This finding implies that despite their claim of discrimination in some related studies, all of the three groups of respondents have a positive attitude on them. The findings confirm the Pew Research Center (2013) report

that the Philippines is the most broad-minded nation in the Asia-Pacific region included in the survey. However, as Ging Cristobal, a Manila-based activist with the International Gay and Lesbian Human Rights Commission, claimed, there might be high tolerance. Still, there is no actual acceptance (Mosbergen, 2015). He further informed that there is still no legal recognition and protection of LGBT people at the national level.

Table 3.4: Summary on the attitude of the principal, teacher and GAD focal person respondents towards LGBT sector

Items	Private		Public	
	WX	V D	WX	VD
2.3. Attitude of the respondents-GAD	4.02	A	3.90	A
2.4. Attitude of the respondents-PRINCIPALS	4.15	A	3.83	A
2.5. Attitude of the respondents-TEACHERS	3.70	A	3.82	A

Legend:

5 – Strongly Agree (SA) *75% - 100% of statement complied with* *WX: Weighted Mean*
4 – Agree (A) *51% - 74% of statement complied with* *VD: Verbal Description*
3 – Moderately Agree (MA) *50%*
2 – Disagree (D) *25% - 49% of statement complied with*
1 – Strongly Disagree (SD) *0% - 24% of statement complied with*

2. What is the level of the principal, teacher and GAD focal person respondents' compliance in implementing the Philippine Department of Education Order Number 32, sewries of 2017?

The five component variables determined the respondents' level of compliance in implementing DepEd Order No. 32, s. 2017. In each variable, the data from the three groups of respondents are presented in tabular forms in the succeeding tables.

4.1 Promoting gender equality involving learners, teachers, and non-teaching personnel
GAD

Table 4.1.1 shows the level of compliance of the GAD focal persons in promoting gender equality involving learners, teachers, and non-teaching personnel. On average, the rating from both groups is "less compliance," whereby the private (x = 2.03) and public schools (x = 2.29) reflect a low level of compliance. Respondents from private schools are not compliant or less compliant with the items, except developing a set of GAD and human rights competencies for the LGBT sector such as the integration of values on respect for oneself and respect for others based on human rights. On the other hand, the focal persons in the public schools are not compliant or less compliant, except enhancing and promoting a K to 12 curriculum that integrates gender equality, human rights, sexuality, and reproductive health education; and getting involved in the proper orientation and training on gender equality, human rights, sexuality, and reproductive health education, human rights, peace education, and child protection.

The finding implies that despite the GAD focal persons' acceptance of the LGBT students, they reveal a low compliance of the policy. There is acceptance or, say, tolerance, as claimed by Cristobal (in Mosbergen, 2015) on the LGBT sector, but the actual promotion of gender equality is not clear. That is probably why the problem of discrimination is still lingering up to the time of the study.

Table 4.1.1 GAD focal persons' level of compliance in promoting gender equality involving learners, teachers, and non-teaching personnel

Items	Private		Public	
	WX	V D	WX	VD
1. Support the Annual Implementation Plans (AIPs) activities related to advocacy on gender equality.	1.50	NC	2.38	LC
2. Include in the school calendar the observance and celebrations related to GAD such as but not limited to Lesbian, Gay, Bisexual, and Transgender (LGBT) Pride Month (June),	1.33	NC	1.63	NC
3. Include in the lesson plan appropriate topics on LGBT.	2.00	LC	2.13	LC

4. Create a set of GAD and human rights competencies for the LGBT sector such as the integration of values on respect for oneself and respect for others based on human rights.	2.83	MC	2.25	LC
5. Encourage Gay Straight Alliance (GSA) as a student club for this minority group.	1.67	NC	2.13	LC
6. Implement LGBT-specific programs or activities in the daily activities, which may include safe zones, gay-straight alliances, and suicide prevention programs.	2.17	LC	2.25	LC
7. Participate LGBT-related professional development in the school.	2.00	LC	2.13	LC
8. Attend seminars and trainings related to LGBT workshops in regional and national level.	1.83	LC	2.38	LC
9. Improve and promote a K to 12 curriculum that integrates gender equality, human rights, sexuality, and reproductive health education.	2.50	LC	2.75	MC
10. Get involved in the proper orientation and training on equality of gender, sexuality as well eproductive health education, human rights, peace education, and child protection.	2.50	LC	2.88	MC
Aggregate	**2.03**	**LC**	**2.29**	**LC**

Legend:
5-Full Compliance (FC) 81%-100% of statement complied with WX=Weighted Mean
4-High Compliance (HC) 61%-80% of statement complied with VD = Verbal Description
3-Moderate Compliance (MC) 41%-60% of statement complied with
2-Less Compliance (LC) 21%-40% of statement complied with
1-No Compliance (NC) 0%- 20% of statement complied with

School principals

Table 4.2 shows the principals' level of compliance in promoting gender equality involving learners, teachers, and non-teaching personnel. As shown, the respondents from private schools are not compliant (x = 1.65), while those in public schools are moderately compliant (x = 2.74). The public school respondents are less compliant or moderately compliant, except attending seminars and training related to LGBT workshops at the regional and national level" that they are highly compliant. Finding implies that school principals in public school are barely able to comply compared with their private school counterparts. Moreover, the private school principals are not responsive, which might have influenced their GAD focal persons' compliance shown in Table 4.1.1.

Table 4.1.2. School principals' level of compliance in promoting gender equality involving learners, teachers, and non-teaching personnel

Items	Private		Public	
	WX	V D	WX	VD
1. Support the Annual Implementation Plans (AIPs) activities related to advocacy on gender equality.	1.00	NC	2.50	LC
2. Incorporate in the calendar of the school the observance as well as celebrations related to GAD such as but not limited to Lesbian, Gay, Bisexual, and Transgender (LGBT) Pride Month (June),	1.50	NC	2.38	LC
3. Include in the lesson plan topics on LGBT.	2.17	LC	2.75	MC
4. Create certain sets of GAD and human rights competencies for the LGBT sector such as the integration of values on respect for oneself and respect for others based on human rights.	2.33	LC	2.75	MC
5. Encourage Gay Straight Alliance (GSA) as a student club for this minority group.	1.50	NC	2.00	LC
6. Implement LGBT-specific programs or activities in the daily activities, which may include safe zones, gay-straight alliances, and suicide prevention programs.	1.33	NC	3.00	MC
7. Participate LGBT-related professional development in the school.	1.17	NC	2.75	MC

8. Attend seminars and trainings related to LGBT workshops in regional and national level.	1.50	NC	3.75	HC
9. Improve and promote a K-12 curriculum that integrates gender equality, sexuality, human rights, as well as reproductive health education.	2.00	LC	2.50	LC
10. Get involved in the appropriate training and orientation on gender, sexuality, equality, as well as reproductive health education, human rights, peace education, and child protection.	2.00	LC	3.00	MC
Aggregate	**1.65**	**NC**	**2.74**	**MC**

Legend:
5 – Full Compliance (FC) 81% - 100% of statement complied with WX: Weighted Mean
4 – High Compliance (HC) 61% - 80% of statement complied with VD: Verbal Description
3 – Moderate Compliance (MC) 41% - 60% of statement complied with
2 – Less Compliance (LC) 21% - 40% of statement complied with
1 – No Compliance (NC) 0% - 20% of statement complied with

Teachers

Shown in Table 4.1.3 is the teachers' level of compliance in promoting gender equality involving learners, teachers, and non-teaching personnel. The private school teachers rated "less compliance" (x = 2.43) while the public schools, "moderate compliance (x =2.79). The private school teachers are moderately compliant in supporting the Annual Implementation Plans (AIPs) activities related to advocacy on gender equality, developing a set of GAD and human rights competencies for the LGBT sector such as the integration of values on respect for oneself and others based on human rights, enhancing and promoting a K to 12 curriculum that integrates gender equality, human rights, sexuality, and reproductive health education, and getting involved in the proper orientation and training on gender equality, sexuality, and reproductive health education, human rights, peace education, and child protection. They are less compliant with the rest of the items.

On the other hand, the teachers in the public schools are moderately compliant with supporting the Annual Implementation Plans (AIPs) activities related to advocacy on gender equality, developing a set of GAD and human rights competencies for the LGBT sector such as the integration of values on respect for oneself and respect for others based on human rights, enhancing and promoting a K to 12 curriculum that integrates gender equality, human rights, sexuality, and reproductive health education, and getting involved in the proper orientation and training on gender equality, sexuality, and reproductive health education, human rights, peace education, and child protection. They are less compliant with the rest of the policy items in this component variable. The finding implies that in promoting gender equality mandated in DepEd Order No. 32, s. 2017, public school teachers are more responsive than their private school counterparts. This result could be due to the public school principals' moderate compliance despite less involvement by the GAD focal person. On the contrary, the private school teachers are less motivated to comply, maybe because the school principal, who is the head of the school, is not compliant. Further, GAD focal persons are not doing quite well as the designated individuals in school to organize activities related to gender rights.

Table 4.1.3. Teachers' level of compliance promoting gender equality involving learners, teachers, and non-teaching personnel.

Items	Private		Public	
	WX	V D	WX	VD
1. Support the Annual Implementation Plans (AIPs) activities related to advocacy on gender equality.	2.73	MC	2.97	MC
2. Include in the school calendar the observance and celebrations related to GAD such as but not limited to Lesbian, Gay, Bisexual, and Transgender (LGBT) Pride Month (June),	2.16	LC	2.54	LC
3. Include in the lesson plan topics on LGBT.	2.31	LC	2.54	LC
4. Create a set of GAD and human rights competencies for the LGBT sector such as the integration of values on respect for oneself and respect for others based on human rights.	2.80	MC	2.89	MC
5. Encourage Gay Straight Alliance (GSA) as a student club for this minority group.	2.20	LC	2.25	LC

6. Implement LGBT-specific programs or activities in the daily activities, which may include safe zones, gay-straight alliances, and suicide prevention programs.	2.25	LC	2.47	LC
7. Participate LGBT-related professional development in the school.	2.14	LC	2.58	LC
8. Attend seminars and trainings related to LGBT workshops in regional and national level.	2.16	LC	2.42	LC
9. Enhance and promote a K to 12 curriculum that integrates gender equality, human rights, sexuality, and reproductive health education.	2.80	MC	3.14	MC
10. Get involved in the proper orientation and training on gender equality, sexuality, and reproductive health education, human rights, peace education, and child protection.	2.71	MC	3.01	MC
Aggregate	2.43	LC	2.79	MC

Legend:

5 – Full Compliance (FC) 81% - 100% of statement complied with WX: Weighted Mean
4 – High Compliance (HC) 61% - 80% of statement complied with VD: Verbal Description
3 – Moderate Compliance (MC) 41% - 60% of statement complied with
2 – Less Compliance (LC) 21% - 40% of statement complied with
1 – No Compliance (NC) 0% - 20% of statement complied with

4.2 Reflecting non-discriminatory attitude as embedded in the curriculum, learning materials, teaching methodologies, and supportive services

GAD

Table 4.2.1 shows that in reflecting non-discriminatory attitude embedded in the curriculum, learning materials, methodologies, and services, private (x = 2.12) and public schools (x = 2.39) are less compliant. Responses from private school GAD personnel indicate no compliance or less compliance with most items but with moderate compliance to ensuring no discrimination of LGBT students in school by checking the reports of the GAD Focal person and the Guidance Counselor, and encouraging students to participate in programs or students organizations that address LGBT bullying and violence. The respondents in public schools are less compliant but moderately compliant with assisting students in promoting policies that prohibit harassment/bullying of LGBT students, ensuring no discrimination of LGBT students in school by checking the reports of the GAD Focal person and the Guidance Counselor, homophobic comments and actions by coaches and student- athletes are completely unacceptable through reminders during regular meetings, and encouraging students to participate in programs or students organizations that address LGBT bullying and violence.

The finding is consistent with the results in the first component variable (Table 4.1.1). It indicates that the GAD focal persons are not compliant with the specific duties of their position. To reiterate, the type of school (public vs. private) also matters in responding to the provision of the policy. They need to improve their performance in protecting the gender right of the students.

Table 4.2.1. Level of compliance of GAD focal persons in reflecting non-discriminatory attitude as embedded in the curriculum, learning materials, teaching methodologies, and supportive services

Items	Private		Public	
	WX	V D	WX	VD
1. Continuously assist students in promoting policies that prohibit harassment/bullying of LGBT students.	2.33	LC	2.75	MC
2. Make it certain that LGBT students are not discriminated/bullied in school by checking the reports of the GAD Focal person and the Guidance Counselor	3.00	MC	3.38	MC
3. Anti-homophobia education is integrated in the lessons.	1.50	NC	2.13	LC
4. Encourage LGBT students to join of campus athletic programs in LGBT-related initiatives.	2.17	LC	2.13	LC
5. Homophobic comments and actions by coaches and student athletes are completely unacceptable through reminders during regular meetings.	2.50	LC	2.63	MC

6. Encourage students to participate in programs or students organizations that address LGBT bullying and violence.	2.83	MC	2.63	MC
7. Ensure the availability Information Education and Campaign (IEC) materials related to the awareness and protection of LGBT sector in the classroom.	1.83	LC	2.00	LC
8. Avail appropriate trainings related to LGBT issues in relations with CPD units.	1.83	LC	2.25	LC
9. Participate in seminars on the awareness of LGBT rights protection and issues for personal growth.	1.50	NC	2.00	LC
10. Include in the teaching methodologies by film showing, drama, play, symposium and other creative activities that tackle LGBT issues.	1.67	NC	2.00	LC
Aggregate	**2.12**	**LC**	**2.39**	**LC**

Legend:
5 – Full Compliance (FC) 81% - 100% of statement complied with WX: Weighted Mean
4 – High Compliance (HC) 61% - 80% of statement complied with VD: Verbal Description
3 – Moderate Compliance (MC) 41% - 60% of statement complied with
2 – Less Compliance (LC) 21% - 40% of statement complied with
1 – No Compliance (NC) 0% - 20% of statement complied with

School principals

Table 4.2.2 presents the principals' level of compliance in reflecting non-discriminatory attitude as embedded in the curriculum, learning materials, teaching methodologies, and supportive services. The private school respondents are less compliant (x = 2.28). They are not compliant or less compliant with most of the items while moderately compliant with ensuring no discrimination of LGBT students in school by checking the reports of the GAD Focal person and the Guidance Counselor, encouraging LGBT students to join of campus athletic programs in LGBT-related initiatives, and encouraging students to participate in programs or students organizations that address LGBT bullying and violence. On the other hand, the public school respondents are highly compliant (x = 3.45). But they are less compliant with ensuring the availability Information Education and Campaign (IEC) materials related to the awareness and protection of LGBT sector in the classroom. This response seems unexpected in public schools because the funding and materials in every program are provided by the government, especially when it pertains to government policies. Also, the schools covered in this study belong to remote areas.

Finding implies that LGBT rights are not given much attention in private schools, unlike the public schools. Future researchers may conduct related studies that can look deeper into the discrepancy between the private and public schools' implementation of DepEd Order No. 32, s. 2017 despite policy awareness and positive attitude towards the LGBT sector.

Table 4.2.2. Level of compliance of school principals in reflecting non-discriminatory attitude as embedded in the curriculum, learning materials, teaching methodologies, and supportive services.

Items	Private		Public	
	WX	V D	WX	VD
1. Assist students in promoting policies that prohibit harassment/bullying of LGBT students.	2.00	LC	3.50	HC
2. Make it certain that LGBT students are not discriminated/bullied in school by checking the reports of the GAD Focal person and the Guidance Counselor	3.17	MC	4.38	FC
3. Anti-homophobia education is frequently integrated in the lessons.	1.33	NC	3.25	MC
4. Encourage LGBT students to join of campus athletic programs in LGBT-related initiatives.	3.33	MC	4.38	FC
5. Homophobic comments and actions by coaches and student athletes are completely unacceptable through reminders during regular meetings.	4.50	FC	3.63	HC
6. Encourage students to participate in appropriate programs or students organizations that address LGBT bullying and violence.	4.00	HC	4.25	FC

7. Ensure the availability Information Education and Campaign (IEC) materials related to the awareness and protection of LGBT sector in the classroom.	1.00	NC	2.38	LC
8. Avail appropriate trainings related to LGBT issues in relations with CPD units.	1.17	NC	3.00	MC
9. Participate in seminars on the awareness of LGBT rights protection and issues for personal growth.	1.17	NC	3.13	MC
10. Include in the teaching methodologies by film showing, drama, play, symposium and other creative activities that tackle LGBT issues.	1.17	NC	2.63	MC
Aggregate	**2.28**	**LC**	**3.45**	**HC**

Legend:
5 – Full Compliance (FC) 81% - 100% of statement complied with WX: Weighted Mean
4 – High Compliance (HC) 61% - 80% of statement complied with VD: Verbal Description
3 – Moderate Compliance (MC) 41% - 60% of statement complied with
2 – Less Compliance (LC) 21% - 40% of statement complied with
1 – No Compliance (NC) 0% - 20% of statement complied with

Teachers

Table 4.2.3 presents the level of teachers' compliance in reflecting non-discriminatory attitude as embedded in the curriculum, learning materials, teaching methodologies, and supportive services. Both teacher respondents from private (x = 2.99) and public schools (x = 3.14) moderately comply with the policy. Looking at the individual items, the teachers from private schools are less compliant and moderately compliant with most of them. They are fully compliant and highly compliant respectively in ensuring no discrimination of LGBT students in school by checking the reports of the GAD Focal person and the Guidance Counselor, and assisting students in promoting policies that prohibit harassment/bullying of LGBT students. On the other hand, teachers in public schools are moderately compliant and highly compliant with most policy items except availing training related to LGBT issues in relations with CPD units.

Finding relates with the data in Table 4.2.2 showing a higher level of compliance in the public schools which could be due to the leadership of the school principals in this area. Thus, from the findings, recognizing LGBT rights is hardly achieved in private schools than in public schools.

Table 4.2.3. Level of compliance of teachers in reflecting non-discriminatory attitude as embedded in the curriculum, learning materials, teaching methodologies, and supportive services.

Items	Private		Public	
	WX	V D	WX	VD
1. Assist students in promoting policies that prohibit harassment/bullying of LGBT students.	3.55	HC	3.54	HC
2. Ensure that LGBT students are not discriminated/bullied at school by checking the reports of the GAD Focal person and the Guidance Counselor	4.29	FC	3.86	HC
3. Anti-homophobia education is integrated in the lessons.	2.82	MC	3.17	MC
4. Encourage LGBT students to join of campus athletic programs in LGBT-related initiatives.	3.12	MC	3.34	MC
5. Homophobic comments and actions by coaches and student athletes are completely unacceptable through reminders during regular meetings.	3.06	MC	3.45	HC
6. Encourage students to participate in programs or students organizations that address LGBT bullying and violence.	3.06	MC	3.36	MC
7. Ensure the availability Information Education and Campaign (IEC) materials related to the awareness and protection of LGBT sector in the classroom.	2.39	LC	2.70	MC
8. Avail trainings related to LGBT issues in relations with CPD units.	2.37	LC	2.58	LC

9. Participate in seminars on the awareness of LGBT rights protection and issues for personal growth.	2.55	LC	2.73	MC
10. Include in the teaching methodologies by film showing, drama, play, symposium and other creative activities that tackle LGBT issues.	2.73	MC	2.72	MC
Aggregate	**2.99**	**MC**	**3.14**	**MC**

Legend:
5 – Full Compliance (FC) 81% - 100% of statement complied with WX: Weighted Mean
4 – High Compliance (HC) 61% - 80% of statement complied with VD: Verbal Description
3 – Moderate Compliance (MC) 41% - 60% of statement complied with
2 – Less Compliance (LC) 21% - 40% of statement complied with
1 – No Compliance (NC) 0% - 20% of statement complied with

4.3 Addressing gender dimension in planning, information exchange, design, and service delivery

GAD

Table 4.3.1 shows the compliance level of GAD focal persons in addressing gender dimension in planning, information exchange, design, and service delivery. Both respondents from private (x = 2.18) and public schools (x = 2.06) are less compliant with the policy. The private school respondents are not compliant or less compliant with most of the policy items but moderately compliant with promoting inclusive education that ensures girls' and boys' and women's and men's equal access to learning opportunities and doing the recommendations of school heads. On the other hand, the public school respondents are not compliant or less compliant except promoting inclusive education to which they are highly compliant. The finding shows that both groups are not fully compliant of the mandate. This result implies that GAD focal persons do not engage more in planning, information exchange, design, and service delivery related to gender equality despite their knowledge of the policy and right attitude towards the LGBT sector.

Table 4.3.1. Compliance Level of GAD focal persons in addressing gender dimension in planning, information exchange, design, and service delivery

Items	Private		Public	
	WX	V D	WX	VD
1. Frequency promote inclusive education that ensures girls' and boys' and women's and men's equal access to learning opportunities, fair treatment in the learning process.	3.33	MC	3.63	HC
2. Include or integrate frequently in the calendar of activities the Lesbian, Gay Bisexual, and Transgender (LGBT) Pride Month Celebration for the months of June.	1.50	NC	1.38	NC
3. Frequently or regularly conduct LGBT related activities and ask for a budget from the GAD Plan.	1.67	NC	1.25	NC
4. Require students to attend symposium on gender-based barriers and the different forms of discrimination by listening to guest speakers from the LGBT community to talk on Gender Issues.	2.00	LC	2.00	LC
5. Integrate the LGBT issues in the subject for the good and wellness of LGBT students.	2.33	LC	2.25	LC
6. Collect, analyze and interpret as well conclude on sex-disaggregated data and gender information for informed decision making.	1.83	LC	2.13	LC
7. Frequently coordinate the GAD Focal person on the Philippine Basic Education Research Agenda specifically its GAD component.	1.83	LC	1.88	LC
8. Make it certain that policies and studies being reviewed by the service are aligned with this policy.	2.00	LC	1.63	NC
9. Sensitive of the policy and take actions of the school heads recommendations.	2.83	MC	2.50	LC
10. Conduct research based interventions relative to the LGBT policy.	2.50	LC	2.00	LC
Aggregate	**2.18**	**LC**	**2.06**	**LC**

Legend:
5 – Full Compliance (FC) 81% - 100% of statement complied with WX: Weighted Mean
4 – High Compliance (HC) 61% - 80% of statement complied with VD: Verbal Description
3 – Moderate Compliance (MC) 41% - 60% of statement complied with
2 – Less Compliance (LC) 21% - 40% of statement complied with
1 – No Compliance (NC) 0% - 20% of statement complied with

School principals

Table 4.3.2 shows the principal's compliance level in addressing gender dimension in planning, information exchange, design, and service delivery. Respondents in private schools are less compliant (x =1.92), while in public schools (x = 2.88), they are moderately compliant. The private school principals are less compliant with being sensitive of the policy and taking actions of the school heads recommendations, moderately compliant with promoting Philipppine-based inclusive education that ensures girls' and boys' as well as women's and men's equal access to learning opportunities, fair treatment in the learning process, and requiring students to attend a symposium on gender-based barriers, and the different forms of discrimination by listening to guest speakers from the LGBT community to talk on Gender Issues. They are fully compliant with integrating the LGBT issues in the subject for the good of LGBT students.

The school principals in public schools are less compliant with the policy. They are moderately compliant with coordinate the GAD Focal person on the Philippine -based Basic Education Research Agenda specifically its GAD component. And they are highly compliant with integrating the LGBT issues in the subject for the good of LGBT students, requiring students to attend the symposium on gender-based barriers and the different forms of discrimination by listening to guest speakers from the LGBT community to talk on Gender Issues, and promoting inclusive education that ensures girls' and boys' and women's and men's equal access to learning opportunities, fair treatment in the learning process.

The finding shows that the school principals' compliance level of this variable varies. The specific item that both groups of principals are highly compliant with is initiating in their context teacher involvement in integrating LGBT issues into their lessons. This finding indicates that they rely on the teachers on the actual implementation of the GAD policy.

Table 4.3.2. Compliance Level of school principals in addressing gender dimension in planning, information exchange, design, and service delivery

Items	Private		Public	
	WX	V D	WX	VD
1. Frequently romote inclusive education that ensures girls' and boys' and women's and men's equal access to learning opportunities, fair treatment in the learning process.	3.33	MC	3.75	HC
2. Include or integrate frequently in the calendar of activities the Lesbian, Gay Bisexual, and Transgender (LGBT) Pride Month Celebration for the months of June.	1.00	NC	2.00	LC
3. Frequently or regularly conduct LGBT related activities and ask for a budget from the GAD Plan.	1.50	NC	2.38	LC
4. Require students to attend symposium on gender-based barriers and the different forms of discrimination by listening to guest speakers from the LGBT community to talk on Gender Issues.	3.00	MC	3.75	HC
5. Integrate the LGBT issues in the subject for the good of LGBT students.	3.67	HC	3.88	HC
6. Collect, analyze, and interpret as well as conclude sex-disaggregated data and gender information for informed decision making.	1.00	NC	2.13	LC
7. Frequently coordinate the GAD Focal person on the Basic Education Research Agenda specifically its GAD component.	1.00	NC	3.00	MC
8. Make it certain that policies and studies being reviewed by the service are aligned with this policy.	1.50	NC	2.25	LC
9. Sensitive of the policy and take actions of the school heads recommendations.	1.83	LC	3.50	LC
10. Conduct research based interventions relative to the LGBT policy.	1.33	NC	2.13	LC
Aggregate	**1.92**	**LC**	**2.88**	**MC**

Legend:
5 – Full Compliance (FC) 81% - 100% of statement complied with WX: Weighted Mean
4 – High Compliance (HC) 61% - 80% of statement complied with VD: Verbal Description

3 – Moderate Compliance (MC) 41% - 60% of statement complied with
2 – Less Compliance (LC) 21% - 40% of statement complied with
1 – No Compliance (NC) 0% - 20% of statement complied with

Teachers

Table 4.3.3 presents the teachers' compliance level in addressing gender dimension in planning, information exchange, design, and service delivery. The data show that respondents in private schools are less compliant (x = 2.57). The respondents are less compliant with the policy but moderately compliant with integrating the LGBT issues in the subject for the good of LGBT students, ensuring that policies and studies being reviewed by the service are aligned with this policy, and being sensitive of the policy and taking actions of the school heads recommendations. They are highly compliant with promoting inclusive education that ensures girls' and boys,' and women's and men's equal access to learning opportunities, fair treatment in the learning process. The teachers in public schools are moderately compliant (x = 2.82). While they are moderately compliant in most items, they are fully compliant with promoting inclusive education that ensures girls' and boys,' and women's and men's equal access to learning opportunities, fair treatment in the learning process. Like their counterparts in the private schools, they are less compliant with including in the calendar of activities the Lesbian, Gay, Bisexual, and Transgender (LGBT) Pride Month Celebration for June, conducting LGBT related activities and ask for a budget from the GAD Plan, and conduct research-based interventions relative to the LGBT policy.

The finding is consistent with the data in planning, information exchange, design, and service delivery. But none of the policy items that teachers strive to comply with reached a higher compliance level. This result implies that implementing the GAD policy in public and private schools selected in this study needs to be improved.

Table 4.3.3. Level of compliance of teachers in addressing gender dimension in planning, information exchange, design, and service delivery

Items	Private		Public	
	WX	V D	WX	VD
1. Promote inclusive education that ensures girls' and boys' and women's and men's equal access to learning opportunities, fair treatment in the learning process.	3.53	HC	3.67	HC
2. Include in the calendar of activities the Lesbian, Gay, Bisexual, and Transgender (LGBT) Pride Month Celebration for the month of June.	2.18	LC	2.34	LC
3. Conduct LGBT related activities and ask for a budget from the GAD Plan.	2.14	LC	2.37	LC
4. Require students to attend symposium on gender-based barriers and the different forms of discrimination by listening to guest speakers from the LGBT community to talk on Gender Issues.	2.53	LC	2.90	MC
5. Integrate the LGBT issues in the subject for the good of LGBT students.	2.69	MC	2.83	MC
6. Gather and analyze sex-disaggregated data and gender information for informed decision making.	2.47	LC	2.80	MC
7. Coordinate the GAD Focal person on the Basic Education Research Agenda specifically its GAD component.	2.45	LC	2.75	MC
8. Ensure that policies and studies being reviewed by the service are aligned with this policy.	2.61	MC	2.95	MC
9. Sensitive of the policy and take actions of the school heads recommendations.	2.67	MC	3.11	MC
10. Conduct research-based interventions relative to the LGBT policy.	2.43	LC	2.50	LC
Aggregate	**2.57**	**LC**	**2.82**	**MC**

Legend:
5 – Full Compliance (FC) 81% - 100% of statement complied with WX: Weighted Mean
4 – High Compliance (HC) 61% - 80% of statement complied with VD: Verbal Description
3 – Moderate Compliance (MC) 41% - 60% of statement complied with
2 – Less Compliance (LC) 21% -40% of statement complied with
1 – No Compliance (NC) 0% - 20% of statement complied with

4.4 Allocating tasks related to LGBT rights protection to the different subunits of the school under study GAD

Table 4.4.1 shows the GAD focal persons' extent of compliance in allocating tasks related to LGBT rights protection to the different subunits of the school understudy. The data indicate that private (x = 2.13) and public school respondents (x = 2.46) are less compliant. Examining the items closely, respondents from the private schools reveal no compliance or less compliance but moderate compliance with providing a learning environment that is gender-sensitive and safe, and addressing bullying and harassment with research-based interventions. On the other hand, GAD focal persons in public schools inform that they are less compliant and did not at all request funds from GAD Plan for the related activities. However, they are moderately compliant with ensuring minimum standards on gender sensitivity that will be integrated into the subject taught, providing a learning environment that is gender-sensitive and safe, and addressing bullying and harassment with research-based interventions.
Hence, both groups of respondents need to improve their compliance level in allocating tasks related to LGBT rights protection to the different subunits of their respective high schools if they had to meet the expectations of the LGBT sector. This variable is one of the main tasks of GAD focal persons.

Table 4.4.1. Level of GAD focal persons' compliance in allocating tasks related to LGBT rights protection to the different subunits of the school understudy

Items	Private		Public	
	WX	V D	WX	VD
1. Follow memos from the principal in implementing the DepEd Order No. 32 for the protection of LGBT students.	1.83	LC	2.25	LC
2. Initiate information dissemination programs and organize activities that promote the protection of children from all forms of abuse, violence, discrimination and bullying.	2.33	LC	2.25	LC
3. Coordinate the guidance counselor and GAD focal persons to conduct seminars and workshop that deals with LGBT concerns.	1.83	LC	2.50	LC
4. Ensure minimum standards on gender sensitivity that will be integrated in the subject taught.	2.50	LC	2.75	MC
5. Provide gender-responsive Learning Resources (LRs) in the classroom.	2.33	LC	2.25	LC
6. Request for funds from GAD Plan relevant to any activities on GAD.	1.50	NC	1.75	NC
7. Actively promote an inclusive environment in the classroom for LGBT.	1.67	NC	2.50	LC
8. Provide learning environment that is gender sensitive and safe.	3.00	MC	3.25	MC
9. Provide LGBT students with access to the restrooms and locker rooms that match their gender identity and meet the students' individual needs.	1.67	NC	2.38	LC
10. Address bullying and harassment with research-based interventions.	2.67	MC	2.75	MC
Aggregate	**2.13**	**LC**	**2.46**	**LC**

Legend:

5 – Full Compliance (FC)	*81% - 100%*	*of statement complied with*	*WX: Weighted Mean*
4 – High Compliance (HC)	*61% - 80%*	*of statement complied with*	*VD: Verbal Description*
3 – Moderate Compliance (MC)	*41% - 60%*	*of statement complied with*	
2 – Less Compliance (LC)	*21% - 40%*	*of statement complied with*	
1 – No Compliance (NC)	*0% - 20%*	*of statement complied with*	

School principals

Table 4.4.2 shows the school principals' compliance level in allocating tasks related to LGBT rights protection to the different subunits of the school understudy. The private school principals are less compliant (x = 1.82). They are generally not compliant with the policy, but moderately compliant with ensuring minimum standards on gender sensitivity for integration into the subject taught and fully compliant with providing a learning environment that is gender-sensitive and safe. Unlike their private school counterparts, the public school principals tend to moderately comply (x = 3.00) with the policy. They are less compliant with promoting an inclusive environment in the classroom for LGBT, but fully compliance with providing a learning environment that is gender-sensitive and safe, and highly compliant with ensuring minimum standards on gender sensitivity that will be integrated into the subject taught.

The finding indicates that the public school principals have higher compliance level compared to the private schools based on the aggregate weighted mean in Table 4.4.2. The result implies that the respondents differ in implementing

LGBT rights at the high school level. But both groups need to improve their level of compliance to be truly effective in their respective policy implementation.

Table 4.4.2. Level of school principals' compliance in allocating tasks related to LGBT rights protection to the different subunits of the school under study

Items	Private		Public	
	WX	V D	WX	VD
1. Follow memos from the principal in implementing the DepEd Order No. 32 for the protection of LGBT students.	1.00	NC	2.88	MC
2. Initiate information dissemination programs and organize activities that promote the protection of children from all forms of abuse, violence, discrimination and bullying.	2.17	LC	3.13	MC
3. Coordinate the guidance counselor and GAD focal persons to conduct seminars and workshop that deals with LGBT concerns.	1.17	NC	3.38	MC
4. Ensure minimum standards on gender sensitivity that will be integrated in the subject taught.	3.17	MC	4.13	HC
5. Provide gender-responsive Learning Resources (LRs) in the classroom.	1.00	NC	2.75	MC
6. Request for funds from GAD Plan relevant to any activities on GAD.	1.33	NC	2.63	MC
7. Actively promote an inclusive environment in the classroom for LGBT.	1.33	NC	2.25	LC
8. Provide learning environment that is gender sensitive and safe.	4.33	FC	4.25	FC
9. Provide LGBT students with access to the restrooms and locker rooms that match their gender identity and meet the students' individual needs.	1.00	NC	3.13	MC
10. Address bullying and harassment with research-based interventions.	1.67	NC	3.00	MC
Aggregate	**1.82**	**LC**	**3.15**	**MC**

Legend:

5 – Full Compliance (FC) 81% - 100% of statement complied with
4 – High Compliance (HC) 61% - 80% of statement complied with
3 – Moderate Compliance (MC) 41% - 60% of statement complied with
2 – Less Compliance (LC) 21% - 40% of statement complied with
1 – No Compliance (NC) 0% - 20% of statement complied with

WX: Weighted Mean
VD: Verbal Description

Teachers

Table 4.4.3 shows the teachers' level of compliance in allocating tasks related to LGBT rights protection to the different subunits of the school understudy. The respondents in private (x = 2.79) and public schools (x = 3.08) are moderately compliant based on the aggregate weighted mean. The private schools are moderately compliant, but less compliant with following memos from the principal in implementing the DepEd Order No. 32 for the protection of LGBT students, requesting funds from GAD Plan relevant to any activities on GAD, and providing LGBT students with access to the restrooms and locker rooms that match their gender identity and meet the students' individual needs. They are highly compliant with providing a learning environment that is gender sensitive and safe.

Similarly, public school respondents are also moderately compliant with the policy. They are highly compliant with providing a learning environment that is gender-sensitive and safe, but less compliant with requesting funds from GAD Plan relevant to any activities on GAD. Consistent with the findings among the three groups of respondents, the public high schools are more compliant in allocating tasks related to LGBT rights protection to the different subunits of the school understudy. However, the level of teachers' compliance in both contexts needs to be improved.

Table 4.4.3 Level of compliance: allocating tasks related to LGBT rights protection to the different subunits of the school understudy-TEACHERS

Items	Private		Public	
	WX	V D	WX	VD
1. Follow memos from the principal in implementing the DepEd Order No. 32 for the protection of LGBT students.	2.53	D	3.04	MA
2. Initiate information dissemination programs and organize activities that promote the protection of children from all forms of abuse, violence, discrimination and bullying.	2.94	MA	3.28	MA
3. Coordinate the guidance counselor and GAD focal persons to conduct seminars and workshop that deals with LGBT concerns.	2.61	MA	2.83	MA
4. Ensure minimum standards on gender sensitivity that will be integrated in the subject taught.	2.98	MA	3.36	MA
5. Provide gender-responsive Learning Resources (LRs) in the classroom.	2.67	MA	3.04	MA
6. Request for funds from GAD Plan relevant to any activities on GAD.	2.22	D	2.52	D
7. Actively promote an inclusive environment in the classroom for LGBT.	2.86	MA	3.02	MA
8. Provide learning environment that is gender sensitive and safe.	3.41	A	3.62	A
9. Provide LGBT students with access to the restrooms and locker rooms that match their gender identity and meet the students' individual needs.	2.57	D	2.91	MA
10. Address bullying and harassment with research-based interventions.	3.10	MA	3.11	MA
Aggregate	**2.79**	**MA**	**3.08**	**MA**

Tables 4.1 to 4.4 present the compliance level of GAD focal persons, school principals, and teachers in implementing DepEd Order no. 32, s. 2017. As presented earlier, the GAD focal persons are less compliant with the policy items expected of them to do in school. Further, the public school teachers are moderately compliant like the school principals. Then, the school principals in the private schools are less compliant. To effectively implement this policy in secondary schools, all three groups of respondents have to improve their compliance level for the protection of the LGBT sector.

Table 4.4.4. Summary of the level of compliance of the respondents in implementing DepEd Order no. 32, s. 2017

Items	Private		Public	
	WX	V D	WX	VD
4.1. Level of compliance: promoting gender equality involving learners, teachers, and non-teaching personnel-GAD	2.03	LC	2.29	LC
4.2. Level of compliance: promoting gender equality involving learners, teachers, and non-teaching personnel-PRINCIPALS	1.65	NC	2.74	MC
4.3. Level of compliance: promoting gender equality involving learners, teachers, and non-teaching personnel-TEACHERS	2.43	LC	2.79	MC

4.4. Level of compliance: reflecting non-discriminatory attitude as embedded in the curriculum, learning materials, teaching, methodologies, and supportive services-GAD	2.12	LC	2.39	LC
4.5. Level of compliance: reflecting non-discriminatory attitude as embedded in the curriculum, learning materials, teaching, methodologies, and supportive services-PRINCIPALS	2.28	LC	3.45	HC
4.6. Level of compliance: reflecting non-discriminatory attitude as embedded in the curriculum, learning materials, teaching, methodologies, and supportive services-TEACHERS	2.99	MC	3.14	MC
4.7. Level of compliance: addressing gender dimension in planning, information exchange, design, and service delivery-GAD	2.18	LC	2.06	LC
4.8. Level of compliance: addressing gender dimension in planning, information exchange, design, and service delivery-PRINCIPALS	1.92	LC	2.88	MC
4.9. Level of compliance: addressing gender dimension in planning, information exchange, design, and service delivery-TEACHERS	2.57	LC	2.82	MC
4.10 Level of compliance: allocating tasks related to LGBT rights protection to the different subunits of the school understudy-GAD	2.13	LC	2.46	LC
4.11. Level of compliance: allocating tasks related to LGBT rights protection to the different subunits of the school understudy-PRINCIPALS	1.82	LC	3.15	MC
4.12. Level of compliance: allocating tasks related to LGBT rights protection to the different subunits of the schools under study-TEACHERS	2.79	MC	3.08	MC

Legend:

5 – Full Compliance (FC)	*81% - 100%*	*of statement complied with*	*WX: Weighted Mean*
4 – High Compliance (HC)	*61% - 80%*	*of statement complied with*	*VD: Verbal Description*
3 – Moderate Compliance (MC)	*41% - 60%*	*of statement complied with*	
2 – Less Compliance (LC)	*21% - 40%*	*of statement complied with*	
1 – No Compliance (NC)	*0% - 20%*	*of statement complied with*	

4. What is the level of perceived capability of the respondents to integrate in their lessons and school activities the promotion of LGBT rights as stipulated in DepEd Order no. 32, s. 2017?

GAD

Table 5.1 shows the GAD focal persons' level of perceived capability in integrating the promotion of LGBT rights in school activities. The private school respondents are slightly capable (x = 2.30), while public schools are moderately capable (x = 2.79). However, the private school focal persons are moderately capable in integrating the promotion of LGBT rights into the daily lesson plan. The public school focal persons are moderately capable except creating a seating plan in the class to easily monitor the students. The level of perceived capability is higher when compared to their counterparts in the private schools.

Contrary to common expectations, these respondents have lower capabilities compared to the school principals and teachers themselves. It is a must that they have to enhance their capability to implement the GAD policy since they are designated to perform this school responsibility.

Table 5.1. GAD focal persons' perceived capability to integrate the promotion of LGBT rights

Items	Private		Public	
	WX	V D	WX	VD
1. Include in the subject LGBT related topics.	1.83	LC	2.88	MC
2. Integrate gender sensitivity issues during class discussions for the benefit of the LGBT students.	2.50	SC	3.00	MC
3. Monitor pupils with tendencies to bully other students.	2.33	SC	2.75	MC
4. Create a seat plan in the class to easily monitor the students.	2.33	SC	2.50	SC
5. Submit weekly reports of students' behavior to the principal.	2.50	SC	2.88	MC

6. Conduct a monthly meeting with parents for students under monitoring.	2.33	SC	2.75	MC
7. Coordinate with the Guidance Counselor and GAD focal person in the conduct of activities related to the GAD Plan for the student to be aware.	2.33	SC	2.63	MC
8. Integrate in the daily lesson plan GAD activities for easy checking of the in-charge Master Teacher.	2.67	MC	3.25	MC
9. Submit reports by means of verification (MOVs) relative to LGBT concerns.	2.00	SC	2.63	MC
10. Remind the Guidance Counselor and GAD focal person to verify bullying cases.	2.17	SC	2.63	MC
Aggregate	**2.30**	**SC**	**2.79**	**MC**

Legend:
5 – Extremely Capable (EC) 81% - 100% of statement can be carried out WX: Weighted Mean
4 – Very Capable (VC) 61% - 80% of statement can be carried out VD: Verbal Description
3 – Moderately Capable (MC) 41% - 60% of statement can be carried out
2 - Slightly Capable (SC) 21% - 40% of statement can be carried out
1 – Least Capable (LC) 1% - 20% of statement can be carried out

School principals

The school principals' level of perceived capability to supervise teachers' integration into their lessons and school activities in the promotion of LGBT rights is in Table 5.2. Private school principals are slightly capable (x = 1.90), but are they extremely capable in coordinating with the Guidance Counselor and GAD focal person in the conduct of activities related to the GAD Plan for the student to be aware. The data reveal that the school principals are more focused on planning activities for student awareness on LGBT rights. On the other hand, the public school principals are moderately capable (x = 3.11). They are least capable in coordinating with the Guidance Counselor and GAD focal person to verify bullying cases, but most capable in creating a seating plan in the class to easily monitor the students, and coordinating with the Guidance Counselor and GAD focal person in the conduct of activities related to the GAD Plan for the student to be aware.

Consistent with the school principals' perceived capability in implementing the policy, the finding in Table 5.2 reveals that school principals in public schools are more capable in integrating the promotion of LGBT rights than their counterparts in private schools. Both groups are extremely capable of coordinating with other persons involved in implementing the GAD Plan for the awareness of the students. This finding implies that school principals perform administrative duties and less teacher supervision in implementing the GAD policy.

Table 5.2. School principals' perceived capability to integrate the promotion of LGBT rights

Items	Private		Public	
	WX	V D	WX	VD
1. Include in the subject LGBT related topics.	1.17	LC	2.75	MC
2. Integrate gender sensitivity issues during class discussions for the benefit of the LGBT students.	2.67	MC	3.50	VC
3. Monitor pupils with tendencies to bully other students.	2.67	MC	3.75	VC
4. Create a seat plan in the class to easily monitor the students.	2.00	SC	4.25	EC
5. Submit weekly reports of students' behavior to the principal.	1.17	LC	2.50	SC
6. Conduct a monthly meeting with parents for students under monitoring.	1.17	LC	2.25	SC
7. Coordinate with the Guidance Counselor and GAD focal person in the conduct of activities related to the GAD Plan for the student to be aware.	4.33	EC	4.38	EC
8. Integrate in the daily lesson plan GAD activities for easy checking of the in-charge Master Teacher.	1.17	LC	3.25	MC
9. Submit reports by means of verification (MOVs) relative to LGBT concerns.	1.50	LC	2.75	MC
10. Remind the Guidance Counselor and GAD focal person to verify bullying cases.	1.17	LC	1.75	LC
Aggregate	**1.90**	**SC**	**3.11**	**MC**

Legend:
5 – Extremely Capable (EC) 81% - 100% of statement can be carried out WX: Weighted Mean
4 – Very Capable (VC) 61% - 80% of statement can be carried out VD: Verbal Description
3 – Moderately Capable (MC) 41% - 60% of statement can be carried out
2 – Slightly Capable (SC) 21% - 40% of statement can be carried out
1 – Least Capable (LC) 1% - 20% of statement can be carried out

Teachers

The teachers' perceived capability in integrating into their lessons and school activities the promotion of LGBT rights is in Table 5.3. Both private and public school teachers are moderately capable with the aggregate weighted mean of (x = 3.23) and (x =3.13), respectively. Additionally, both groups claimed high capability in monitoring pupils with tendencies to bully other students and creating a seating plan in the class to easily monitor the students. The finding implies the need to improve their capability in these areas to have a stronger impact on the promotion of LGBT right in both private and public schools covered in this study. The realization occurs when all the three groups taken as respondents can collaborate in terms of school-based activities in their respective settings.

Table 5.3. Teachers' perceived capability to integrate the promotion of LGBT rights

Items	Private		Public	
	WX	V D	WX	VD
1. Include in the subject LGBT related topics.	3.08	MC	3.05	MC
2. Integrate gender sensitivity issues during class discussions for the benefit of the LGBT students.	3.27	MC	3.23	MC
3. Monitor pupils with tendencies to bully other students.	3.98	VC	3.51	VC
4. Create a seat plan in the class to easily monitor the students.	3.65	VC	3.52	VC
5. Submit weekly reports of students' behavior to the principal.	3.29	MC	2.97	MC
6. Conduct a monthly meeting with parents for students under monitoring.	3.24	MC	2.98	MC
7. Coordinate with the Guidance Counselor and GAD focal person in the conduct of activities related to the GAD Plan for the student to be aware.	3.22	MC	3.10	MC
8. Integrate in the daily lesson plan GAD activities for easy checking of the in-charge Master Teacher.	2.78	MC	3.03	MC
9. Submit reports by means of verification (MOVs) relative to LGBT concerns.	2.73	MC	2.77	MC
10. Remind the Guidance Counselor and GAD focal person to verify bullying cases.	3.04	MC	3.12	MC
Aggregate	**3.23**	**MC**	**3.13**	**MC**

Legend:
5 – Extremely Capable (EC) 81% - 100% of statement can be carried out WX: Weighted Mean
4 – Very Capable (VC) 61% - 80% of statement can be carried out VD: Verbal Description
3 – Moderately Capable (MC) 41% - 60% of statement can be carried out
2 – Slightly Capable (SC) 21% - 40% of statement can be carried out
1 – Least Capable (LC) 1% - 20% of statement can be carried out

Summary on the level of perceived capability of the respondents to integrate their lessons and school activities the promotion of LGBT rights as stipulated in DepEd Order no. 32, s. 2017

As mentioned earlier, the full implementation of the promotion of LGBT rights as stipulated in DepEd Order no. 32, s. 2017 needs collaborative effort among the school principal, teachers, and GAD focal persons. As shown in Table 5.4, results reveal a higher level of perceived capability among public school respondents. Yet, both public and private schools seem to have not maximized the implementation for the benefit of the LGBT sector during the conduct of this study.

Table 5.4. Summary of the respondents' perceived capabilities to integrate the promotion of LGBT rights.

Items	Private		Public	
	WX	V D	WX	VD
2.18. Perceived capability-GAD	2.30	SC	2.79	MC

2.19. Perceived capability -PRINCIPALS	1.90	SC	3.11	MC
2.20. Perceived capability -TEACHERS	3.23	MC	3.13	MC

Legend:
5 – Extremely Capable (EC) 81% - 100% of statement can be carried out WX: Weighted Mean
4 – Very Capable (VC) 61% - 80% of statement can be carried out VD: Verbal Description
3 – Moderately Capable (MC) 41% - 60% of statement can be carried out
2 – Slightly Capable (SC) 21% - 40% of statement can be carried out
1 – Least Capable (LC) 1% - 20% of statement can be carried out

3. What is the extent of involvement of the respondents on the provisions of DepEd Order No. 32 s, 2017?

GAD

The GAD focal persons' extent of involvement on the provisions of DepEd Order No. 32 s., 2017 is presented in Table 6.1. The private school respondents rarely involved (x = 2.18) in the implementation of the policy. The result reflects their lack of involvement shown in the following responses: never involved, rarely involved, and sometimes involved. But they often involved in promoting the protection of children against all forms of gender-based violence, abuse, discrimination, and bullying. On the other hand, the public school respondents sometimes involved (x = 2.98) in the policy implementation. They never involved in providing library resources/books about sexual diversity in one corner of the classroom.

The finding supports the previous results, which show that GAD focal persons in the public schools are more capable (Table 5.1), and more involved (Table 6.1) than the private school counterparts. However, both groups of respondents cannot provide library resources/books about sexual diversity in the classroom. Perhaps, they rely on the teachers to do this task rather than the GAD focal persons themselves.

Table 6.1. Extent of GAD focal persons' involvement on policy implementation

Items	Private		Public	
	WX	V D	WX	VD
1. Ensure that students will join an open forum for all male and female students about the Philippine Department of Education Order Number 32 series of 2017	1.67	NI	3.25	SI
2. Include professional development on LGBT issues and infusing these issues into the lessons.	1.83	RI	2.75	SI
3. Provide Library resources/books about sexual diversity in one corner of the classroom.	1.50	NI	1.38	NI
4. Promote inclusive education that ensure girls and boys and women and men equal access to learning opportunities, fair treatment in the learning process and equitable outcomes as well as access to opportunities in all spheres of life.	3.17	SI	3.50	OI
5. Involve in promoting the protection of children against all forms of gender-based violence, abuse, discrimination, and bullying.	3.50	OI	4.13	OI
6. Address gender-based barriers and the different forms of discrimination as a result of being exposed in gender inequality suffered by vulnerable and marginalized groups.	2.83	SI	3.75	OI
7. Involve the students in the promotion of gender equality and non-discrimination through engagement in subjects taught, learning materials, teaching methodologies, and support services that aims to eliminate gender stereotypes, but also transforming gender relations towards empowerment and social change.	3.00	SI	3.63	OI
8. Strengthen structures, systems, and methodologies that promote coordination to address gender dimensions in planning, information exchange, and design and delivery services.	1.67	NI	3.13	SI
9. Involve in the innovation of activities relative to the Philippine Department of Education Order Number 32 series of 2017.	1.33	NI	2.13	RI

10. Involve in the post-evaluation of the Philippine Department of Education Order Number 32 series of 2017	1.33	NI	2.13	RI
Aggregate	**2.18**	**RI**	**2.98**	**SI**

Legend:

5 –Always Involved (AI) *81% - 100% of statement is performed* *WX: Weighted Mean*
4 – Often Involved (OI) *61% - 99% of statement is performed* *VD: Verbal Description*
3 – Sometimes Involved (SI) *41% - 60% of statement is performed*
2 – Rarely Involved (RI) *21% - 40% of statement is performed*
1 – Never Involved (NI) *0% - 20% of statement is performed*

School principals

The principals' extent of involvement on the provisions of the Philippine Department of Education Order Number 32 series of 2017 is in Table 6.2. The private school principals rarely involved ($x = 2.13$) in the policy implementation. They participate more in promoting inclusive education that ensures girls and boys and women and men equal access to learning opportunities, fair treatment in the learning process and equitable outcomes, as well as access to opportunities in all spheres of life; addressing gender-based barriers and the different forms of discrimination as a result of being exposed in gender inequality suffered by vulnerable and marginalized groups; and involving in promoting the protection of children against all forms of gender-based violence, abuse, discrimination, and bullying which they are "often involved" and "always involved," respectively. In contrast, the public school principals often involved ($x = 3.65$) more appropriately than their private school counterparts. Similarly, they cannot provide library resources/books about sexual diversity in one corner of the classroom, but focus on promoting the protection of children against all forms of gender-based violence, abuse, discrimination, and bullying. The public school principals often involved in four more activities than their private school counterparts.

The finding further supports the fact that type of school is a factor in the successful policy implementation. Thus, LGBT students in private schools do not get the adequate protection that they desire in the private schools even during the enforcement of the Philippine Department of Education Order Number 32 series of 2017.

Table 6.2. Extent of school principals' involvement on policy implementation

Items	Private		Public	
	WX	V D	WX	VD
1. Effectively and efficiently ensure that students will join an open forum for all male and female students about the Philippine Department of Education Order Number 32 series of 2017	1.00	NI	2.75	SI
2. Effectively and efficiently include professional development on LGBT issues and infusing these issues into the lessons.	1.00	NI	3.00	SI
3. Effectively and efficiently provide Library resources/books about sexual diversity in one corner of the classroom.	1.50	NI	1.63	NI
4. Effectively and efficiently promote inclusive education that ensure girls and boys and women and men equal access to learning opportunities, fair treatment in the learning process and equitable outcomes as well as access to opportunities in all spheres of life.	3.50	OI	3.50	OI
5. Effectively and efficiently involve in promoting the protection of children against all forms of gender-based violence, abuse, discrimination, and bullying.	4.67	AI	4.25	AI
6. Effectively and efficiently address gender-based barriers and the different forms of discrimination as a result of being exposed in gender inequality suffered by vulnerable and marginalized groups.	4.00	OI	4.00	OI
7. Effectively and efficiently involve the students in the promotion of gender equality and non-discrimination through engagement in subjects taught, learning materials, teaching methodologies, and support services that aims to eliminate gender stereotypes, but also transforming gender relations towards empowerment and social change.	1.67	NI	4.00	OI

8. Effectively and efficiently strengthen structures, systems, and methodologies that promote coordination to address gender dimensions in planning, information exchange, and design and delivery services.	1.83	RI	2.88	SI
9. Effectively and efficiently involve in the innovation of activities relative to the Philippine Department of Education Order No 32, s. 2017.	1.17	NI	2.38	RI
10. Effectively and efficiently involve in the post-evaluation of the Philippine Department of Education Order Number 32 series of 2017	1.00	NI	2.38	RI
Aggregate	**2.13**	**RI**	**3.65**	**OI**

Legend:

5 –Always Involved (AI) *81% - 100% of statement is performed* *WX: Weighted Mean*
4 – Often Involved (OI) *61% - 99% of statement is performed* *VD: Verbal Description*
3 – Sometimes Involved (SI) *41% - 60% of statement is performed*
2 – Rarely Involved (RI) *21% - 40% of statement is performed*
1 – Never Involved (NI) *0% - 20% of statement is performed*

Teachers

Table 6.3 shows the teachers' extent of involvement on the provisions of the Philippine Department of Education Order Number 32 series of 2017. The private school teachers sometimes involved (x = 2.95) like their counterparts in the public schools (x = 3.06). They rarely or sometimes involved in the implementation of the policy but often involved in promoting inclusive education, child protection, addressing gender-based barriers, and promoting gender equality. The public school teachers, on the other hand, have a lower level of involvement in most items, from sometimes involved to rarely involved. They rated only three of the policy items "often involved." Like the private school teachers, they often involved in promoting child protection, addressing gender-based barriers and different forms of discrimination, and gender equality.

The finding implies that even if the respondents have lower levels of involvement in this area, they seem to focus on the main concerns of thePhilippine Department of Education Order Number 32 series of 2017, which are child protection, addressing the Philippine gender-based barriers and different forms of discrimination as well as gender equality.

Table 6.3. Extent of teachers' involvement on policy implementation

Items	Private		Public	
	WX	V D	WX	VD
1. Ensure that students will join an open forum for all male and female students about the Philippine Department of Education Order Number 32 series of 2017	2.65	SI	3.02	SI
2. Include professional development on LGBT issues and infusing these issues into the lessons.	2.49	RI	2.97	SI
3. Provide Library resources/books about sexual diversity in one corner of the classroom.	2.27	RI	2.52	RI
4. Effectively and efficiently promote inclusive education that ensure girls and boys and women and men equal access to learning opportunities, fair treatment in the learning process and equitable outcomes as well as access to opportunities in all spheres of life.	3.69	OI	3.38	SI
5. Effectively and efficiently involve in promoting the protection of children against all forms of gender-based violence, abuse, discrimination, and bullying.	3.80	OI	3.63	OI
6. Effectively and efficiently address gender-based barriers and the different forms of discrimination as a result of being exposed in gender inequality suffered by vulnerable and marginalized groups.	3.55	OI	3.44	OI
7. Effectively and efficiently involve the students in the promotion of gender equality and non-discrimination through engagement in subjects taught, learning materials, teaching methodologies, and support services that aims to eliminate gender stereotypes, but also transforming gender relations towards empowerment and social change.	3.45	OI	3.58	OI

8. Effectively and efficiently strengthen structures, systems, and methodologies that promote coordination to address gender dimensions in planning, information exchange, and design and delivery services.	2.80	SI	2.85	SI
9. Effectively and efficiently involve in the innovation of activities relative to Philippine Department of Education Order Number 32 series of 2017.	2.47	RI	2.64	SI
10. Effectively and efficiently involve in the post-evaluation of the Department of Education Order Number 32 series of 2017	2.33	RI	2.59	RI
Aggregate	**2.95**	**SI**	**3.06**	**SI**

Legend:
5 –Always Involved (AI) 81% - 100% of statement is performed WX: Weighted Mean
4 – Often Involved (OI) 61% - 99% of statement is performed VD: Verbal Description
3 – Sometimes Involved (SI) 41% - 60% of statement is performed
2 – Rarely Involved (RI) 21% - 40% of statement is performed
1 – Never Involved (NI) 0% - 20% of statement is performed

Summary on the extent of respondents' involvement in the implementation of the Philippine Department of Education Order Number 32 series of 2017. Table 6.4 shows the summary of the data from the three groups of respondents. The data reveal that GAD focal persons, school principals, and teachers' extent of involvement is low as shown by the aggregate weighted mean, which is between "rarely involved" and "sometimes involved" except for the school principals in the public schools with the aggregate rating of "often involved."

This finding supports the view that without clear guidance on the importance of a policy protecting the LGBT group, it could not serve much (*Teaching Tolerance,* March 2013). Meyer (2010) argued the absence of clear protection could lead to contradicting interpretation and application of the policy.

Table 6.4. Summary on the extent of involvement on policy implementation

Items	Private		Public	
	WX	V D	WX	VD
2.21. Extent of involvement-GAD	2.18	RI	2.98	SI
2.22. Extent of involvement-PRINCIPALS	2.13	RI	3.65	OI
2.23. Extent of involvement-TEACHERS	2.95	SI	3.06	SI

Legend:
5 –Always Involved (AI) 81% - 100% of statement is performed WX: Weighted Mean
4 – Often Involved (OI) 61% - 99% of statement is performed VD: Verbal Description
3 – Sometimes Involved (SI) 41% - 60% of statement is performed
2 – Rarely Involved (RI) 21% - 40% of statement is performed
1 – Never Involved (NI) 0% - 20% of statement is performed

4. **Is there a significant difference in the level of compliance to implement the provisions of the Philippine Department of Education Order Number 32 series of 2017 among the GAD focal persons, principals, and teachers?**

- **Promoting gender equality involving learners, teachers, and non-teaching personnel**

Table 7.1 shows the Kruskal–Wallis test of differences among the principals, GAD focal persons, and teachers regarding their compliance level in promoting gender equality involving learners, teachers, and non-teaching personnel. As shown, there is a significant difference at 5% level of significance among the groups in terms of the said compliance. However, this difference is only between teachers and GAD focal persons. Mean ranks show that teachers reported a higher compliance level than the latter. Thus, it rejects the null hypothesis of no difference.

- **Reflecting non-disciplinary attitude as embedded in the different curricula, diverse learning resources or materials, teaching, different strategies or methodologies, and different support services**

These group of respondents also differ in reflecting non-disciplinary attitude as embedded in the different curricula, differentiated learning materials, teaching, diverse methodologies or strategies, and different support services, as shown in Table 7.2. As seen, the difference is significant at 5% level of significance. But this difference is only between teachers and GAD focal persons, with teachers' compliance level higher than the latter. Thus, it rejects the null hypothesis of no difference.

- **Addressing gender dimension in planning, information exchange, and design and service delivery**

Table 7.3 shows the difference among principals, teachers, and GAD focal person in addressing gender dimension in planning, information exchange, and design and service delivery. As seen, the mean ranks appear to differ. However, this difference is not statistically significant at the 0.05 level, suggesting that the three groups of respondents have similar levels of compliance in this category. Thus, it accepts the null hypothesis.

- **Allocating tasks related to LGBT rights protection to the different subunits of the school understudy**

Table 7.4 shows the mean rank differences among principals, teachers, and GAD focal persons in allocating tasks related to LGBT rights protection to the different subunits of the school understudy. However, the differences are not significant at the 0.05 level. This finding suggests that the three groups have statistically similar levels of compliance in this category. Therefore, it accepts the null hypothesis.

- **Level of compliance to implement the provisions of the Philippine Department of Education Order Number 32 series of 2017**

Table 7.5 shows the differences among principals, teachers, and GAD focal persons in the overall extent of compliance to implement the provisions of the Philippine Department of Education Order Number 32 series of 2017. As shown, while mean ranks differ, this difference is significantly different at the 5% level of significance. However, this difference is only between teachers and GAD focal persons, with GAD focal persons' compliance level higher than the teachers'. Thus, it rejects the null hypothesis of no difference.

Table 7. Difference between the respondents' level of compliance and other key variables

	Mean Ranks for Sample			H	df	P value	Remarks
	Principal	Teacher	GAD				
7.1 Difference among principals, teachers and GAD focal persons in terms of promoting gender equality involving learners, teachers and non-teaching personnel	13.1	21.2	12.3	6.33	2	0.042	Significant
7.2 Difference among principals, teachers and GAD focal persons in terms of reflecting non-disciplinary attitude as embedded in the different curricula, diverse learning materials, teaching, methodologies or atrategies and different support services	16.5	20.3	9.8	7.22	2	0.027	Significant
7.3 Difference among principals, teachers and GAD focal persons in terms of addressing the different gender dimension in terms of effective planning, efficient information exchange, and effective design and efficient service delivery	14.5	20.6	11.4	5.65	2	0.060	Not Significant
7.4 Difference among principals, teachers and GAD focal persons in terms of allocating tasks related to LGBT rights protection to the different subunits of the school understudy	14.5	20.6	11.4	5.65	2	0.060	Not Significant
7.5 Difference in the mean ratings among the principals, teachers and GAD in the level of compliance to implement the provisions of the Philippine	10.2	15.2	21.2	7.82	2	0.020	Significant

Department of Education Order Number 32 series of 2017							

5. Is there a significant relationship between the extent of policy compliance and knowledge, attitude, involvement, capability?

Table 8 shows the relationship between the extent of compliance and other key variables such as knowledge, attitudes towards the LGBT sector, involvement, and capability to implement the pro-LGBT policies. In general, the variables tend to influence the compliance level, and the relationship suggests an association between the higher levels of these variables and compliance. Thus, improving the knowledge, attitudes, involvement, and capability of the principals is necessary for implementing LGBT policies to have higher compliance levels among them.

Knowledge and compliance

Table 8 presents the Spearman rho correlations showing a significant relationship between the overall extent of compliance and knowledge at the 0.05 level. This relationship indicates an association between higher levels of knowledge and compliance. And the individual compliance categories show this kind of relationship. The respondents with higher levels of knowledge tend to promote gender equality, reflect non-discriminatory attitude in the curriculum, address gender dimension in planning and other forms of service delivery, and allocate tasks to subunits to preserve LGBT rights. Thus, it rejects the null hypothesis of no relationship.

Attitudes and compliance

Spearman rho correlations reveal a significant relationship between the overall extent of compliance and the attitudes toward LGBT at five (5%) level of significance(Table 8). The relationship indicates an association between the higher levels of positive attitudes and compliance. And the individual compliance categories show this kind of relationship, except promoting gender equality involving diverse learners, diverse teachers and diverse non-teaching personnel, in which the correlation or association is not statistically significant. The respondents with the higher levels of knowledge tend to reflect non-discriminatory attitudes in the curriculum, address gender dimensions in planning and other forms of service delivery, and allocate tasks to subunits to preserve LGBT rights. Thus, it rejects the null hypothesis of no relationship, except promoting gender equality involving learners, teachers and non-teaching personnel.

Involvement and Compliance

Table 8 presents the Spearman rho correlations showing a significant relationship between the overall extent of compliance and involvement at the 0.05 level. The relationship indicates an association between the higher levels of involvement and compliance. And the individual compliance categories show this kind of relationship. The respondents with the higher levels of involvement tend to promote gender equality, reflect non-discriminatory attitude in the curriculum, address gender dimension in planning and other forms of service delivery, and allocate tasks to subunits to preserve LGBT rights. Thus, it rejects the null hypothesis of no relationship.

Capability and Compliance

The tests of relationships through Spearman rho correlations in Table 8 show a significant relationship between the overall extent of compliance and capability at the 0.05 level. The relationship indicates an association between higher levels of perceived capability and compliance. And the individual compliance categories show this kind of relationship. The respondents with higher levels of capability tend to promote gender equality, reflect non-discriminatory attitude in the curriculum, address gender dimension in planning and other forms of service delivery, and allocate tasks to subunits to preserve LGBT rights. Thus, it rejects the null hypothesis of no relationship.

Table 8. Relationship between policy compliance and other key variables

Variables	Spearman rho	P value	Remarks
Knowledge and compliance categories			
Promoting gender equality involving learners, teachers and non-teaching personnel	0.348	0.000	Significant

Reflecting non-discriminatory attitude as embedded in the curriculum, learning materials, teaching, methodologies, and support services.	0.236	0.000	Significant
Addressing gender dimension in planning, information exchange, design, and service delivery	0.243	0.000	Significant
Allocating tasks related to LGBT rights protection to the different subunits of the school under study	0.217	0.000	Significant
Overall extent of compliance and extent of knowledge	0.289	0.000	Significant
Attitudes toward the LGBT and compliance			
Promoting gender equality involving learners, teachers and non-teaching personnel	0.070	0.295	Not Significant
Reflecting non-discriminatory attitude as embedded in the curriculum, learning materials, teaching, methodologies, and support services.	0.264	0.000	Significant
Addressing gender dimension in planning, information exchange, design, and service delivery	0.174	0.009	Significant
Allocating tasks related to LGBT rights protection to the different subunits of the school under study	0.254	0.000	Significant
Overall extent of compliance and attitude	0.208	0.002	Significant
Extent of involvement and compliance			
Promoting gender equality involving learners, teachers and non-teaching personnel	0.603	0.000	Significant
Reflecting non-discriminatory attitude as embedded in the curriculum, learning materials, teaching, methodologies, and support services.	0.614	0.000	Significant
Addressing gender dimension in planning, information exchange, design, and service delivery	0.640	0.000	Significant
Allocating tasks related to LGBT rights protection to the different subunits of the school under study	0.668	0.000	Significant
Overall compliance and extent of involvement	0.693	0.000	Significant
Perceived capability and compliance			
Promoting gender equality involving learners, teachers and non-teaching personnel	0.514	0.000	Significant
Reflecting non-discriminatory attitude as embedded in the curriculum, learning materials, teaching, methodologies, and support services.	0.596	0.000	Significant
Addressing gender dimension in planning, information exchange, design, and service delivery	0.622	0.000	Significant
Allocating tasks related to LGBT rights protection to the different subunits of the school under study	0.645	0.000	Significant
Overall compliance and perceived capability	0.655	0.000	Significant

6. Is there a significant difference in the policy compliance of the Basic Responsive Education Policy between public and private secondary schools in Dumaguete City?

Table 9 shows the Mann-Whitney U test of differences between private and public schools regarding the extent of compliance to the Basic Responsive Education Policy. In terms of the overall compliance, the difference between the two groups is significant at the 0.05 level. The public school respondents tend to have higher levels of compliance than their private school counterparts. The different compliance categories reflect this difference, except reflecting non-discriminatory attitude as embedded in the different methodologies, different learning resources or materials,

curriculum, teaching, and different support services. The results suggest that public school respondents tend to promote gender equality, address gender dimension in planning and other forms of service delivery, and allocate tasks to subunits to preserve LGBT rights more than the private school counterparts. But they have statistically similar compliance levels in reflecting non-discriminatory attitude as embedded in the different curricula, different learning resources or materials, teaching, different strategies or methodologies, and different support services. Thus, it rejects the null hypothesis of no difference, except in the latter category.

Table 9. Difference between public and private secondary schools in terms of policy compliance of the Basic Responsive Education Policy

Variable	Mann-Whitney U	Z	P value	Remarks
Promoting gender equality involving teachers, learners, and non-teaching personnel	3914.5	2.67	0.008	Significant
Reflecting non-discriminatory attitudes as embedded in the different developed learning resources or materials, curriculum, teaching, methodologies or strategies as well as support services.	4273	1.86	0.063	Significant
Addressing dimensios of gender in planning, design, information exchange as well service delivery	4112.5	2.22	0.026	Significant
Task related allocation to LGBT rights and protection to the different subunits of the school under study	3908.5	2.69	0.007	Significant
Overall compliance	3768	3.01	0.003	Significant

Note: In all comparisons in Table 9, it is consistently shown that the public school has a higher rating compared to the private schools.

7. What implementation model can be designed to institutionalize the promotion of LGBT rights protection in Basic Education?

As reflected in the Model Summary, r^2 is .541, which means that 54% of the model explains the identified outcome variables, which are the Extent of Compliance of the Philippine Department of Education Order Number 32 series of 2017

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.735[a]	.541	.528	.66121
a. Predictors: (Constant), meanExtent of Implementation, meanExtent of Attitude, meanExtent of Knowledge, meanExtent of Perceived Capability				

Results of the ANOVA test further shows that the model significantly predicts the outcome variables. As shown in the table, the F-value of 42.95 yielded a p-value of .000. This finding is less than the set level of significance; hence, the model significantly predicts the extent of compliance of the Philippine Department of Education Order Number 32 series of 2017

ANOVA[a]					
Regression Model	Sum of Squares (SS)^2	Degrees of Freedom	Mean Square (MS)^2	F-Value	Probability Value

1	Regression	75.110	4	18.778	42.950	.000[b]
	Residual	63.830	146	.437		
	Total	138.941	150			
a. Dependent Variable: mean Extent of Compliance						
b. Predictors: (Constant), mean Extent of Involvement, mean Extent of Attitude, mean Extent of Knowledge, mean Extent of Perceived Capability						

In the model, the beta weight of the extent of attitude is 0.299, perceived capability is 0.280, and involvement is 0.400. This finding indicates that of the three that significantly correlated with the extent of compliance at 0.05 alpha, involvement has the highest weight or has the highest contribution to compliance, followed by attitude, and lastly, by perceived capability.

The linear regression equation or the equation for computing the prediction of the criterion variable (the extent of compliance) is:
Extent of Compliance = -0.246 + 0.400 X extent of involvement + 0.299 X extent of attitude + 0.280 X extent of perceived capability. To illustrate, a respondent with the extent of involvement score of 5, extent of attitude of 4 and extent of involvement of 3, his/her predicted extent of compliance is: -0.246 + 0.400 x 5 + 0.299 x 4 + .280 x 3 = 3.79 (High Compliance). Using the standard error of the estimate in the model to determine the range to which the value of the predicted variable would likely fall at 0.05 level of significance and the regression equation, the predicted extent of compliance would likely be within 3.79 plus/minus 0.66 or 3.13 – 4.45.

Moreover, the attributes' disparity in the beta coefficients conveys a message. Based on the difference in their contribution to one's extent of compliance, there should also be a difference in the weights/emphasis in implementing the activities offered to enhance the respondents' extent of compliance. To be more specific, if, for instance, the allotted ten days for the intervention, with beta weights of 0.400 for involvement, 0.299 for the extent of attitude, and 0.280 for the extent of perceived capability, involvement should be made four days, and three days each for the extent of attitude and perceived capability.

Coefficients[a]

Regression Model		Unstandardized Coefficients		Standardized Coefficients	t-Value	Probability Value
		Beta Coefficienst	Standard Error	Beta Coefficients		
1	(Constant)	-.246	.712		-.345	.731
	mean Extent of Knowledge	-.017	.188	-.005	-.088	.930
	mean Extent of Attitude	.299	.115	.148	2.595	.010
	mean Extent of Perceived Capability	.280	.074	.313	3.809	.000
	mean Extent of Involvement	.400	.071	.444	5.653	.000

a. Dependent Variable: mean Extent of Compliance

The table shows the hierarchical linear regression used to determine the unique contribution of each of the variables to the variance of the overall extent of compliance to gender-responsive policy. As shown, Model 1, entering only knowledge, causes R^2 to change from 0 to 0.059, and this change in the amount of variance explained in the extent of compliance led to an F-ratio of 9.27, which is significant at the 0.05 level. In Model 2, entering knowledge and attitude, R^2 increases by 0.054 and this change is significant. In the third model, entering the perceived capability in addition to the previous two variables, R^2 increases by 0.328, whose F-ratio is also significant at the 0.05 level. Lastly, entering the extent of involvement in the fourth model, R^2 increases by 0.101, whose F-ratio is also significant. This result means that each of the four independent variables has a unique contribution in accounting for the variance explained in compliance. They all influence the extent of compliance. However, among these variables, the extent of perceived capability has the largest unique contribution in explaining compliance.

R square and R square changes in the model.

Model Summary

Regression Model	R	R^2	Adjusted R^2	Standard Error of the Estimate	Change Statistics				
					R^2 Change	F-Value Change	Degrees of Freedom1	Degrees of Freedom 2	Probability Value of F-Value Change
1	.242[a]	.059	.052	.93695	.059	9.271	1	149	.003
2	.335[b]	.113	.101	.91277	.054	8.996	1	148	.003
3	.663[c]	.440	.429	.72751	.328	85.978	1	147	.000
4	.735[d]	.541	.528	.66121	.101	31.958	1	146	.000

a. Predictors: (Constant of the regression equation model), mean Extent of Knowledge

b. Predictors: (Constant of the regression equation m odel), mean Extent of Knowledge, mean Extent of Attitude

c. Predictors: (Constantof the regression equation model), mean Extent of Knowledge, mean Extent of Attitude, mean Extent of Perceived Capability

d. Predictors: (Constant of the regression equation model), mean Extent of Knowledge, mean Extent of Attitude, mean Extent of Perceived Capability, mean Extent of Involvement

Compliance (.059*EOK)+(.054*EOA)+(.328*EOP)+(.101*EOI)

Where

EOP = Extent of Perceived Capability (32.8%)
EOI = Extent of Involvement (10.1%)
EOK = Extent ok Knowledge (5.9%)
EOA = Extent of Attitude (5.4%)

Conclusion

The findings of the study have led to the following conclusions:

1. In a school context, people differ in terms of their gender responsiveness. In general, GAD focal persons are more likely to be gender-responsive, and principals the least. Thus, school administrators are less likely to be gender-responsive than teachers and GAD focal persons.

2. The respondents differ in terms of their responsiveness to the specific and itemized categories of the policy. Teachers are more likely to (a) promote gender equality that would always include learners, teachers, and non-teaching personnel, (b) reflecting non-disciplinary attitude as embedded in the curriculum, learning materials, teaching, methodologies and support services than principals, and GAD focal persons.
3. Moreover, several factors comprising (a) knowledge on the different itemized provisions of the Philippine-based Gender-Responsive-Basic Education Policy; (b) attitudes towards LGBT sector; (c) perceived capability integrating into the lessons and school activities the promotion as well as integration of LGBT rights; and (d) extent of involvement in observing the provisions of gender-responsive basic education policy influence the variations in gender-responsiveness in the schools. Teachers, GAD focal persons, and principals who have higher levels of these factors tend to be more gender-responsive, and vice versa.
4. The type of school also influences gender-responsiveness. Public schools are more likely than private schools to (a) promote gender equality, (b) address gender dimension in planning and other forms of service delivery, and (c) allocate tasks to subunits to preserve LGBT rights.

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Acquiring the potential of service quality hotels

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Abstract: Tourism potential is inseparable from supporting the quality of hotel services to guests. Hotels or restaurants are quite an important part of satisfying them on a trip. Restaurant activities provide products intended for tourists and guests. The service of a restaurant will result in visitor satisfaction, namely by increasing the development of the restaurant industry anywhere. In its activities, the restaurant must also have good quality service, namely by providing satisfaction to the guests such as speed and accuracy in serving guests, and of course serving in a friendly and courteous manner. To realize good service to satisfy tourists, they need to make service standards known as restaurant standard service steps. Meanwhile, hotels also play a role in enlivening the world of tourism. In addition, the performance of the hotel business determines the development of economic activity in the handicrafts and catering business. In addition, cultural tourism activities also enliven the development of the tourism business. The wheels of the economy occur due to the emergence of the needs of tourists. Efforts to improve the performance of the hotel and tourism business depended on the service quality of the hotel managers and their respective tour operators. This study aims to examine the role of service quality of satisfying tourists that have an impact on increasing the number of their visits. This study uses quantitative and qualitative research methods by employing hundreds of related respondents. The results of the study show that service quality is sufficient to meet the needs of guests and tourists. However, some things need to be improved.

Keywords: Guest, Hotel, Restaurant, Service quality, Tourism

Introduction

If we examine, tourism is an activity based on environmental utilization activities in the world today and is growing rapidly. Meanwhile, transportation is a supporting factor of tourism. Transportation also contributes to tourists' decisions on traveling. The growth of tourism businesses also increases the needs of tourists. At the same time, this need is a business opportunity for local communities in meeting the needs of family life and local income. Meanwhile, hotels also play a role in enlivening the world of tourism. In addition, the hotel business is also a labor-intensive business that fosters the development of micro-economic activities and entrepreneurship in the fields of handicrafts and culinary business. In addition, cultural tourism activities also enliven the development of the tourism business. The wheels of the economy occur due to the emergence of the needs of tourists. Efforts to improve the quality of service quality (SQ) of the hotel management and tour operators respectively. This study aims to respond to local government targets and examine the role of service quality of satisfying tourists, which have an impact on increasing the number of their visits to the city.

Literature review

Service quality has a positive and significant effect on the satisfaction of guests who visit the hotel (Asmelash & Kumar, 2019). The quality of service which consists of tangible, reliability, responsiveness, confidence, and empathy

has an influence on the satisfaction of guests staying at the hotel. While the reliability of the staff has a significant effect on the satisfaction of guests staying at the hotel. The responsiveness of the staff also has a significant effect on guest satisfaction. Furthermore, staff empathy has a less significant effect on customer satisfaction. Meanwhile, hotel facilities affect customer satisfaction. The quality of service staff and hotel facilities greatly affects guest satisfaction (Park & Jeong, 2019). Furthermore, tangible service is the company's ability to provide the best service for customers and this is a concrete thing. This means that this quality can be seen and felt directly by customers, which includes the hotel's physical building, its facilities, to the appearance of the employees serving. In addition, giving gift vouchers to customers as a form of cashback or thanks for staying for 3 nights is also included in the tangibles service (Behdioğlu, Acar & Burhan, 2019; Bonillo, Baldassarri, Marco & Cerezo, 2019). The next dimension of customer satisfaction is reliability. Reliability is the hotel's ability to provide services for customers. If tangibles is about concrete things, reliability is arguably more abstract. This is because reliability is in direct contact with guests' expectations. These expectations include punctuality at check-in to the friendliness provided by employees and staff (Singh & Prasher, 2019).

Just as the name suggests, responsiveness is directly related to responsiveness. That is, responsiveness is about how the company provides services that are responsive to all the wants and needs of customers (guests). Usually this responsiveness is also followed by a coherent delivery but still easy for guests to understand (Feng, Ren, & Zhang, 2019; Gajewska & Grigoroudis, 2017; Park & Jeong, 2019). The next dimension is assurance. Assurance is related to certainty, precisely the certainty of the behavior of business actors towards their customers or guests. This assurance can be obtained, for example, from good communication, extensive knowledge, to a polite and courteous attitude to customers. With assurance, guests' confidence in the performance of the hotel they visit increases (Behdioğlu et al., 2019; Naghizadeh, 2019). The last dimension of the 5 dimensions of guest satisfaction is empathy. Empathy is related to guest satisfaction. This is closely related to sincere and close attention to each customer. Empathy of the staff helps guests in knowing the specific needs and wants of customers. With these 5 dimensions of customer satisfaction, hotel managers and staff can easily identify what guests really want. With this dimension in customer satisfaction, it can even help to improve the quality of hotel performance and services provided. Staff or managers should not hesitate to always ask for feedback from customers regarding their satisfaction. In addition to being an evaluation, it can also make customers feel more comfortable in enjoying the services of hotel staff (Hudson, Botzen, Poussin & Aerts, 2019; Park & Jeong, 2019; Singh & Prasher, 2019).

Methodology

The services provided by an organization become the main component of the success of an information system implementation. Good service will produce good quality. The quality of an information system can be measured using the Service Quality (Servqual) method with the aim of measuring the level of service quality and customer satisfaction (Behdioğlu et al., 2019; Park & Jeong, 2019). This method assesses an information system with 5 dimensions, namely tangibility, reliability, responsiveness, assurance and empathy. Tabulation of this study data using SAS 9 Content Assessment 202, software (Stepantsov, 2018; Viya, Schneider & Pearsall, 2020; Wada, 2009) and based on content analysis (Chambon, Galtier, Arnal, Wainrib & Gramfort, 2018; Collins et al., 2018; Hengky & Kikvidze, 2018; Neuendorf, 2020).

Research method 1

The first research, this study seeks and assesses the current service quality performance. A total of 110 respondents (Chen, Jou, & Chiu, 2016, 2021; Han, Byun, Cho, & Rim, 2021; Kao et al., 2021) received a questionnaire that responded and answered the questionnaire in the form of a guest group discussion (Croce, E., & Perri, 2017; Nyumba, Wilson, Derrick & Mukherjee, 2018).

Research method 2

The second research, further study aims to find and assess the performance of service quality expectations of guests. A total of 120 respondents (Han et al., 2021; Kao et al., 2021) received a questionnaire that responded and answered the questionnaire in the form of guest and stakeholder group discussions (Croce, E., & Perri, 2017; Nyumba et al., 2018).

Result and discussion

The tabulation results (Table 1 and Table 2) indicate that the hotel's SQ almost meets its requirements, only the empathy, responsiveness and tangible aspects still need to be improved. These three things cause a gap. The first gap is between guest expectations and hotel management perceptions. The gap was created because the hotel management misunderstood what guests expect.

The second gap is between hotel management's perception of guest expectations and service quality specifications. This gap occurs due to mistranslation of the correct perception of the hotel management towards the expectations of guests or customers into the form of a benchmark for service quality. Another gap is between service quality specifications and service delivery to guests. The existence of this gap is more due to the inability of hotel human resources to meet standards established service quality.

Table 1: Hotel SQ Performance

SQ - Tourism and hospitality	% Freq
Reliability	0,22
Guarantee	0,18
Empathy	0,17
Responsive	0,19
Shaped	0,16
Nilai Kappa = K	0,57

Table 2. Expected Performance

SQ - Tourism and hospitality	% Freq
Reliability	0,23
Guarantee	0,20
Empathy	0,21
Responsive	0,18
Shaped	0,19
Nilai Kappa = K	0,6489

There are several ways to eliminate gaps. Firstly, to eliminate the gap by providing an opportunity for guests to express their dissatisfaction to the hotel manager, find out the wishes and expectations of similar guests, find out the wishes and expectations of customers through the sales intermediaries (intermediaries), conduct research on important guests, ask their satisfaction after they transact with the hotel manager. In addition, enhancing the interaction between hotel managers and guests or improving the quality of communication between human resources within the hotel and reducing bureaucracy.

Second, improving the leadership quality of hotel managers, enhancing the commitment of human resources to service quality, standardizing certain jobs, especially those that are routine in nature and setting goals to be achieved effectively and in accordance with the wishes and expectations of guests. Finally, n facilitates the flow of communication between personnel, marketing, and operational units. Paying greater attention to vital aspects of service quality, keeping messages conveyed externally from shaping guests' expectations beyond the hotel's capabilities and encouraging guests to become loyal customers

Conclusion

SQ barely lived up to the guests' expectations. To meet the expectations of guests. SQ can be achieved by narrowing the gap, namely by providing an opportunity for guests or customers to convey their dissatisfaction to the hotel manager. In addition, management should find out the wishes and ask the satisfaction of guests or customers after they transact with hotel staff and management. Furthermore, hotel management should strive to improve their interactions with customers by improving the quality of communication between human resources within hotels and reduce bureaucracy.

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Theme 6:

Emerging technology in food, veterinary and animal husbandry (ETFVAH)

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Innovative potato production technology and its influence on quality of tubers

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Abstract: The objective of the paper was to compare the technologies, techniques of reproduction and their use in seed production of potatoes. The paper describes the use of the most important achievements of biotechnology, advanced breeding methods and emerging technologies for solving practical problems in potato cultivation and increasing their resistance to diseases and improving their quality. The most important, safe techniques for the propagation of potato propagating material is in vitro micro-propagation. Among alternatives to conventional propagated potatoes, the Micropropagation, through the aeroponic system (soilless cultivation in the air) is a prospective method of potato cultivation in terms of food safety and sustainability, as the cultivation of plants happens in the air, without any substrate. The nutrient solution is injected into the root zone at short intervals. The biggest advantages are higher yield with optimal quality, reduced consumption of water and nutrients, operation in a closed system and safety for the environment. Thus, an effective method of cooling the root zone and improving plant growth at higher temperatures under glass, signifies advantages making it widely be used in agricultural practice and in the micro-tubers production, offering a high reproductive rate as the tuber harvesting is possible for several times during the growing season and pathogen-free propagation material. The emerging technology enabled methods enable the production of seed potatoes in areas unsuitable for agriculture, unfavourable climatic conditions, or tropics, and allows for considerable water savings.

Keywords: Aeroponics, Agriculture, Hydroponics, Innovative technologies, Micro-propagation, Propagation material

Introduction

The potato (*Solanum tuberosum* L.) is a significant cultivation as farm production in everywhere globally. This species is developed in 180 countries around the world. As per the FAO data (FAO 2019), potatoes are harvested predominantly in Asia, followed by Europe, and America. The prime potato producers in Europe are Ukraine, followed by Poland, Germany, Belarus, Netherlands, Romania, and France. Potatoes are a good source of fiber, which assists in weight loss, prevents heart disease, keeps cholesterol and blood sugar levels in check, and is full of antioxidants to protect against diseases and vitamins that help our body function properly (Sawicka & Diallo, 1997; Sawicka, 2004; Badoni & Chauhan, 2010, Sekrecka & Michałowska, 2013). The potato is the world's most important non-grain edible crop, preceded only by rice, wheat and corn (FAO 2019). It belongs to the family *Solanaceae* and the genus *Solanum*, which includes about 2,000 species, 235 of which are bulbous species. The potato (*Solanum tuberosum* L.), widely cultivated all over the world, is tetraploid and has two subspecies, i.e. ssp. *tuberosum*, adapted

to long days and ssp. *andigena* adapted to short days. Potato breeding is a burdensome task due to biotic factors, mainly cytoplasmic sterility of the cell nucleus, tetrasomic inheritance and inbreeding depression. In tropical and subtropical countries, the improvement of potato varieties is faced with numerous challenges as European varieties are adapted to long day conditions and their reproduction in tropical conditions leads to rapid degeneration and progressive accumulation of viral diseases, resulting in a decline in yields. In addition to this, limitations on tuber storage and use in hot and humid Indian conditions were other bottlenecks. Over the past seventy years, ICAR-CPRI (India) has developed and introduced to cultivation over 70 improved varieties and one TPS population, meeting the needs of farmers in subtropical and tropical countries. First of all, the immune requirements to various biotic and abiotic stresses. In order to shorten the development time of a potato variety, knowledge of new generation breeding is needed (Luthra, Gupta, Tiwari, Kumar, Bhardwaj, Sood, Dalamu, Kaur, Raj Kumar, Vanishree, Mhatre & Chakrabarti. 2020).

Potato Market across the globe is segmented by Geographies and is projected to record a CAGR of 1.0% forecasted over 2021-2026. Even in traditionally non-potato-consuming countries, they are popular due to their long shelf-life, further the processed food industry, have a bulk demand for potato consumption, which has skyrocketed globally. The consumption has shifted from fresh potatoes to value-added, processed food products, including frozen potatoes for French fries and dehydrated potato flakes mashed as ingredients in the snacks, and distributed food aid. Potatoes have been one of the best inexpensive foods even during the pandemic (Mordor, 2020). Demand for potato has been rising during the pandemic as it can be stored longer than other vegetables (Sutanuka, 2020). Large producers get high profits as they are able to take potatoes to the large markets in urban areas where there is more demand for potatoes and could sell at high prices. The price is influenced at the farm level depending on the demand, urban consumers consume the crop in the form of chips and crisps. The potato market can be classified as seed potato, edible potatoes, starch potatoes and for food processing (for French fries, crisps, frozen, dried products and many more) (Godfrey, Mwajkaje & Agnes, 2012).

The potato is one of the few cultivated species considered to be "life support" for space travel. Advanced scientific research indicates that, as needed, the potato can provide food and oxygen to people living on other planets (Wheeler 2006, Gupta 2017). Potato tubers are also used for vegetative reproduction. They are a special seed material that is much less durable than the seeds. However, vegetatively propagated plants are susceptible to diseases caused by viruses, viroid's, bacteria, fungi, and nematodes. All these pathogens accumulate in the soil and in subsequent generations of plants, and therefore tubers can transmit and accumulate soil-borne diseases (Struik and Wiersema, 1999, Hajare, Chauhan, and Kassa, 2021). The high quality of the seed material plays an essential role in the potato production and supply chain. Controlled reproduction of tubers in the breeding- and seed potatoes farms as well as the application of national and EU legislation and international standards characterizing the formal system favor the production of certified seed potatoes (Striuk, Wiersema 1999; Hirpa, Meuwissen, Tesfaye, Lommen, Lansink, Tsegaye and Struik, 2010, Sekrecka & Michałowska 2014). However, their cost for end users is one of the main economic problems in the formal systems of many countries around the world. Such seed potato material may constitute from 30 to 70% of the total cost of commercial production (Mateus-Rodriguez, Haan de, Andrade Piedra, Maldonado, Hareau, Barker, Chuquillanqui, Otazu, Frisancho, Bastos, Pereira, Medeiros, Montesdeoca & Benitez, 2013).

Owing to the advanced adaptation of the viral diseases through the propagation material, the access to better quality seed potatoes is the main limitation in potato growing. In addition to the higher expenses incurred on seed potatoes, propagation is very low paced in reproduction, theoretically 10 times, and practically only 4-6 times (Roca, Espinoza, Roca, & Bryan 1978; Sekrecka & Michałowska, 2014; King, 2019, Hajare et al., 2021). The shortage of good quality propagating material was considered to be the most important reason for restraining production of potatoes, especially in countries which are economically emerging. The potato, however, was an early beneficiary of advances in seed production, both in conventional and modern biotechnology, which resulted in the use of biotechnology and advanced breeding methods to solve practical problems in growing and increasing their disease resistance and quality improvement. Meristem cultures were biotechnologically carried out initially to eradicate infection of viruses on a continuous basis from the clones of potatoes. Later, this method was joined along with micro-propagation to obtain uninfected seed potatoes. Quick propagation of uninfected clones through micro-propagation in combination with traditional propagation means has already developed as an essential part of seed

generation in many places such as Europe, Asia, and America (Hussey & Stacey 1981; Danielle & Colleman, 2001; Donnelly, Coleman, Coleman, 2003; Coleman, Hajare et al., 2021).

The orthodox approach to potato multiplication contains replantation of it from the earlier harvest (Fairbanks, 2014, Sekrecka & Michałowska 2014, Mohapatra & Batra, 2017; Michałowska, Przewodowska, Piskorz & Olejnik 2019). The constant tuber salvaging controls promptly the diseases that are tuber-borne and a low multiplication rate. It requires replanting the seed tubers in many cycles before getting enough, in a large area of land specifically allotted to cultivate potatoes. These bottlenecks are overcome by speedy multiplication methods such as Micropropagation, Hydroponics and Aeroponics (), Shimeli & Melis 2013). The potato is the best crop, globally carrying on the to tackle food security, revenue generation and poverty reduction. Hence, the aim of this review was to present the latest technologies and techniques for potato multiplication in order to be able to provide better food security in the world, especially in developing countries (Gupta 2017). This paper uses standard deviation approach to analyze the volatility of returns of BIMB within the periods of 2010 till 2016. The main reason to evaluate the performance of BIMB is because BIMB is the first Islamic bank established in Malaysia. Besides that, BIMB is the first full-fledged Islamic banking system used a sharia contract such as *mudhrabah*, *musharakah*, *ijarah* and etc. (Luthra et al., 2020).

Methodology

Database. The following databases were used: AGRICOLA (EBSCO), CAB Abstracts, CAB eBooks; CSIRO Publishing Journals; Current Contents Connect (ISI), FSTA - Food Science and Technology Abstracts (EBSCO), GeoRef (ProQuest), GreenFILE (EBSCO) have been searched using key terms such as: 'aeroponic technologies', 'hydroponic technologies' 'food safety', "innovative technologies", "micro-propagation", "propagation material", "micro-propagation techniques", "plant health".

Admission Criteria. Scientific research (in vitro and in vivo) with the use of field and laboratory tests has shown that innovative technologies have been analysed in the potato cultivation technique, which have an impact on the health of plants and their resistance to abiotic and biotic factors. Works not only in English but also in other languages were taken into account in order not to limit the scope of the work. In addition, a manual database search was performed to locate previous articles based on references to already published systematic review articles.

Exclusion criteria. Studies involving species other than potato were excluded. Moreover, presentations, letters to the editor, unpublished materials and theses were excluded. Search results were limited to original scientific articles published between 1962 and 2021. Duplicate articles from different databases were searched and only one was kept.

Result and discussion

Micropropagation

Milestones in the development of plant breeding and biotechnology

Lack of knowledge about the optimal properties of certified material, the use of improved technologies and practices make it difficult to apply new technologies in the production of seed potatoes (Islam & Chowdhury 1998; Kaguongo, Gildemacher, Demo, Wagoire, Kinyae, Andrade, Forbes, Fuglie and Thiele, 2008, Hirpa et al., 2010, Gudeva, Mitrev, Fidanka and Mite 2012, King et. al., 2019). However, research is continuing to improve the various steps in the formal system for the production of healthy seed.

The most important milestones in breeding and biotechnology:

- In 1778 in England, mass occurrence of diseases on potato plants was recorded. In the same year, the Manchester Agricultural Society announced a competition to investigate the causes of potato diseases and provide methods of combating them. Demonstrating that the cause of potato degeneration is the spread of viral diseases was not easy and has been the subject of many scientific papers.
- 1878 Marshall portrayed degeneration as the aging process of vegetatively reproduced varieties. The theory linked degeneration with the influence of environmental conditions and persisted for quite a long time, until the present century.
- 1918 – Quanjer in the Netherlands proved the viral nature of potato degeneration.
- 1938 – Maguro used the in vitro micropropagation technique to study the tuberization process of potatoes.

- 1940 – Ball – obtaining the differentiating cells in the tissues and then the first whole plant from a fragment of a shoot; Skoog and Tsui – the role of auxins and cytokinin's in the differentiation of plant tissues and organs.
- 1949 – Limasset and Cornuet showed that the young organs of a potato contain very little or no virus. However, they were unable to demonstrate or challenge the presence of these viruses in meristems by local damage method. This discovery allowed the possibility of freeing potato plants from viruses by micropropagation.
- 1950 – practical significance. Obtaining a virus-free plant and mastering the plant cloning technique by meristem cultures; Whole plant regeneration from cell; somatic embryos in suspension and callus cultures (Steward and Reinert) (Wang & Hu, 1982).
- 1955 – Morel and Martin demonstrated the possibility of regeneration of potato clones (*Solanum tuberosum* L.) attacked by viral diseases by in vitro micro-propagation.
- 1960 – development of the principles of micro-propagation; development of a universal MS medium (Murashige & Skoog, 1962).
- 1970 – Power et al. – Protoplast fusion; Carlsson - in vitro selection of tobacco biochemical mutants; Nagata, Takebe – Regeneration of tobacco plants from protoplasts; Carlson – the first interspecies fusion; Seibert - Induction of daughter shoots from cryopreserved growth tips.
- 1980 – Flores – establishment of the hair root culture; Neuehaus - Automation of mass production of plants with the use of embryo and organogenesis (Roca et al., 1978, Hussey & Stacey, 1981).
- 1990 – successful cryopreservation of cell cultures (Smith & Drew, 1990; Warren 1991; Gupta, 2017).

The next stage, important for the release of potato plants from viruses, was the combination of thermotherapy with the in vitro method and the size of initiation of growth meristems (Gudeva et al., 2012; Sekrecka & Michałowska, 2014; Michałowska et al., 2019). The achievements of biotechnology allow increasing the amount of high-quality material produced from disease-free seedlings in vitro, shortens the production pattern in the seed, which in the case of potatoes is one of the longest among arable crops (Banadysev, 2012; King et al. 2019). The aim of this biotechnology work is to improve the vigor and quality of seed potatoes. This, in turn, improves production efficiency and increases yields. The innovative production of seed potatoes uses modern biotechnological techniques and usually consists of three stages:

The first stage, i.e., micro-propagation, is based on the method of single-node shoots, which mainly uses stimulation for the development of side buds (Michałowska et al. 2019). In the second stage, minitubers are produced from in vitro seedlings obtained in sterile laboratory conditions or from microtubers. After the dormancy period follow the third stage, which consists in their reproduction of minitubers in the field for three generations to produce a sufficiently large amount of base material, which is the basis for the production of certified seed potatoes, sold to farmers for use in the commercial production (Mbiyu, Muthoni, Kabira, Elmar, Muchira, Pwaipwai, Ngaruiya, Otieno & Onditi, 2012; Kabira, Elmar, Muchira, Pwaipwai, Ngaruiya, Otieno & Onditi, 2012; Michałowska et al., 2019, King et al., 2019). The main goal, for biotechnologists, is conducting sprout cultures and nodal segment cultures as primary explants in the selected potato cultivars. The growth of explants, the individual stages of organogenesis of explants on various hormonal media, and the possibility of microtubers are important in this process (Gudeva et al. 2012, King et al. 2019).

Generalizing the achievements of biotechnology, they allow to increase the amount of high-quality material produced from disease-free seedlings in vitro. Thanks to this, it is possible to shorten the production pattern of seed material, which in the case of potatoes is one of the longest among arable crops (Banadysev, 2012; Gupta, 2017, Michałowska et al., 2019).

In *vitro* technology

The most economically efficient tissue culture technique is substituted to the traditional method of vegetative dissemination in plants, called micro-propagation. The advantage of micropropagation over traditional approaches, in a relatively short time, produces more plants from one single plant, probably in all seasons (Mohapatra & Batra 2017, Michałowska et al. 2019). This method of reproduction is necessary in the case of potato, which is a vastly heterozygous class, in order to obtain homogeneous plants (Roca et al. 1978). Potatoes are swiftly multiplied large scale through meristem, apical cultures, angular shoots grown from nodal cuttings grown *in vitro* (Lutaladio et al.

2009, Kakuhenzire, Tibanyendera, Night Kashaija, Lemaga, Kimoone, Kesiime, Otazu, Ortiz and Barker 2017, Lakhiar et al. 2018), and by producing adventitious shoots straight on the explants or secondarily through the callus phase. These developments are projected during the second start of agriculture process which is probably towards productivity development, profit generations, and eco-friendly safe (Roca et al., 1978; Xuan, Debasis, Eun & Kee, 2003; Bandysev 2012; Mohaatra & Batra, 2017; Michałowska et al., 2019).

The process of potato tuberization is composite, and facilitated in vitro, by their reduced size and weight. The microtube's possess enormous gains through storage, transport, and cultivation practices. They are sown in the soil and can be grown in bulk all the year. They are classified by features such as morphological and biochemical, compared with other tuber producers, as the potato micro tubers have revolutionized the world potato production (Bandysev, 2012; Mohaatra & Batra, 2017, Michałowska et al. 2019). Various growth regulators have been used to induce potato microtubers in vitro (Donnelly et al., 2003, Hossain, 2005, Farran & Mingo-Castel 2006, El-Sawy, Bekheet and Aly, 2007, Hirpa et al., 2010; Rykaczewska, 2016; Michałowska et al., 2019). Physiological Research showed that in vitro tuberization is a precise approach with many factors such as: hormone blend, photoperiod, nutrient composition, and many more (Kanwal, Amina & Shoaib, 2007; King, 2019).` *In vitro* technology has been used in many countries for production of propagating material free from potato diseases (Lutaladio et al. 2009, Mbiyu et al., 2012). Currently, the microtubers potato mass multiplication protocol is automated using a bioreactor system (Xuan et al., 2003; Michałowska et al., 2019). Tissue culture methods produce viral-free sample microtubers as seed potatoes, that are sown in safe production ecosystems for the minitubers (basic seed) cultivation. Basic or sample seeds pass into production phase to link the chain for certified seed intended for direct sale to farmers. An important goal for seed production is to standardize the nutrients for the growth of potato plants and the induction of microtubers.

It is also called tissue culture, where the plant cells from the mother plant are made to grow on an artificial media, enabled by growth media which are solid, liquid, or semi-solid, in disinfected containers or tubes. This is flexible and has a great growth rate. Meristem culture is the most commonly used, where the axillary or apical rising top portions (0.1 to 0.3 mm) is divided and grows into sprouts on simulated in a meticulously conditioned nutrient locations, eliminating viruses in the planting material. The chromosome multiplication and more auxin concentration in the meristematic tissue will obstruct the virus proliferation through intervention by nucleic acid absorption and, there occurs disabling activity pushes the apical region activity to some other position. Tissue culture is not limited by time period, or weather as they can be cultivated on a laboratory scale at all times of the year. Yet, this technology has high operational costs and requires specialized equipment, various nutrients, supporting energy sources, nurturing vitamins, expensive as media formulation requires specific growth regulators, and require specialized skills and knowledge acquired through formal training, and high care or hygiene as inadequacy of equipment sterilization would contaminate leading to complete loss of planting materials (Mbiyu et al., 2012). *In vitro* proliferation approaches using plantlets and seedling knots are consistent in keeping the genetics and veracity of the replicated clones. The first generation potato microtubers tissue culture seeds can address the glitches of resettling seedlings from in vitro to *in vivo*. Due to their lesser sized and lighter microtubers weight, with greater advantages during packing, transport, and cultivation mechanization. Potato seeding's are planted in the soil in a greenhouse, in foil tunnels and produced at any time of the year. They have a common features in morphology and biochemical to old-style potato tubers. The cultivation of microtubers in vitro is key for the production and stowing of valued potato varieties (Michałowska et al., 2019).

The microtubers of Potato acquired in vitro culture from the cutting of single-node are very suitable for storing and replacing fit germplasm. Initial explants with nodal segments, have developed efficiency with respect to the tuber plantlets (Gudeva et al., 2012) the best results were obtained with the composition of MS medium (Marushige & Skoog, 1962) with cytokinin and auxin, particularly MS + 2 mg dm^{-3} BAP + 1 mg / l NAA, in case of the cultivars (Agrija) created 13% more microtubers than the others. More sucrose applications can induce signals that lead to amassing of starch, and to grow the presence of microtubers, the sucrose absorption goes high (Hajare et al., 2021) shows the application of plant tissue growth using side buds as plantlets for in vitro micro-propagation of potato. The shoots they initiated grew two to three times after transplantation on MS medium supplemented with various absorptions of BAP and Kinetin. The greater number of multiple sprouts was gained on MS medium having 2.5 mg dm^{-3} of kinetin. However, the shared action of BAP and Kinetin ensured not show several further positive outcomes

on sprout proliferation in these studies. The highest percentage of rooting and the highest number of roots / shoots were established on MS medium supplemented with 1.0 mg dm^{-3} IBA + 0.5 IAA (Figure 1).

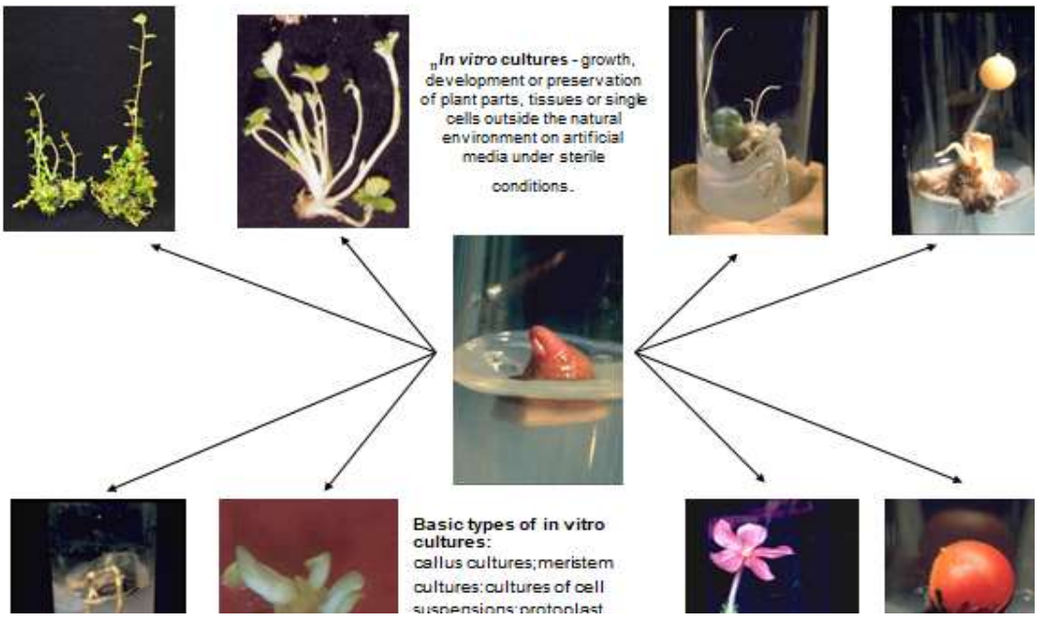

Figure 1: In vitro cultures - growth development, preservation of plant parts and basic types of *in vitro* cultures

Potato micropropagation is understood as a set of methods of vegetative multiplication with the use of in vitro tissue cultures used on a production scale. The task of micro-propagation (*in vitro* cultures) is primarily to improve plant health. In vitro micropropagation and the production of mini-tubers on a larger scale were already dealt with in the world in the 1950s. (Wang & Hu, 1982; Simko, 1993, Khan, Hoque, Sarker & Muhlbach, 2003; Kanwal, Amina & Shoaib, 2006; Badoni & Chauhan, 2009; Sekrecka & Michałowska, 2013; Hajare et al., 2021).

The microtubers are obtained by an in vitro microtuberization process. They are generally very small, their caliber does not exceed 10 mm, and have an average weight of 0.7 g (Diallo 1997; Striuk & Wiersema 1999). For the production of microtubers, single-node in vitro plant fragments are used, which are exposed to chemical and physical factors that induce tuberization. The microtubers multiplication factor is relatively low (Sekrecka & Michałowska, 2014). The main advantage of this method is the production of tubers in a controlled, closed environment, regardless of the season. An additional advantage is the relatively low cost, since microtuberization takes place in complete darkness. Factors important in the microtuberization process include, among others sucrose level and presence of growth regulators in the medium, and incubation temperature and light. The energy source for this process is sucrose. The optimal concentration in the medium is 8%. Both lower and higher sucrose concentration may have a negative effect on the number and size of microtubers obtained (Woznicki, Møllerhagen, Heltoft & Kusnierek, 2021). The inclusion of growth hormones to the substrate may stimulate or inhibit tuberization, but it is not necessary for the formation of tubers in the glass (Struik & Wiersema 1999). The microtubers are produced all year round and then planted under cover in temperate climates. Currently, more and more emphasis are placed on the use of non-hormonal micro-reproduction systems. Until now, little attention has been paid to them, probably due to the relatively slow and ineffective growth of explants. The development of a micro-reproduction system without hormones is advisable as such systems allow production without subsequent hormone disrupted problems and may be commercially viable. Production of mini-tubers under covers (greenhouse, foil, or mesh tent), where it is much easier to ensure proper and accelerated plant growth in order to obtain a relatively large number of tubers suitable for field production (Zaklukiewicz & Sekrecka 1994; Sekrecka & Michałowska, 2014). Tubers from the first generation of in vitro plants or microtubers are called minitubers (Hajare et al., 2021).

The starting material is the tested tuber. In vitro plants are derived from apical meristems or tuber sprout sections. Self-feeding plants have a small accumulation of young dome-shaped cells at the ends of each shoot that can divide, which can be used in tissue production and organ differentiation (shoots, leaves, flowers). The Meristem consists of 3 zones with different activities:

- apical, central zone, inactive for flower induction, called the "waiting" meristem.
- annular zone – precursor of the differentiation organ: initial ring.
- sub-terminal, axial zone, related to the merystem (Zaklukiewicz & Sekrecka, 1994; Michałowska et al., 2019).

Meristem cultures are considered to be fragments of the meristem dome of various sizes, ranging from 0.1 mm to 1 cm in length. Most often, however, the size of the apical meristem is defined as <0.1 mm. Meristems are divided into 3 groups:

- without leaf buds (0.1-0.2 mm).
- with seedlings of 2 primary leaves (0.21-0.4 mm).
- with seedlings of 4 primary leaves (0.41-1 mm) (Zaklukiewicz & Sekrecka, 1994; Michałowska et al., 2019; Hajare et al., 2021).

The size of the growth meristems has a great influence on the possibilities of obtaining plants in vitro. The easiest method is to plant the sprouts after disinfecting the dome with leaf buds into nutrient tubes. We call this method "Stem Cutting". The second option of obtaining plants in vitro is more complicated, but gives a sense of security (Figure 2). It requires additional stages of harvesting growth meristems (Badoni & Chauhan, 2009; Cambourios, Zebarth, Ziadi & Perron, 2014).

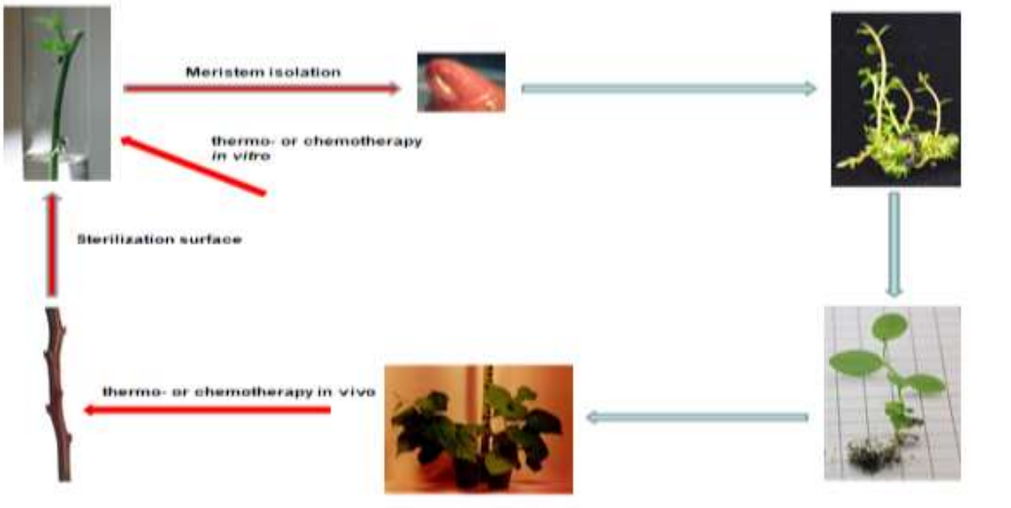

Figure 2: Scheme of realizing plants from endogenous microorganisms

Factors influencing the isolation of growth meristems

The success of obtaining plants from apical meristems in vitro depends on whether or not meristem domes without leaf buds or domes with seedlings of 1-2 pairs of primary leaves are isolated. It is easier to obtain plants from meristems having more leaflets, but harder to obtain virus-free plants from them. Precise cutting of the explants is of great importance - the cut must be on a drop of water and should be quickly placed on the nutrient medium so that the cut surface adheres to the nutrient medium. In the case of too much tearing of the tissue and placing it on the medium too late, oxidation processes take place faster, which leads to the death of the explants. It is very difficult to grow meristem cultures smaller than 0.1 mm (Simko, 1993; Sekrecka & Michałowska, 2014). In vitro plants can be derived from meristems (apical bud) or angular buds. Meristem cultures are carried out when there is no healthy starting material, and it is necessary to free the plants from pathogens. Most often, thermo- or chemotherapy is included in parallel. Using a healthy starting material, whole buds can be isolated by removing only the outermost buds (Badoni & Chauhan, 2010, Sekrecka & Michałowska, 2013; Michałowska et al., 2019).

Factors Affecting Plant Tissue Culture

Growth Media includes minerals, development factors, carbon basis, and hormones. The ecological factors are light, heat, light exposure period, sterility, and the substrate. The explant sources the younger, less differentiated the plantlets for better tissue culture (Badoni & Chauhan 2010, Sekrecka & Michałowska 2013). Genetics differentiate the species in responsiveness to tissue culture. However, in many cases, the diverse genotypes in a species have flexible reactions to tissue culture; somatic embryogenesis relocated between melon cultivars over sexual hybridization (Srivasta et al., 2012, Sekrecka & Michałowska, 2014).

Steps of micropropagation and tissue culture applications micropropagation

There are 4 phases of micro-multiplication:

- Stage 0 – Collection, disinfection of the plant tissue & provisioning of the mother plant.
- Stage I – Beginning of culture – plantlet positioned into growth substrate
- Stage II – Growth – plantlet relocated to shoot media; and constantly divided.
- Stage III – Rooting – plantlet shifted to root substrate.
- Stage IV – Relocation to soil –plantlet into soil; hardened off (Simko 1993, Gudeva et al. 2012).

Ways of preserving the germplasm preservation:

- Soma clonal distinction & mutation range.
- Embryonic culturing.
- Haploid & Diploid Production.
- In vitro hybridization – Protoplast Fusion
- Industrial Cell Culture Products (Al-Gaadi, 2016).

Features of Micropropagation and Potential Uses for Micropropagation in Plant Breeding

Micropropagation in Plant proliferation eradicates virus from sick vegetal assortment. Moreover, via meristem culture otherwise every now and then through thermal actions of cultured matter (or grouping). Preserve a heterozygous plant collection for marker expansion. Through multiple clones, every genotype of a clone be given in to numerous assessments. Crop inbred vegetation for fusion seed invention wherever inherited seed generation is inadequate for conservation of male sterile lines (Al-Gaadi, et al., 2016). Clonal reproduction is a good way of preserving the heterozygosity. Development phase can be recycled for numerous occasions to crop an infinite number of clones: Normally used for economic gains are many ornamental types, in which some are vegetatively proliferated yields. Easy part of this activity is to use construction cycles which are flexible to all field farming periods, and ecological impacts. Disease-free plants can be produced: has been used to eliminate viruses from donor plants (Al-Gaadi et al., 2016; Wasilewska-Nascimento et al., 2019).

Germplasm Preservation, Cryoprotection, Cryopreservation Requirements

They are two methods of germplasm preservation: Slow development method, wherein the temperatures drop, sunlit, and substrate increases the osmotic retarders, growth decelerators, tissue dehydration, medium-term protection for 1 to 4 years; Cryopreservation includes ultra low temperatures, tops cell separation & metabolic methods, on an enduring basis (Wasilewska-Nascimento et al., 2019). Pre-Culturing. Regularly, a speedy development phase generates cells with minor vacuoles and small water mixture with Glycerol, DMSO, PEG, etc., to shelter contrary to ice destruction and modify the arrangement of ice crystals (Gudeva et al., 2012; Mbiyu et al., 2012).

Freezing. The record crucial phase here; includes two types, wherein the slow freezing permitting for cytoplasmic dehydration, while the rapid freezing consequently leads to quick intracellular freezing with little dehydration (Wasilewska-Nascimento et al., 2019).

Cryoprotection requirements are following:

- Stocked frequently in aqueous nitrogen (-196°C) to evade all variations during crystallization of ice crystals that happens more than -100°C.
- Thawing - regularly happened due to rapid warming to escape away from the disturbances in ice crystal growth.
- Recovery (Al-Gaadi et al. 2016).

Thawed cells must be essentially cleaned of from the cryoprotectants then fostered to its usual development. Must be devoid of lump generation to preserve inherited constancy (Warren, 1991; Wasilewska-Nascimento et al., 2019).

Stages of micro-reproduction

Stages of micro-reproduction:

1. Plant micropropagation at the laboratory stage: plant in vitro > plant in vitro (glass).
2. Micro-propagation in the greenhouse – production of mini-tubers: in vitro plant> mini-tubers (soil).
3. Micro propagation in the field: mini-tubers > seed potatoes (soil).

First, healthy plants taken from the in vitro gene bank are passaged several times until the planned number of plants is obtained. Plants are run in test tubes on Murashige-Skoog medium (Marushoge & Skoog 1962, El-Sawy et al. 2007). Transferring in vitro cultures into the field takes place in two ways; by rooting the plantlets. After 2-3 weeks from the last passage, well-rooted plants (in tubes) with 2-3 leaves can be planted under covers, by creating microtubers in the glass (test tubes). They have a diameter of 3-8 mm and a mass of 0.05-0.15 g. Their physiological state is homogeneous (Sekrecka & Michałowska, 2014; Michałowska et al., 2019, Hajare et al., 2021). The rate of in vitro plant preparation is largely dependent on the cultivar multiplication ratio (i.e., the specificity of plant growth in test tubes). This coefficient ranges from 5-15 internodes (stem section with 1 leaf). The substrate for the cultivation of mini-tubers is a mixture of compost soil, peat, and sand. It is more advantageous to plant the plants in vitro to a permanent location. The optimal density is the number of plants · m^2, as this density gives the highest proportion of tubers with a diameter of 1.5 cm. Intensive protection against aphids is carried out throughout the growing season, and in the second cycle, additionally against potato blight. Randomly selected plants are re-checked for viruses and PSTV (tuber spindle) by electrophoresis or c-DNA, and for other viruses by bioassay or ELISA (enzyme immunoassay) or other more sensitive test. This test makes it possible to test very young plants (2-3 weeks old). High sensitivity 1000 times higher than traditional methods and thus better detectability by testing tubers or sprouts. After harvesting, tuber samples are tested for Corynebacterium sepedonicum and viruses (Sekrecka & Michałowska, 2014; Hajare et al., 2021).

One plant in vitro yields 5-24 mini-tubers depending on the planting date, the fertility of the prepared soil, plant density per 1 m2 and, finally, the variety itself (Muthon et al. 2013). Calibration of minitubers: the produced mini-tubers are sorted into 3 groups: diameter> 3 cm, 3-2 cm, <2 cm. All tubers> 2 cm in diameter are transferred to conservation breeding and planted in the field (fig. 3) (El-Sawy et al. 2007, Sekrecka & Michałowska 2014, Michałowska et al. 2019, Wasilewska-Nascimento, Jankowska, Boguszewska-Mańkowska, 2019).

Figure 3: The size of the mini-tubers of 'Owacja' cv. compared to the seed potato

After planting microtubers, e.g., in a greenhouse or a tunnel with an area of gross of 200 m2 is harvested, depending on the variety, from 45 to 90 thousand. mini-tubers, which can then be planted on 0.7-1.3 ha. In the production of one planted microtubers, depending on the variety and planting density, 6 to 12 minitubers are obtained, which are planted in the field as pre-basic material for PB II. The pattern of reproduction is shown in Figure 3 and photos on the third cover page. Each stage of reproduction is subject to health checks, as shown in Figure 3. Microtubers are produced throughout the year and then planted under covers. Conservative breeding of all varieties is currently

carried out using this method. At the current level of production, the harvest from the second year of field propagation from an area of about 1 ha is a commercial material (basic and qualified materials depending on the order) (Burski, 2006; Sekrecka & Michałowska, 2014, Al-Gaadi et al., 2016). Microtubers and micro-seedlings are planted under covers and minitubers are obtained from them (Srivastava, Kumar, Joseph, Sharma, Bag and Singh, 2012), which are planted in the field as pre-basic material (PBII). This method has both advantages and disadvantages.

Advantages of micro-reproduction:
Elimination of viral diseases transmitted from tubers.

- Obtaining an increased yield.
- Achieving a higher multiplication factor.
- Reduction of the dependence on the physiological state of the mother tuber.
- Reduction of the number of tests and reduction of the labor intensity of health assessment.
- In vitro plants are a convenient form for the exchange and transport of materials internationally
- flexible response to market needs (Srivastava et al. 2012).
- the possibility of obtaining many plants in a short time. Depending on the rate of plant development, which varies from one variety to another, from one starting plant after 6 consecutive cuts, 730-1,000,000 plants can be obtained.
- independence from the season of the year because all works at the stage of in vitro cultures are carried out in laboratory conditions, and the development of cultures takes place in strictly defined conditions, artificial, imitating natural ones.
- the possibility of creating a healthy collection and maintaining it for a long period of time without the risks that occur in the field.
- in vitro starting material with an appropriate health certificate does not require re-testing.
- after organizing an in vitro collection (plant bank), plants can be reached at any time and propagated regardless of the season (Srivastava et al., 2012; Sekrecka & Michałowska, 2014).

The achievements of biotechnology have therefore allowed to increase the amount of high-quality material produced from disease-free seedlings in vitro, making it possible to shortening the production pattern of seed material, which in potatoes is one of the longest among plants cultivated (Banadysev 2012).

Disadvantages of micro-propagation:

- quite expensive method, requiring the organization of a specialized laboratory in septic conditions,
- in the case of contamination of materials in vitro with fungi and bacteria, the losses are very serious,
- The produced diasporas are small, weak and have a long growing season and a very slow initial growth, there is a risk of spontaneous mutations (Srivastava et al., 2012; Sekrecka & Michałowska, 2014, Michałowska et al., 2019).

The size and quality of the crop is influenced by many factors. First of all, these are: genotype, planting date and density, soil fertility, as well as care and protection measures. In addition to ensuring the appropriate phytosanitary conditions (disinfection of greenhouses, tents, substrate replacement, keeping the premises free of pests (aphids, spider mites and thrips), protection against potato blight, etc.), the production of mini-tubers plays an important role, similarly to field cultivation, the composition of the substrate, its structure, appropriate pH, and richness in nutrients (macro- and microelements). One of the most important factors determining the seed value of minitubers (apart from health) is their size. Numerous studies indicate lower usefulness of the smallest tubers (less than 1 cm in diameter), hence the conditions that ensure the maximum share of larger fractions in the yield, i.e., those with a diameter of more than 1 cm, play a key role in the production. The size of minitubers is significantly influenced by: planting density per area unit and the physiological and chronological age of planted in vitro plants and microtubers. The optimal age for plants planted under covers is approx. 4 weeks; the yield of minitubers is about 50% higher compared to the yield of 2-week-old plants (Diallo, 1997; Burski, 2006; Sekrecka & Michałowska, 2014; Wasilewska-Nascimento et al., 2019).

The use of minitubers in breeding practice

Micro-propagation allows for a great improvement in conservative breeding, e.g., allows you to resign from clone propagation or reduce the scope of tests for health assessment. Minitubers obtained in own laboratories of tissue cultures of breeding units are the starting material for conservative cultivation of potato cultivars (Siewierska, 2011). This healthy propagating material is used primarily for conservative breeding, the aim of which is to maintain genetically fixed traits of a given potato variety (Diallo, 1997). The end product of this reproduction in a 2-3-year cycle are seed potatoes referred to as mother material. By using micro-rotation techniques, it is possible, apart from the guarantee of high healthiness of the material, to quickly, within 2 years, adjust the supply of seed potatoes of a given variety to the changing demand. Prior to planting the minitubers in the field, it is essential to prepare them in advance, i.e., to store them, thoroughly fractionate them and germinate them properly. The influence of the temperature during the storage period on the seed value of minitubers is similar to that in the traditional production of seed potatoes. Higher temperatures accelerate the aging process of minitubers by lowering their development potential. In order to maintain their good seed value, it is necessary to maintain constant, low temperatures. It is especially important when storing tubers from spring harvest for almost 10 months. Mechanized techniques for planting minitubers have already been developed. Regardless of the reproduction scheme, each of the selected fractions of tubers should be planted in a separate "block". In this way, in addition to better leveling of the field, it is possible to carry out additional care and protection treatments for individual batches of material during the vascularization (Sekrecka & Michałowska, 2013, 2014; Gupta 2017; Kamrani, Chegeni & Hosseinniya, 2019).

Hydroponic system

All known technologies for the production of mini-tubers fall into two categories: with and without a substrate. The classic method is the production of mini-tubers in greenhouses, foil or mesh tents on natural soils or soil substrates in vases (Banadyse 2012, Sekrecka & Michałowska 2013). Such a standard method of reproduction in the formal system, carried out in vivo, is a long-term, even more than 10-year, laborious process. When using this method, the multiplication factor is relatively low (Striuk, Wiersema 1999, Hajare et al. 2021), which makes it difficult to meet the demand for high-quality seed potatoes. Otherwise, this method requires sterilization of the substrate, which increases production costs (Hossain, 2005; Otazu, 2010; Mbiyu et al., 2012; Hajare et al., 2021). Due to climate change, Schafleitner, Ramirez, Jarvis, Evers, Gutierrez, De Scurrah, Ramirez, Jarvis, Evers, Gutierrez and De Scurrah (2011) predicted that the greatest losses in land suitability for potato cultivation would occur in southern Africa and the tropical highlands. In addition, India, the second largest potato producer in the world (FAO, 2019), is projected to lose 11% by 2080 (Kumar, Govindakrishnan, Swarooparani, Nitin, Surabhi and Aggarwal, 2014). Therefore, alternative production systems that allow for an increase in global food security in future climate scenarios should be explored by expanding the area under potato cultivation, using areas with inadequate or degraded soils. Hydroponics is soilless a cultivation method in which plants are grown using nutrients. This cultivation system removes dependence on agricultural land and soil, reduces the presence of diseases and can mitigate the negative effects of extreme weather events by using precise dosing of nutrients (fertigation).

Lakhiar et al. (2018) described a type of hydroponic production as a useful system to produce a variety of crops, including potatoes. Hydroponic potato production has also been studied at NASA (2006), Tibbits, Cao, and Wheeler, (1994). Potato in soilless cultivation requires an advanced production setup, which may limit the widespread adoption of this technology. Woznicki et al. (2021) investigated the hydroponic production of potato minitubers on a substrate of: perlite, soil, a combination of perlite and vermiculite; perlite and moss of peat; soil and perlite; perlite-soil-composted cattle manure, and finally perlite-soil-vermicompost. These studies showed that the yield of minitubers was higher on substrates without soil (Kamrani et al., 2019). Rolot and Seutine (1999) concluded that soilless cultivated minitubers produce minitubers of higher caliber and higher average weight compared to soil cultivated minitubers. Hydroponic systems for ware potato production were also considered (Lommen et al. 2007, Woznicki et al.. 2021). New technological solutions introduced in recent years, the so-called soilless, replace conventional soil production, rely on water solutions of minerals (hydroponics). Examples of hydroponics include the NFT & DFT, which are nutrient film technique and deep flow technique respectively. In NFT systems, roots grow directly in a shallow (2-3 mm), continuously flowing layer of nutrient solution. DFT systems use large tanks, filled with nutrient solution, on which floating plates hold the plants upright while their roots hang directly in the nutrient solution. As the roots are suffering from insufficient oxygen when immersed in the aqueous solution, another

modification of hydroponic cultivation has emerged. Chang, Park, Kim and Le (2012) designed the first aerohydroponics device as an alternative to NFT, in which the lower part of the roots is submerged in the nutrient medium and the upper part a portion is exposed to a spray medium.

Plantlets when moved in to a hydroponic arrangement can facilitate quick creation of sterile high quality mini-tuber seeds for marketable use. Hydroponic arrangement is culturing in a nutrient liquid that has a well-adjusted quantity of the vital facilitators that are compulsory for the vegetal development. The NFT arrangement comprises of a succession of PVC or asbestos upwardly racked slope, in which a slimmer film of 1 cm thick nutrient aqueous solution streams over the roots of the vegetation. Using a submersible pump, solution flowing down the slope is collected and pumped back to the top, permitting continuous movement of the nutrient aqueous solution. The DFT arrangement has a tank where the plants, placed on a platform have their roots submerged in 5-20 cm deep nutrient solution, here the nutrient recirculation is through a pump. These hydroponic methods provide adequate supply of nutrients to the plant for multiple harvests and with the yield increase (Mbiyu et al. 2012, Thiago, Factor, Jünior and De Araüjo, 2012). The diagram of the hydroponic system is shown in Figure 4.

Figure 4: Schema of Hydroponic system

Benefits of Hydroponic Growing:

- the possibility of establishing crops in areas unsuitable for soil cultivation, e.g., in dry areas,
- no restrictions in the field of plant rotation - any plants can be grown one after the other, also in monoculture, because there is no soil fatigue phenomenon,
- higher yields due to denser sowing and faster plant growth and development,
- lower contamination of products due to non-application of pesticides and no heavy metal uptake from soil,
- possibility of postponing flowering and fruiting beyond the normal season,
- elimination of some heavy manual work (soil replacement, digging, hoeing, etc.),
- saving water (Thiago, 2012, Woznicki et al. 2021).

In humid settings of Brazil, Central and South African countries, depending on the elevation, potatoes can be planted and cropped month on month every year, which promotes the occurrence of pests and diseases, especially viral diseases. One of the main strategies for increasing the healthy rate of seed potato propagation and creation is to practice hydroponic arrangements, with or without media, in channels, boxes and pots. In hydroponic arrangements without media, the aeroponic arrangement is effective as it produces a high multiplication factor, with an average of 47 tubers per plant, equated to NFT / DFT of 35 / 37 tubers per plant, correspondingly. When using substrates, better results are obtained in pots with 12 tubers in plant^{-1}, tracked through capillary irrigation and box systems with 8 - 7 tubers in plant^{-1}, correspondingly. In general, hydroponic systems have a significantly high impact on the production of seed potatoes. Among hydroponic systems with pot substrate, they proved to be the best option.

However, higher yields of seed-fraction tubers were gained in the hydroponic arrangements without media, or in the aeroponic arrangement, which gave the best results (Thiago et al., 2012).

The use of hydroponics in the production of ware and seed potatoes can mitigate crop losses in very sensitive regions (e.g., the tropics). Wozniacki et al. (2021) conducted preliminary studies to test the prospects of hydroponic ware potato production on wood fiber by associating various fiber categories and fertigation approaches. Hydroponic potato production on wood fiber gave a 200% more yield than that which happened through usual cultivation in the field. However, the tuber quality to some extent decreased (dry matter low in content). The cultivation method and fertigation strategy influenced the productivity of ware potatoes. The cultivation of potatoes on wood fiber is conceivable and may in the imminent supplement traditional production structures and even develop as a significant alternative in those regions of the world where field cultivation is impossible for climatic reasons. However, the influence of the fiber wood characteristics and the various fertigation strategies used on the yield possibilities and quality of tuber needs further investigation. Optimizing these features will be crucial for a hydroponic system.

Aeroponic system

This is quite expensive involving the plant growth in a mist setting, deprived of the use of soil or aggregates. The suspended roots are in misted nutrient medium, and more successful than any other technique, consumes less time labor dependence, as they conserve water and energy. The recirculation requires less water and easy to monitor the nutrients and pH, and reduced fertilizer requirement. This minimizes the risk of fertilizer overload as residues into the water table. They are minimum space efficient, and plants can grow at higher density with a constant power supply throughout the growth period. The cost of installation and operational costs are high and can produce disease-free potato seed tubers. However, around which are risks of soma clonal differences that are brought in through tissue culture, which needs to be taken care of Langemeier & Shock (2019), Mohanty &, Baruah (2019).
Classification of aeroponic crops Aeroponic culture or aeroponic system is classified as soilless culture. It is included in the group of hydroponics, along with stagnant hydroponics and NFT (nutrient film technique) which use no media. If, however, it is defined that "the substrate is the root growth environment", it can be considered that the substrate in aeroponic cultivation is air (Langemeier & Shock, 2019).

Aeroponics - what is an aeroponic system?

Growing a plant in the air or in fog short of the normal practice of soil or another dense substrate is called aeroponics. The aeroponic system does not require soil and the roots are suspended in the air to receive oxygen and nutrients. The nutrient solution containing all macro- and microelements is injected into the root environment in the form of a mist. Aeroponic systems generally use less water compared to other types of hydroponic methods. It is one of the most effective, low-emission types of farming methods. In an aeroponic arrangement, vegetation is generally introduced into the stand openings at the top of the tank placed in a closed container. Due to the lack of substrate for the root zone of plants, a collar supporting the stems must be prepared. These sleeves essentially be stiff adequate to hold the vegetation upright, but supple enough to permit space for root growth (Farran and Mingo-Castel 2006, Gopinath, Vethamoni & Gomathi, 2017; Kakuhenzire et al., 2017, Mohanty & Baruah, 2019).

What is an aeroponic system and how does it work?

In this system cultivate suspended plants in a closed or semi-closed environment by spraying overhanging roots and the lower stem of the plant. The leaves and crown, often referred to as a canopy, protrude above. A pump and sprinkler system creates steam (hydro-atomized with a blend of water, growth associated hormones and nutrients) from a nutrient-rich aqueous solution and atomize a mist into the tank to irrigate the overhanging plant roots. The atomized shower delivers the required quantity of nutrient that excites the plant's development and permits it to grow comfortably (Figure 5) (Gopinath et al., 2017; Kakuhenzire et al., 2017; Mohanty &, Baruah, 2019; Langemeier & Shock, 2019).

Figure 5: Aeroponic system in potato cultivation

Aeroponic plant cultivation is used in vegetable production in tropical and subtropical countries. This method enables the cooling of plant root systems (Lee 1993). The research conducted by Him, and Lee (1998) showed that cooling the root zone increased photosynthetic activity and increased plant productivity. Cooling down the root zone of plants of temperate climates and plants adopted for cultivation in tropical climates causes an increase in the ratio of the mass of shoots to roots, as a result of greater transport of assimilates in the plant. High temperature of the root environment causes symptoms of iron deficiency, which is not found in aeroponic cultivation, as a result of cooling down the root systems (He & Lee, 1998; Mohanty & Baruah, 2019). The cooling effect of root systems depends on the volume of the injected medium covering the root systems, which in aeroponic cultivation have both vertical and horizontal distribution (Tan et al., 2002). The temperature of the root environment has a significant impact on the development of root systems (Menzel, Turner, Doogan & Simpson, 1994). Du and Tachibana (1994) showed that the presence of N, P, K, Ca, Mg, Fe, Mn, and B in the leaves decreased when the temperature of the root zone increased from 25°C to 35 and 38°C. Stoltzfus et al. (1998) showed that an increase in the temperature of the root zone above 35°C reduces the content of P, Zn and Mn in the shoots, while the content of P and Zn in the roots increases linearly. Tan et al. (2002) showed that plants grown at the temperature of the root zone of 20°C had longer roots, a greater number of hairs, and a larger root area than plants grown in high thermal conditions, typical for the tropical climate zone. Plants grown at a temperature of 20°C in the root zone had a greater number of fine and delicate roots, which was significantly related to their smaller diameter. The plants having a temperature of 20°C in the root environment had a higher content of N and P in the leaves. The buildup of N-NO_3, K, Ca, Cu, Fe, Mg, Mn and Zn in leaves and roots was more in the root zone temperature of 20°C than in the non-cooled root zone conditions. They emphasize that the temperature of the root environment has a significant impact on the morphology of the root system, the absorption of nutrients by the roots, enzymatic and phytohormone activity, and the ratio of nutrients between the roots and the above-ground part of plants (Tan, He & Lee, 2002; Kakuhenzire et al., 2017; Lakhiar et al., 2018; Rykaczewska, Zarzyńska & Boguszewska-Mańkowska, 2018).

Aeroponic potato mini tuber production arrangement?

The key advance in agricultural research and innovation is the aeroponic arrangement. This modern finding might expose a new world of openings for potato and minitubers harvesters (Lakhiar et al., 2018; Mohanty & Baruah, 2019). The aeroponic system (soilless cultivation in air) is recognized as a prospective method in terms of food safety and sustainability. Commercial production of seed potatoes in this technology is developing, among others in China and India. Modern aeroponic structures for the production of mini-bulbs operate under fully controlled conditions. They consist of an aeroponic chamber, an installation for the administration and collection of nutrients, and a system supporting and securing the fogging devices. Such cultivation ensures a high reproduction rate, multiple harvesting, free from pathogens of propagation material during the growing season. Aeroponics allows for the multiplication of seed potatoes, especially in areas unsuitable for agriculture and in climatic conditions unfavorable to traditional potato cultivation (tropics). It is also tested for use in human-crew space flights, due to the spatial flexibility of aeroponic structures and significant water savings (Kakuhenzire et al., 2017; Wasilewska-Nascimento et al., 2019). The number of test results characterizing minitubers is still insufficient produced in aeroponic systems. From the

research of Farran and Mingo-Castel (2006) shows that the yield of such minitubers it may be low and may be related to the small size of the daughter tubers.

Advantages and disadvantages of aeroponic crops

The main advantages of aeroponic farming leads to greater yields, their best quality, improved use of the greenhouse space, increased farming cycles, enhancement of phytosanitary settings, greater level of mechanization, reduction of farming costs, operation in a looped system and extensively deliberated on the applied impact associated with the root cooling methods (Massantini, 1977a; Molitor, 1991; Leoni et al., 1994; Repetto et al., 1994; Kreija & Hoeven, 1996; Lima, 1996; Tan et al., 2002; Mohanty & Baruah, 2019). The possibilities of increasing the cultivation cycles and plant density on the cultivated area were documented (Mohanty & Baruah, 2019). This authors developed the High Density Aeroponic System (HDAS) in greenhouse tomato cultivation. He investigated the density of 20 plants m^2 in the first 2 cultivation cycles and 35 plants m^2 in the third cycle. Plants occupied the cultivated area in the greenhouse for 90-95 days. Moreover, significant savings in the consumption of water and fertilizers constitute an important item in the balance of economic effects. The advantage of aeroponic crops is also that they function in closed systems. Aeroponic production under glass may be the first branch of plant production that does not pollute the natural environment. Extremely important practical importance is the fact that no substrate is used in aeroponic cultivation. This advantage is considered to be the most important, especially in view of the increasing acreage of mineral wool cultivation and the problems associated with its disposal. Plant root systems in aeroponic crops are much better developed than in crops with the use of substrates considered to be the best, such as mineral wool, expanded clay or coconut fiber. The root systems of plants in aeroponic cultivation develop throughout the entire period of plant cultivation at the maximum oxygen content and maximum humidity of the root environment, without encountering substrate resistance. In aeroponic crops, there is no antagonism between the humidity and air conditions of the root environment. This is the first cultivation technology in which these two parameters do not contradict each other (Mbiyu et al., 2012; Pala, Mizenko, Mach & Reed, 2014; Langemeier & Shock, 2019).

The main disadvantage is the high cost of such cultivation (Ritter, Angulo, Riga, Herran, Relloso and Jose, 2001, Komosa 2002, Mateus-Rodriguez, et. al., 2013, Rykaczewska et al., 2018, Langemeier & Shock 2019). Aeroponic cultivation creates further opportunities to increase yields with optimal quality and not polluting the environment. It is the most scientifically and technically advanced method of growing plants. Aeroponic cultivation does not require any substrates, with significantly lower consumption of water and nutrients, and is a future method of cultivating horticultural plants in practice (Mohanty & Baruah, 2019).

New Technology Adoptions to Increase Production

Emerging Technologies application

Precision farming uses information technology to gather and exploit the specific data about fields, for instance mapping of the soil, yield, robotic directed arrangements, drones, satellite imagery, and various production practices for positive relation to farm size. Precision agricultural technologies improves profitability, and promotes better management controls. However, new adoption of precision agriculture technologies, would consume costs (Michael et al., 2019). Through this technology application the potato crops and seed tuber lots are treated through intervention at the smallest scale and at the right time, optimized with time, dosage, and site of application. Using technologies such as GPS for sensing and dosages create responses which generate right decision control systems affecting the yield of crops, to effectively manage the value chain, by tracing, tracking, and learning for improving the performance. Potato suffers from suboptimal biotic and abiotic environmental conditions as it is more sensitive to drought than the cereals, requiring interventions through decision support systems (DSS) at specific locations depending on the quality of the crop harvested per plant. The soil is evaluated spatially depending on the rooting depth, water holding capacity, pH, organic matter, then ensuring all inputs such as seed tubers, fertilizers, protection agents and water, at every level of the site, offers conditions that are favorable. DSS in potato production for planting times and densities, fertilization, irrigation, control for dealing with losses due to diseases, pests, weeds, and harvest scheduling have a time component, which can be taken care through hardware and equipment to interact for right row spots on the soil map by considering the soil layer whether sandy or thinner depending on the yielding ability and then be suitably spaced (Bisness, 2020; World, 2020). Emerging technology applications in potatoes take care of the sensitivity of yield, quality to crop controls and environmental conditions, competitively using the spatial

and temporal variability of soil conditions and crop growth through geospatial IT and manage the differences more precisely, involving soil sampling techniques intensively, watching cautiously the yield, identified through soil and plant sensors for the location, time and intensity of dosage required at specifically in the field (Cambouris, et al., 2014). Precision agricultural techniques offer variable-rate applications of crop inputs that can significantly benefit the crop, the environment and the grower's bottom line, saving on agrochemicals, promoting sustainability by applying fewer chemicals just enough to meet the crop's nutrient needs, across the field, enhancing the plant performance and reduce fertilizer costs. Such applications avoid excessive nutrient levels which shoot up the risk of nutrient losses in the environment, degrade water quality and increase greenhouse gases to the atmosphere.

Various sensors and technologies for mapping in-field variations determines the better options for creating prescriptions for variable-rate applications on potato fields, using cameras to capture thermal imagery and multispectral imagery, by mounting on drones or field equipment, and mapping weeds, crop health, disease, heat emission from the soil, moisture content through yield monitors and soil moisture sensors. These applications are suitable for different options such as elevation and slope mapping using real time or instantaneous kinematics global positioning system (RTK-GPS) and radars which are enabled by lights called light detection and ranging (LIDAR), creating a digital model for mapping water flow across landscapes for identifying soil erosion and depositions (Carolyn, 2019). The size of the tuber is the vital control point, as such potatoes sized up for 45mm or up to that has more demand in the salad market, therefore use of emerging technology having a joint connection of GPS, satellite and image caught by drone to monitor the growth of potato from its plant stage till the end of burn down, supports to forecast tuber size and exact burn-down time, maximizing yields and profit margin. Observing the activities under the ground aids the result on haulm clearance by characterizing on the yield and distribution size for every cropping, thus deciding the exact date for the crops to be charred, considering the prediction of weather and the development of other crops. Thus, accurate prediction before burning down the crop delivers the customer expectations on the size and quality (Business, 2020). Remote sensing and global positioning system technologies identify the time-based differences in cropping, together with variabilities in yield and its space. Electromagnetic spectrum of visible and near infrared, hold confirmed success in evaluating the type, health, soil moisture, concentration of nitrogen and plant yield.

Progression in remote sensing methods improved the practice of multispectral imageries to control and observe plant settings, concentrations, and yield estimates. Remote sensing provides the three-dimensional and chronological land tropical features, with the ecological influences on the harvest. The vegetation measurements obtained through remote sensing on yield and biomass engage with coarse or simpler resolutions of the images obtained from the satellite, for a wider evidence on the plant cover environments and yield evaluations in measurable indices supporting the decision making of export and import across the region can be assured. Forecasting the yields is classically related with specific agronomical parameters, namely the density, potency, development, and sickness, that can affect the yield. RS also provides a close analysis of vegetal health, with the spectral reflection factor of the vegetation is reliant on the phenology, stage, and health. Normalized difference vegetation index (NDVI) improves the agile smart farming by relating the leaf area index (LAI) and the plants photosynthetic activity, it is also an indirect method to measure primary thruput by its quasi-straight-line model applying the Fraction of Absorbed Photosynthetically Active Radiation (FAPAR). TERRA MODIS pictures can evaluate potato yield, within an error tolerance of 15%, compared to that determined by real data obtained from a sample of 50 farms. Only through the use of decision support tool and return of investment prognosis, the mappings that are projected on the yield can be analyzed with spatial records for the deployment of variable rate technology (VRT) to realize a specific implementation of field-level inputs that can enhance the returns across the entire field (Al-Gaadi et al., 2016).

Emerging technology applications require parameters for controlling. Salient technology linked farming parameters are productivity, yield, income, improvised methods, market expansions, means of support impact and farm prosperity, and activity management. Productivity - Farming productivity is the proportion of farming outputs to agronomic inputs; where the output is generally considered as the economic value of the tradeable output, and discounts all transitional products in its process. Agricultural productivity is a comparative index. Further to the automations and machinery mechanizations that happened in the farming practices, it is now the role of emerging technologies that are influencing the productivity, namely the data on precisely timed climatic changes weather, fog, and rain. Implementation to emerging technologies competitively complement to assist improvements in

productivity, and farming production without much emphasize on our environment (Umachandran, 2015). Yield - It is the degree of the desired merchantable production per unit area through novelty, rigorous farming, conception of enhanced agrobusiness tools, pursuing more for amended high-yielding varieties, expansion of irrigation infrastructure modernization of management techniques, distribution of hybridized seeds, synthetic fertilizers, pesticides to farmers, and microbiological facilitations technology. Income - It is the money thus earned from carrying farming operations and the revenues from tributary byproducts of the original crop; subtracting land value, effort impacts that made the vegetation, rental payments made for any utilizations and services.

Improvised methods

This includes mobile network and connectivity bandwidths, which the agricultural marketing can leverage superior access to data and customers, progressively adding to the agriculture market facts and to time the prices, based on perishability of the produces/ products. This real time information interprets into precise capture of the demand projections and a boosted capability to regulate the process of production and accomplish the establishment of right supply chains. Market is visible and voids Monopoly or spurious market practices. Profitably closing the chain of agriculture within the constraint parameters of time, finances, and commerce. Communication channel is strengthened with producers, wholesalers, intermediaries, dealers, and small vendors. Facilitates better peer coordination and community living. Leverages economies of scale and reduces the cost of transportations, hedging with truck providers for aggregating volumes and cubicle spaces utilization, thereby achieving optimization in Logistics & Transport. Market expansions - This includes competition level fields and reaches the market on time and avoids speculative loss on pricing. Customers can budget their expenses as there is a relatively clear band of price for the commodities based quantity, quality, grades, and product presentation, thus an Open Market is evolved. Market demand and consumer trends are affected by the unique Value additions and innovative commercial practices of the sellers. Producers make more informed decisions about the choices of the customer and their needs, thereby obtaining data that focuses for more commercialization. Advantages of mobile phones in marketing, increases the diffusion of mobile networks and gadgets offered more chances to fully utilize the information, which is extensively available, facilitates agronomic markets to function proficiently, and manage the challenges.

The stakeholders can reduce their costs, profitably price the goods, and get market information to improve the value (supply) chain to fluctuating demands. It further strengthens the bond of brotherhood and fosters community living. Livelihood Impact and Rural Prosperity - This affects the investments on livelihood, prosperity for farming growth opportunities and relationships with agronomic investments is the main component of an agricultural expansion strategy. There needs to be an actual request for the commodities produced in the domestic market intended towards endurance of the agrobusiness activity. Adverse Seasons handling or combat such periods through innovative partnerships. The collaborations are enabled and constructed amid assemblages of farm producers, for qualitative straight communication with establishments and dealers, or for the capacity to distribute produces, just-in-time as per quality required. Activity Management - Knowledgeable use of inputs help agriculturalists to progress their business scalability to promote yields over recovered practices of inputs to recognize resourceful startups, get through them more competitively priced products that can be applied at the best required opportunity. Beneficial impact on larger masses happens through enhanced negotiation influence. Agriculturalists can rise their authority to bargain and exchange with dealers, only based on their skill to comprehend pricing in numerous markets, by eliminating business intermediaries, so to directly reach and sell to bulk buyers. To avail the above benefits of big data applications in agriculture the emerging technology implementation is a must, as it has a cost imperative which is an investment paying dividends on a longer run, reduced logistics and transportation costs, more cultured publicity with clear pricing, wider and grounded networks, pioneering cooperation's, conversant with input resources, enhanced farm business controls (Umachandran et al., 2017).

Conclusion

The potato is susceptible to manipulation in tissue culture. Since potato tissue is easily multiplied, it can be used extensively in the production of high-quality seed material. Meristem culture in combination with thermotherapy and / or chemotherapy is now standardly used to obtain healthy, pathogen-free potato plants. Plants in vitro can be propagated into successive plants in vitro or for microtubers production. Microtubers and micro-seedlings are planted under covers, and minitubers are obtained from them and planted in the field as pre-basic material (PBII).

The wide use of micro-propagation in conservation breeding prevents the spread of quarantine pathogens in seed production, and also enables the production of seed potatoes of potato varieties with low resistance to viruses. The aeroponic system (soilless cultivation in the air) is considered a prospective method of growing crops in terms of food safety and sustainability. This system means the cultivation of plants only in the air, without any substrate. The nutrient solution is injected into the root zone at short intervals. The greatest advantages of aeroponic systems are higher yield with optimal quality, reduced consumption of water and nutrients, operation in a closed system and safety for the environment. The aeroponic system is also an effective method of cooling the root zone and improving plant growth at higher temperatures under glass. Due to its significant advantages, the aeroponic system can be widely used in agriculture practice as well as in the production of minitubers.

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Sweet potato (*Ipomoea batatas* L. [Lam]) as an alternative to climate change in Europe

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Abstract: Climate changes in the recent period, with a tendency to increase pedological and atmospheric droughts, determine Europe to choose new plant species that can more easily withstand thermal and hydrothermal stress, because the southern part of Hungary, Romania, Slovakia, and Poland is a natural background, who favouring of significant the impact of drought on crops. The importance of growing sweet potatoes is due both to the possibility of expanding the yield in areas where potatoes are degenerating and the need to diversify the vegetable assortment with less known species but with high nutritional value that will effectively use the mesoclimatic conditions, especially in sandy soil in of Romania, or Polish. New varieties of sweet potatoes to establish profitability of their cultivation in marginal soils in south-eastern and central-eastern Europe. The high nutritional, energy, pharmacological and fodder value of sweet potato is an important subject of scientific research, not only in America, Africa, and Asia, but also in Europe under the conditions of climate change. The content of basic substances, such as carbohydrates, proteins, lipids, carotenoids, anthocyanin's, vitamins, minerals, and secondary metabolites, both in the root tubers and in sweet potato leaves, makes it a very nutritious herbaceous plant ensuring food safety for humans and animals. Sweet potato products can be effectively used as ingredients in food, medicine, cosmetics, but also as an energy base in European conditions and can compete with products imported from other continents.

Keywords: Sweet potato, Food safety, Energy value, Medicinal value, Nutritional value, Use value, Functional food, Climate changes, Mesoclimatic conditions

Introduction

Columbus in 1492 brought *Ipomoea batatas* L. (Lam.) tubers to Europe, and Portuguese explorers in the 16th century brought it to Africa, India, Southeast Asia, and East India. Spanish sweet potatoes were brought from Mexico to the Philippines in the 16th century. The introduction of sweet potatoes to the Pacific Islands apparently occurred in prehistoric times. Fossil charred sweet potato storage roots were found in northern New Zealand and were dated

about 1,000 years ago, strongly supporting the prehistoric transfer theory, possibly by Peruvian or Polynesian travelers (Zhang, Wang, Liu, and Wang, 2009, Lebot, 2019). This species was first described in Spain around 1564, and it was well known even before the potato (*Solanum tuberosum* L.) (Zhang et al. 2009). The first sweet potato clones introduced in Europe were of tropical origin and could not cope with the temperate European climate, so the species remained a botanical curiosity for decades. Soon, new, selected sweet potatoes began to be introduced into cultivation in Southern Europe and they were soon distributed around the world, where it is cultivated to this day on over 8 million hectares with an annual production of over 90 mln t (FAO, 2020). Sweet potato has a cross-breeding system and reproduces vegetative, with each variety being considered a clone. The consumption of sweet potatoes (*Ipomoea batatas* L. Lam.) In Europe is steadily increasing. *I. batatas* is a hexaploid species (2n = 6x = 90) with a basic chromosome number x = 15 (Salehi, Krochmal-Marczak, Skiba, Patra, Anil, Tripathi, Al-Snafi, Arserim-Uçar, Konovalov, Csupor, Shukla, Azmi, Mishra, Sharifi-Rad, Sawicka, Fokou, Martorell and Capasso, 2020; Shen, Xu, Li, Jin, Liu, Clements, Yang, Rao, Chen, Zhang & Zhu, 2019). The first sweet potato clones introduced into cultivation were of tropical origin and did not cope with the temperate European climate (Roullier, Benoit, McKey and Lebot, 2012a; Roullier, Kambouo, Paofa, McKey and Lebot, 2012b; Sawicka, Michałek, Pszczółkowski and Danilčenko 2018). The sweet potato propagates vegetatively, and each variety is considered a clone. The border crossing and self-compliance system maintains a high level of heterozygosity and genetic diversity (Roullier, Duputié, Wennekes, Benoit, Manuel, Rossel, Tay, McKey and Lebot, 2012c; Lebot, 2019). In recent decades, improved varieties have been introduced in Europe (from Georgia, North Carolina, Louisiana, Israel, Ireland, or the USA). However, they are characterized by a low dry matter content, rich in sugars, which, although meeting the requirements of the American market, is not to the liking of European consumers. Sweet potato is already grown in many European countries, including Portugal (24,000 t), Spain (14,000 t), Italy (13,000 t), Greece (4,000 t) and France (over 5,000 t) (Lebot, 2019, FAO, 2020). This is important not only for South-Western Europe, but also for Central and Eastern Europe, where the demand for safe, gluten-free food and a vegetarian diet is constantly growing. So, there was an opportunity to diversify crops in this region of Europe.

The EU market is valued at over 350 million euros, with over 300 000 tons of imported sweet potatoes per year. The demand for sweet potato in this region of the world is growing by as much as 12% per year (FAO, 2020), while the consumption of sweet potato per capita in Europe is still low. The use of sweet potatoes is becoming widespread, and their popularity is steadily increasing, leading to an increasing demand for both fresh and processed consumer products. There is therefore a need for genotyping and morphological characterization of commercial varieties that should be performed in different countries in order to identify duplicate sweet potato clones known by different names. *I. batatas* viruses can be established and transmitted between cultivation cycles by stalk cuttings or slips (shoots grown from ripe sweet potatoes) used as planting material. These viruses are transmitted from one plant to another by sap-sucking insects such as aphids. Over the years, many European farmers have imported planting material as seedlings directly from abroad without serious control. This species is a very efficient "carbon sink" and can produce up to 50 t ha^{-1} of fresh root tubers in good conditions in five months of vegetation, practically without the use of herbicides, thanks to the fast vegetative soil cover (Mwanga, Andrade, Carey, Niski, Yencho & Gruneberg, 2017). However, routine tests are possible to test the health of the materials in commercial nurseries prior to using the cuttings for propagation. PCR is a more sensitive and specific method of detecting these viruses compared to conventional tests or ELISAs (Lebot, 2019). Variety selection in Europe aims to identify genotypes adapted to long days and summer droughts, especially in organic farming systems. Sweet potato produces significantly more energy per day than wheat or rice, while requiring less water (Manners and van Etten, 2018). Hence, in this review attention was paid to the adaptation of sweet potato to the weather conditions prevailing in south-eastern and central-eastern Europe. The aim of the study was also to summarize the existing knowledge about the health benefits of sweet potato, as well as to determine the possibilities of using this species in the production of functional food. A better understanding of the relationship between the genetics of sweet potatoes and their adaptation to Europe's diverse environments will yield forms suitable for field cultivation.

Materials and methods

Database. The following databases like: Cochrane, Google Scholar, PubMed, ProQuest, ScienceDirect, and Semantic Scholar were searched using key terms such as: "antibacterial effect", "anti-diabetic", "anticarcinogenic effect", "antioxidant effect", "antifungal effect", "hepatoprotective effect", "climate changes", "type 2 diabetes", "food

energy value", "functional food", "food safety", "medicinal value", mesoclimatic conditions "," nutritional value " , "use value", "carbohydrates", "bioactive compounds", "natural compounds", "antidiabetic compounds", "health". **Admission Criteria**. Scientific studies (in silico, in vitro and in vivo) using various research models, such as human cell lines and laboratory animals, have reported that bioactive sweet potato compounds have health effects, including on type 2 diabetes, were analyzed. only in English, but also in other languages, so as not to limit the scope of the work. In addition, a manual search was performed to locate previous articles based on references to already published narrative articles and systematic review articles.

Exclusion criteria. All studies that looked at other types of diabetes were excluded. Presentations, letters to the editor, unpublished data and theses were excluded. Search results were limited to original scientific articles published between 1990 and 2021. Duplicate articles from different databases were searched and only one was kept. Data on the effects of climate change and its impact on the yield and quality of sweet potato were also extracted.

Influence of climatic and physiological factors on the yield and quality of sweet potato

A sweet potato needs an adequate supply of water during planting and for several weeks after planting. This species can tolerate moderate drought in the 2nd and 3rd month of growth, and in the 4th or 5th month it can tolerate even severe drought (Manners and van Etten 2018). In semi-dry growing conditions, the yield requires about 500 mm of water for a period of 4 months. Assuming the average yield of root tubers for storage on the level 30 t ha-1, with 33% DM of tubers for storage. This corresponds to a water requirement of 500 dm kg^{-1}, which is much lower than that of rice, which requires 1600 dm kg^{-1} DM or wheat (900 dm kg^{-1} DM) (Manners & van Etten 2018; Krochmal-Marczak, Sawicka, Bienia & Otekunrin, 2020a). Under conditions of high water stress, the relative water content of the leaves decreases and the leaves wilt, while their water potential decreases and the leaves age rapidly. However, in the early stages of drought, sweet potato returns to the turgor after wilting, but there are large differences between cultivars in response to water shortage during vegetation. The relative content of free amino acids, soluble sugars, ATP, and chlorophyll a / b is positively correlated with drought tolerance (Zhang et al., 2009; Roullier, Rossel, Tay, Mckey & Lebot, 2011; Manners & van Etten, 2018; Sawicka et al., 2018). In *I. batatas plants*, drought increases water use efficiency (WUE), thus minimizing evapotranspiration by reducing photosynthesis regulation, leading to biomass loss (Agarwal, Aponte-Mellado, Premkumar, Shaman, and Gupta, 2012; Gouveia, Ganança, De Nóbrega, De Freitas, Lebot, & Carvalho, De. 2019a, Gouveia, Ganança, Slaski, Lebot & Pinheiro de Carvalho 2019b, Gouveia, Ganança, Lebot, Pinheiro de 2020, Krochmal-Marczak, Krochmal-Marczak, Kiełtyka-Dadasiewicz, Sawicka, 2019a, Krochmal-Marczak, Sawicka, Michałek, 2019b). Sawicka et al. (2018), Gouveia et al., (2019b, 2020) suggests a drought avoidance strategy. The characteristics of the canopy are therefore crucial. Crop growth rate (CGR), net assimilation rate (NAR) and leaf area index (LAI) depend on the phenotypic variability of the cultivars. After planting, the LAI grows rapidly and then gradually decreases, but usually remains above 4.0 in the second half of the crop (Sawicka et al., 2018).

Average air temperature and solar radiation are considered to be the main climatic factors influencing the CGR (Krochmal-Marczak & Sawicka 2006). In the first half of the sweet potato development cycle, DM production depends on the size of the LAI, and these are closely related to air temperature. In the second half of the cycle, DM production and the root tuber growth rate depend on the NAR value and their relationship to solar radiation. The growth rate of storage roots is significantly influenced by solar radiation through NAR and CGR, of course when the LAI is above the optimal value (Sawicka et al. 2018). The canopy type may also have an impact on the net assimilation coefficient of sweet potato cultivars (Lebot, 2019). The taller varieties usually have an efficient photosynthetic surface and give a high yield of tubers in a relatively short time (Sawicka et al., 2018; Krochmal-Marczak et al., 2019b).

The factors that modify the photosynthetic surface are the length of the stem and the number of leaves per stem length unit. Some varieties with only small canopies, a short stem and small leaves may yield higher yields than those with long stems and broad leaves (Lebot, Michalet & Legendre, 2016). Identification and quantification of phenolic compounds responsible for the antioxidant activity of sweet potatoes with different flesh colors using high performance thin layer chromatography (HPTLC) (Krochmal-Marczak et al. 2019a). Varieties with short internodes produce short stems and a large photosynthetic surface in a small area and are more productive than the scattered,

long internode varieties (Lebot 2019; Sawicka et al., 2018). On the other hand, varieties with small canopies showed a positive reaction to tuber storage. The efficiency of DM and the effective growth of DM in their roots is important (Lebot, 2019). At harvest time, sweet potato root tubers are exposed to a variety of fungal, bacterial and insect pests; the most serious is the sweet potato retractor (Cylas formicarius, Coleoptera: Brentidae). Sweet potato growers have tried to identify compounds in the storage root periderm that could inhibit the growth of fungi or bacteria or act as a natural deterrent to weevil weevils to contribute to the development of resistant cultivars (Krochmal-Marczak, Krochmal-Marczak, Sawicka, Krzysztofik, Danilcenko & Jariene 2020b). Hydroxycinnamic acids (HCA) are associated with weevil resistance (Wallingford, Lebot, Abraham, Kaoh, Rogers & Molisalé 2019; Lebot 2019). Breeding of varieties with higher HCA content may be interesting (Sawicka et al. 2018, Low & Thiele 2020). The individual HCAs were also analyzed and tested in bioassays. Caffeic acid, in turn, inhibits the growth of pathogenic fungi. Its inhibitory effect suggests an effect on the thickness of the periderm. Caffeic acid levels may also help protect sweet potatoes (Jackson, Harrison, Thies & Bohac, 2011). Chlorogenic acid (CGA) and dicavoylquinic acids (DICQA) are the most important HCAs in the periderm. They may contribute to the improvement of resistance to storage root diseases. CGA has also been shown to be an effective insect growth repellent (Wallingford et al., 2019, Krochmal-Marczak et al. 2020b). Scopolamine and scopoline (its glycoside) were analyzed both in the periderm and cortex tissues. Tested in vitro on various species of fungi, they inhibited their growth. Scopolamine and scopoline concentrations may be useful chemical markers, especially useful in the cultivation of sweet potato varieties with resistance to root diseases (Wallingford et al., 2019; Low & Thiele 2020). For both HCA and coumarin, there is a need to test their bioactivity on a wider spectrum of pathogenic fungal species and sweet potato insect pests in Europe. The content of these bioactive compounds could be increased by conventional breeding (Low & Thiele, 2020), an analytical technique could screen numerous hybrids to select those with the highest content for selection. High-performance thin layer chromatography (HPTLC) is a powerful high-throughput analysis tool. It was used in the studies by Lebot et al. (2016), who to analyse nearly 300 sweet potato varieties and secondary metabolites in the periderm.

For sweet potato consumers, however, the taste criteria are the most important for the registration of new varieties. A breeding program was developed and carried out to breed sweet potato varieties rich in secondary metabolites (Lebot, 2012; Low & Thiele, 2020; Moyo, Ssali, Namanda, Nakitto, Dery, Akansake, Adjebeng-Danquah, van Etten, de Sousa, Lindqvist-Kreuze, Carey & Muzhingi, 2021). It turned out that the purple-flesh varieties are very rich in DICQA (Lebot et al., 2016). The varieties with orange flesh, on the other hand, contain more carotenoids than varieties with white or cream-colored tuber flesh. Sugar-free varieties have also been identified. The sweetness of tuber flesh comes from the content of maltose resulting from the hydrolysis of starch and beta-amylase during baking (Lebot, 2017). A positive correlation was also found between starch and dry matter content, and a negative correlation between starch content and protein, minerals, fiber, and sugars. Orange-colored varieties tend to contain more carotenoids than white or cream-colored varieties. Consumers, on the other hand, prefer varieties rich in starch and dry matter (Moyo et al., 2021).

Chemical composition

Ipomoea batatas, due to the high nutritional value of tubers, is becoming an increasingly popular vegetable among consumers in Poland (Sawicka, Pszczółkowski and Krochmal-Marczak, 2004, Sawicka & Krochmal-Marczak 2006, Sawicka, Pszczółkowski, Krochmal-Marczak, Barbaś and Özdemir 2020; Krochmal-Marczak & Sawicka, 2013, 2015; Krochmal-Marczak, Sawicka, Słupski, Cybulak, & Paradowska, 2014; Krochmal-Marczak et al., 2020a). Tubers of this species contain 21.51-34.36% dry matter, including about 14% starch, over 5% sugars; 3-8% protein, 0.6-0.9% crude fiber, 1% crude fat and vitamins: B1, B2, PP, C, as well as small amounts of β-carotene and secondary metabolites (Sawicka et al., 2004; Sawicka et al., 2020a; USDA, 2018). The nutritional value of sweet potato tubers is about 50% higher than that of potato tubers (Sawicka et al. 2004, Krochmal-Marczak et al., 2014, Cartabiano-Leite, Porcu, and de Casas 2020). Tubers and leaves of I. batatas can also be an excellent raw material for food processing, due to their very rich chemical composition, especially processing specializing in the production of nutrients for young children and infants, as well as in baked, fried, or candied products (Krochmal-Marczak et al., 2013; Krochmal-Marczak & Sawicka, 2015).

Sweet potato leaves contain approx. 12.2% dry weight, including approx. 4% protein, B vitamins, β-carotene, and vitamin C (approx. 11 mg / 100 g fresh weight), they are also an excellent source of lutein (Krochmal-Marczak et al. 2019b). The nutritional value of 100 grams of raw leaves is estimated to be 35 Kcal (147 KJ) with significant amounts of mineral salts, especially calcium, phosphorus, and potassium. The Ca: P ratio in the leaves is 0.4: 1. (USDA 2018). Young sweet potato leaves are used in Taiwanese cuisine and in West African countries (Guinea, Sierra Leone, and Liberia), as well as in Northeast Uganda and East Africa as a vegetable and spice (Zhang et al. 2009, Lebot, 2010). Due to the high content of soluble sugars, sweet potato can serve as an easily digestible food for children and an excellent food for diabetics (Allen et al., 2012; Krochmal-Marczak et al., 2014; Krochmal-Marczak & Sawicka, 2015; Sawicka et al., 2020a). *I. batatas* should be considered a raw material for the production of functional foods to aid in the treatment of metabolic diseases such as type 2 diabetes (Sawicka et al., 2020). It is also a valuable medicinal plant with anti-cancer, anti-diabetic and anti-inflammatory properties and can be used as a raw material for the pharmaceutical industry, but it can also be used to enrich the daily diet. The sweet potato is a staple variety with a high nutrient content and higher energy value than potato, and is modeled to thrive on all continents. This species was clonally introduced in Europe, so its genetic base is narrow (Mwanga et al., 2017; Lebot, 2019). In order to breed varieties adapted to the new environment, in the conditions of climate change, resistant to diseases and pests and various market needs, it is necessary to extend the genetic basis of the propagating material. This proposal brings together scientists working with agronomists, breeders, physiologists, private sector producers in France, Germany, Poland, and Romania, and possibly also in other European countries. The integrated approach will add value to varieties, especially as functional foods, and their use in breeding programs can be promoted. Low and Thiele (2020) concluded that the development and growth of Orange Flesh Sweet Potato (OFSP) varieties over the past 25 years is a groundbreaking innovation in sweet potato breeding to address the urgent need for high levels of vitamin A among children under five. years of age in sub-Saharan Africa. When this innovation was introduced, consumers strongly preferred white or yellow-flesh sweet potatoes, so it was necessary to create a demand to meet this need. This was contrary to the overall breeding strategy of responding to consumer demands. An additional element of this innovation was also nutritional education, aimed at educating consumers about the significant health benefits of Orange Flesh Varieties (OFSP). These efforts will focus on sharing increased genotypic and phenotypic information using new data processing tools.

Sweet potato as functional food

In recent years, functional food has become more and more popular all over the world, which has an additional, documented impact on human health. This food helps to reduce the risk of developing civilization diseases, such as obesity, diabetes, cardiovascular diseases, and cancer. One of the ways to prevent these diseases is food enriched with various bioactive ingredients, incl. vitamins, minerals, polyunsaturated fatty acids, which reduces the risk of developing civilization diseases (Lebot, 2012, 2019; Malapa & Jung, 2013; Krochmal-Marczak, Krochmal-Marczak, Sawicka & Tobiasz-Salach, 2018; Krochmal-Marczak et al., 2019 a, 2020a, 2020b). For example, essential amino acids, present in tubers, in appropriate amounts, contribute to the maintenance of the water balance and the regulation of fluid content in the circulatory system and in intra- and extracellular spaces. Due to the buffering properties of proteins, after consumption, they participate in maintaining the acid-base balance (Sawicka et al., 2004; Krochmal-Marczak et al., 2014, 2020b). Insoluble fiber contained in sweet potato tubers can prevent constipation, diverticulosis, hemorrhoids, and obesity. As a food additive, it can slow down the absorption of glucose and cause a feeling of fullness. Soluble pectin's maintain normal blood cholesterol levels, and soluble fiber helps to reduce LDL cholesterol levels, which is very beneficial for diabetics as they are at increased risk of coronary heart disease (Ayon, Islam & Hossain, 2020). Due to the content of vitamin C, provitamin A, thiamine, riboflavin, niacin, pantothenic acid, vitamin B6, folate, choline, α- and β-tocopherol and vitamin K, sweet potato tubers can prevent: blindness and degenerative eye diseases (Sawicka et al., 2018). β-carotene may support the treatment of certain cancers (stomach, pancreas, mouth, and gums), prevent macular degeneration, improve vision in the dark, increase milk secretion in breastfeeding women, detoxify the body, heal diarrhea, regenerate damaged skin (Krochmal-Marczak & Sawicka, 2015). In addition, β-carotene reduces the risk of type 2 diabetes and contributes to changes in cholesterol fractions - lowering LDL and increasing HDL, as well as reducing the risk of cardiovascular diseases (Low & Thiele, 2020).

The World Cancer Research Foundation, together with the American Cancer Research Institute, indicates that there is a link between β-carotene consumption and the development of esophageal cancer. In turn, chlorogenic acid has antitumor and antiviral properties, and caffeic acid is effective in combating cancer and HIV. Lutein and zeaxanthin are involved in the prevention of atherosclerosis, certain cancers, and eye diseases (Krochmal-Marczak & Sawicka 2013b, Sawicka et al., 2018; Low & Thiele, 2020). Potassium in sweet potato tubers helps to reduce blood pressure and thus minimizes the risk of coronary heart disease. Vitamin B6 prevents heart disease, strokes, depression, and insomnia, while vitamin C strengthens immunity and enhances wound healing (Roullier et al. 2011, 2019). Phytosterols in *I. batatas* tubers lower high cholesterol and may also reduce the risk of cancer by binding to potentially carcinogenic agents in the gastrointestinal tract. In addition to the edible root tuber, the sweet potato also has edible leaves and aerial shoots. The leaves can be used to make infusions for the treatment of type 2 diabetes and inflammation of the mouth. Sweet potato leaves are used in the treatment of the prostate (Sawicka et al. 2018). They contain a number of minerals, such as: Ca, P, Mg, Na, K, S, Fe, Cu, Zn, Mn, Al and Se, and in this respect they are comparable to spinach. The level of iron, calcium and carotenes is among the best vegetables (Krochmal-Marczak & Sawicka, 2013b; Lebot et al. 2013; USDA, 2018). Sweet potato leaves are also rich in protein, vitamins such as: vitamin B and A (Krochmal-Marczak & Sawicka, 2015). There are also fatty acids in the sweet potato leaves. Monounsaturated fatty acids, found in this part of the plant, reduce the concentration of the so-called "Bad" cholesterol (LDL) (Ayon et al., 2020, Low & Thiele 2020). As a result, they have a protective effect on the artery wall and reduce the risk of atherosclerosis. It has been shown that replacing saturated mono- or polyunsaturated fatty acids reduces the level of total cholesterol and LDL cholesterol in the blood serum. In addition, monounsaturated fatty acids do not lower HDL cholesterol and do not affect the level of triglycerides (Low & Thiele, 2020). The polyunsaturated fatty acids in the aerial parts of this plant, such as linoleic acid (omega 6) and α-linolenic acid (omega 3), must be supplied with food, as they are essential for the proper development of young organisms and the health of adults. They are also used to create prostaglandins (tissue hormones) that affect cardiovascular function, digestion, and many other processes. They lower cholesterol and reduce the aggregation of platelets, thus preventing the formation of blood clots and atherosclerosis (Krochmal-Marczak & Sawicka, 2013b, 2015; Low & Thiele, 2020).

Functional food, in addition to the traditional nutritional function, has an additional, documented, beneficial effect on human health. Consuming it allows you to reduce the risk of developing many civilization diseases, such as obesity, diabetes, skin diseases, diseases of the cardiovascular system, and cancer. Such a raw material used for the production of functional food may be sweet potato (*I. batatas*). "Functional food", apart from its conventional meaning, must have a beneficial effect on the human body in amounts that are expected to be respected with a diet; however, they cannot be tablets or drops, but an integral part of the correct food (Mwanga et al., 2017; Sawicka et al., 2018; Krochmal-Marczak, 2019a). Over the last decade, the traditional perception of sweet potato has changed, and it is now recognized that sweet potato has enormous potential to contribute to the alleviation of malnutrition and hunger in developing countries. Orange-flesh sweet potato in particular, with a high content of provitamin A, has become an outstanding example of the effectiveness of biofortified primary crops in combating vitamin A deficiency, not only in sub-Saharan Africa, however, has a significant research deficit in the Europe, hence, it is an important candidate for additional, innovative research and investment.

Added value to European research and innovation

The added value of sweet potato research is giving Europe access to a broad genetic base and building partnerships through a network of research institutes and universities focusing on organic farming systems. New pest and disease resistant genotypes of I. batatas must be obtained. This will allow the selection of genotypes with maximum allelic diversity to be introduced in populations with high starch content, with low in sugar, high in carotenes and high in phenols. Therefore, there is a chance to select varieties in terms of the variability of their main compounds, as well as secondary metabolites, enabling the identification of potential parents with outstanding features for breeding programs. There is also the possibility of increasing the potential yield of sweet potato, which will be the basis for favoring European varieties over imported ones, leading to an improvement of the varieties for current and future climate change.

Conclusion

Sweet potatoes are highly heterozygous, and selection and replacement of elite varieties will provide sufficient variety. The best genotypes of I. batatas should be selected as raw materials for the production of functional food, on the basis of their chemical composition, according to criteria defined by both producers, consumers, and end-users in the food chain. The distribution of varieties will have a direct impact on the biodiversity of sweet potato. The introduced varieties will directly contribute to increasing the productivity and economic effects in conventional and ecological agricultural systems. This will increase the availability of raw material for a variety of high-quality products, with increased health benefits for consumers and greater economic benefits for producers by creating new functional products and new markets, and in the long term - a steady return on investment (Lebot 2019). Sweet potatoes can be used to fill marginal areas. The international exchange of germplasm can make a direct contribution to the FAO Treaty and Nagoya Protocol (FAO 2020). The transfer of technology and information on germplasm will create a lasting partnership for the conservation of genetic resources and apply to breeding programs. This will help to strengthen the various links between research, the implementation of innovative technologies and the private sector.

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COVID-19 Identification Based on Keras DenseNet201 Architecture Model Using CT Image

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Abstract: Coronavirus illness 2019 (COVID-19) is a spreading sickness produce by the new Coronavirus named serious basic respiratory disorder Covid 2 (SARS-CoV-2). It has been widely increased worldwide after all the beginning of 2020. many Deep Learning (DL) has been demonstrated for classification, segmentation, and detection takes in medical imaging. The principal investigation in this paper, we applying keras DenseNet-201 transfer learning prototype to classify and eventually obtain an empirical and realistic computer-aided symptomatic prototype. In this inspection, we removed the noises from the computed tomography (CT) images into build a new data source, then used the customize keras DenseNet-201 mould construct on transfer learning to bring out features frequently, and exercised softmax activation classifier to codify the CT images. The model is evaluated dataset from COVID-19-CT Database. Examinations are made across 746 CT figures.in the dataset, contain 349 CT images of patients with COVID-19 and 379 CT images for non-COVID-19. The classification model shows around 90.94% testing accuracy. Comparatively, this approach obtains high precision rate rather than other propose methods which are predicted to use small size of dataset samples.

Keywords: COVID-19, Database, Deep Learning, DenseNet-201, Keras, SARS-CoV-2

Introduction

The World Health Organization (WHO) has declared the Covid disease 2019 (COVID-19) a pandemic. On 31 December 2019, an assortment of instances of pneumonia of stowed away reason, in the city of Wuhan, Hubei area in China, was accounted for to the World Health Organization (Lowe, 2020). In January 2020, a previous secret new infection was bring up, along these lines named the 2019 novel Covid, and trails gained from case and assessments of the infection's hereditary qualities demonstrated that this was the reason for the flare-up. This novel Covid was named Coronavirus Disease 2019 (COVID-19) by WHO in February 2020.The infection is address to as SARS-CoV-2 and the connected illness is COVID-19. Matured individuals and those with hidden ailments like cardiovascular infection, diabetes, persistent respiratory sickness, or malignant growth are bound to foster genuine ailment. Different testing techniques have been extended to analyze the sickness. The standard indicative technique is by distinguishing proof of the infection's nucleic corrosive by constant opposite record polymerase chain response (rRT-PCR), record interceded intensification (TMA), or by invert record circle intervened isothermal enhancement (RT-LAMP) from a nasopharyngeal swab (Zhang, 2020). Your lungs may become kindled, making it intense for you to relax. This can prompt pneumonia, a disease of the minuscule air sacs (called alveoli) inside your lungs where your blood trade oxygen and carbon dioxide. In case your primary care physician does a CT sweep of your chest, they'll perhaps see shadows or inconsistent regions called "ground-glass murkiness." For some individuals, the side effects end with an oversee and a fever. More than 8 out of 10 patients are gentle. Be that as it may, for few, the confusion

gets more genuine. Around 5 to 8 days after manifestations start, they have succinctness of breath (known as dyspnea). Intense respiratory intense lung injury (ARDS) dispatches into a couple of days after the fact (Ozturk, 2020).

Figure 1: Non Covid

Figure 2: Covid.

Non Covid and Covid images are shown in "Figure 1" and "Figure 2".

There is a shortage of experienced doctors to perform the medical examination of the increasing number of patients every day. clinical reported that about 15% to 40 % of covid-19 patients are wrongly identify as non covid-19.In this paper we have proposed an automatic method to detect covid-19 on the geometric structure of the covid-19 chest CT image sample. To discriminate the geometric structure of the covid-19 and non-covid-19 figures, we have used the Keras DenseNet-201 transfer learning model to classify covid-19 images.

Literature review

In the beyond couple of years, incited by the appeal for fast clarification of chest X-beam pictures, numerous scientists look for help from profound learning models to determine cases tainted to have COVID-19 (Hemdan, 2020 ; Apostolopoulos, 2020). L. Wang has proposed COVID-Net with a profound CNN intended to group COVID-19 contamination, pneumonia viral, pneumonia bacterial, and ordinary (non-COVID19 disease) X-beam figuring datasets (Wang, 2020). Coronavirus Net accomplishes a general exactness of 83.5% for a (Fang, 2020). Another agent, Clinicians and radiologists can likewise peruse and dissected CT irregularities to perceive specific trademark optical property in the lungs identified with COVID-19, for example, the respective and furthest ground-glass darkness (GGO) in the unfavourable and the aspiratory solidification haziness in the late stage (Toussie, 2020 ; Ai , 2020). X. Xu et al has set up an early screening model to change COVID-19 from pneumonia and sound cases utilizing 618 aspiratory CT tests and arrived at an absolute precision of 86.7% (Xu, 2020).

There is further wonderful organization design adjustment which have yielded forceful outcomes. The Network in Network (NIN) development contain miniature multi-facet perceptron into the channels of convolutional layers to take out more mind boggling highlights (Lin, 2014). In Deeply Supervised Network (DSN), inside layers are straitly regulated by assistant classifiers, which can fortify the inclinations gathered by before layers (Lee, 2015). Stepping stool Networks bring sidelong associations into auto encoders) delivering forcing exactness on semi-administered learning assignments (Pezeshki, 2016 ; Rasmus, 2015). In, Deeply-Fused Nets (DFNs) were proposed to further develop knowledge stream by combining transitional layers of went against base organizations (Wang, 2016). The increase of organizations with pathways that limit update misfortunes was likewise displayed to more readily picture order model.

Methodology

Data augmentation

We randomly select 242 images for full of covid-19 areas and 280 images for non-covid-19 areas for training set and 55,57 images are covid-19 and non-covid images for validation set respectively. It has come from chest COVID-19-CT Database (WebMD, 2020). We were removed noises from original CT images and resize the image into 224 × 224 pixels, without losing any information. we used these images as sample data for our classification model. As the images do not have any labels, we created label for covid-19 images as "COVID" and non-covid images as "NonCOVID". Samples associated with the labels are shown in "Figure 4".

In this investigation, we have used 70 percent of the trails (522) for teaching, 15 present of the trials (112) are going to validation and the remaining 15 percent of the samples (112) are used for testing. Due to the model input purpose, after all the CT image samples were taken from varies sources, they have differing sizes between 124 × 153 and 1485 × 1853 so we have resized to 224 × 224 pixels, therefore the input sample lose a significant amount of information.

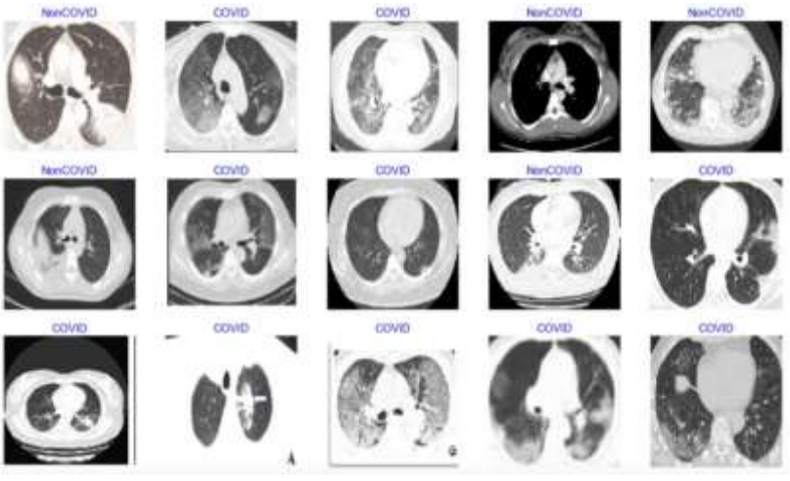

Figure 4: Example samples with labels.

Transfer learning

Transfer learning is about purchase feature rendition from a pre-trained model, so we don't have to train a new pattern from abrade. The pre-trained exemplar is normally trained on vast datasets that are a quality criterion in the computer vision boundary. The weights achieve from the models can be restate in other computer vision tasks. These prototypes can be used straitly in manufacturing predictions on new duty or unsegregated into the presses of training a new exemplar (Mwiti, 2017). Including the pre-trained models in a new model leads to bottom training time and lower generalization fault. It is especially very helpful when we have a small size training dataset. In our examination, we have very small dataset. therefore, this transfer learning approach is best chaise for training the model. In this case, we can, use the weights from the pre-trained models to ready the weights of the new prototype. Fine-tuning is a compulsory step in transfer learning. It will generally upgrade the performance of the mode (Bae, 2012).

Densenet201

DenseNet-201 is a convolutional neural organization (CNN) that is 201 layers profound. You can charge a pre-trained rendition of the organization prepared on in excess of 1,000,000 figures from the ImageNet information base. The pre-trained organization can order pictures into 1000 article classification, like console, mouse, pencil, and numerous creatures. As an end, the organization has read up rich element portrayals for a mesh verity of pictures. The organization has a picture input size of 224-by-224 (Mathwork, 2018).

DenseNet-201 is one of the new discoveries in neural networks for visual object recognition. Convolutional organizations can be extensively more profound, more awesome, and efficient to prepare on the off chance that they hold more limited connections between layers near the info and those close to the result. In this paper, we invite this checking and set up the Dense Convolutional Network (DenseNet), which append each layer to each and every layer in a feed-forward style. While customary convolutional networks with L layers have L interrelation - one between each layer and its next layer - our organization has L (L+1)/2 straight associations. For each layer, the component guides of all past layers are applied as data sources, and its own element maps are worked as contributions to every single resulting layer. DenseNets-201 have grouped engrossing command: they decrease the evaporating angle issue, fortify component spread, empower highlight reuse, and extensively lessen the quantity of boundaries. We evaluate our recommend engineering on four amazingly forceful item acknowledgment benchmark undertakings (CIFAR-10, CIFAR-100, SVHN, and ImageNet). DenseNets-201 stop by huge update over the cutting edge on a large number of them, while requiring less memory and estimation to achieve high execution (WebMD, 2020). Sample of prediction shown in "Figure 3". Below figure, described input images as a CT image and output as a text message. this massage

is covid or non-covid.

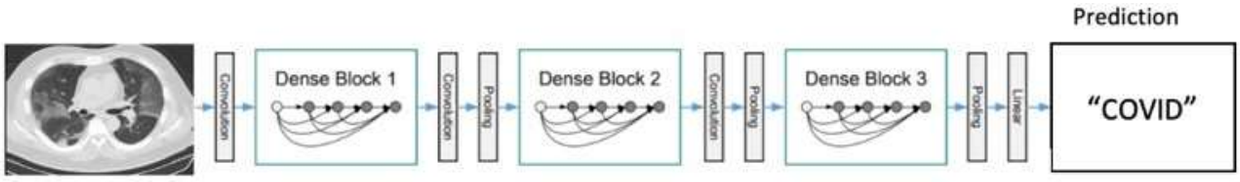

Figure 3: Example of prediction route for sample.

Modify DenseNets-201 Network

Our objective was to classify into two classes. We used Keras open-source software library. Keras acts as an interface for the TensorFlow library The final layers of the original network were modified by removing the last layer and add four layers. As one fully connected layer is not enough to generate a single linear unit (commonly known as ReLU) (Lee, 2015). First Add layer that standardizes its bits of feedbacks. Clump standardization applies a change that keeps up with the mean result near 0 and the result standard deviation close to 0. In the array normalization arguments, we set axis value is 1, momentum value is 0.99 and epsilon value is 0.001 (Wang, 2016). second, add Dense layer with dimensionality of the output space value is 128, kernel_regularizer assigned estimate the mean of the data to avoid overfitting with penalty value is 0.008, activity_regularizer allocated estimate the mean of the data with penalty value is 0.006, bias_regularizer distributed estimate the mean of the data with penalty value is 0.006 and activation is "relu". Third layer, we added dropout layer with a dropout rate of 40% while the training process. Finally, the fully connected layer outputs the predicted sequence with "softmax" activation. The structural diagram of the DenseNets-201 model is appear in "Figure 5".

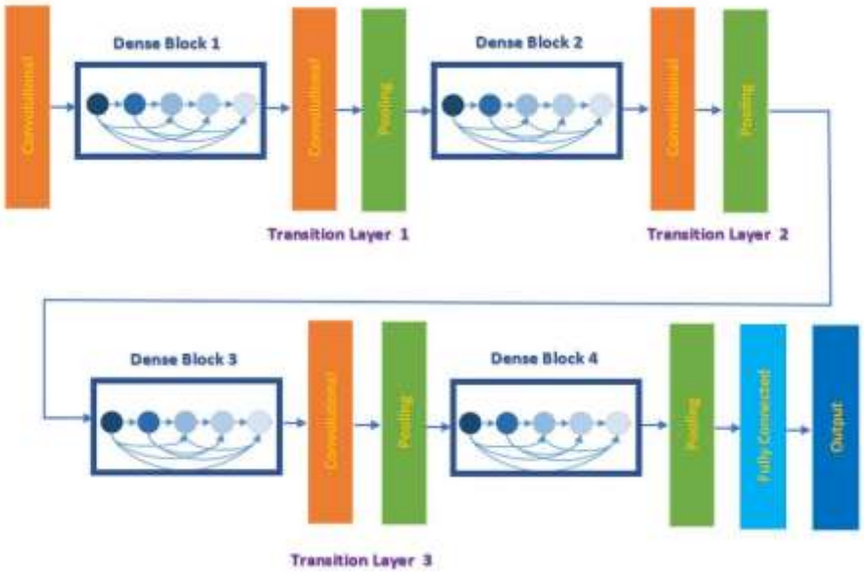

Figure 5: The structural diagram of the DenseNets-201 model.

Experiments and Results

Data description

In this evaluation, we have utilized the COVID19-CT dataset. The dataset comprises absolutely of 746 chest CT pictures. There are 349 chest CT pictures of patients with COVID-19 and 397 chest CT pictures showing non-COVID-19, however other aspiratory infections. The positive CT pictures were gathered from preprints about COVID-19 on medRxiv and bioRxiv, and they include different appearances of COVID-19. Since the chest CT pictures were taken from various sources, they have shifting sizes between 124 × 153 and 1485 × 1853.

Metrices for Assessment

In clinical expression, valuable implies that the patient has Coronavirus sores, while genuine positive (TP) implies that patients with Coronavirus sores are inspected by a pre-characterized test broadcast strategy, and they are appropriately named as Coronavirus sores. Bogus positive (FP) is characterized as clinical misdiagnosis of a patient non-Coronavirus sores who are wrongly named as tolerant non-Coronavirus injuries who are erroneously named as a patient with Coronavirus sores, which result in clinical misidentify. Negative implies that the patient is non-Coronavirus, and genuine negative (TN) is the patient non-Coronavirus injuries and is anticipated as non-Coronavirus. Bogus negative (FN) is characterized as a state wherein a patient with a Coronavirus sore is named as a Coronavirus test, which is a place that causes disregarded analysis. The accuracy and review are communicated as. The precision and recall are expressed as:

$$\textbf{Pression} = TP/(TP+FP) \quad (1)$$

$$\textbf{Recall} = TP/(TP+FN) \quad (2)$$

The overall accuracy (AC) is calculated using Eq. (3).

$$\textbf{AC} = (TP+TN)/(TP+TN+FP+FN) \quad (3)$$

The F1- Score is calculated according to the upcoming equation:

$$\textbf{F1 – score} = 2 \times (\text{precision} \times \text{recall})/(\text{precision} - \text{recall}) \quad (4)$$

$$\textbf{PrecisionMacroAvg} = ((Prec1+Prec2+\cdots+Precn))/n \quad (5)$$

$$\textbf{RecallMacroAvg} = ((Recall1+Recall2+\cdots+Recalln))/n \quad (6)$$

$$\textbf{Weighted Avg} = ((x1w1+x2w2+\cdots+xnwn)\ )/((w1+w2+\cdots wn)) \quad (7)$$

Training method

The prototype is instructed for 25 epochs with a batch size of 32. We have used Adam optimizer with a learning estimate of (1e-3) and categorical cross entropy loss (Singhal, 2018). we were applied Freeze the second layer using layer2.trainable false. The learning rate is decreased after every five epochs by factor of 0.5. The training and validation loss and accuracy of the model are show in “Figure. 6” and “Figure. 7”.

Result and discussion

In the experiment of Covid-19 identification with Chest CT image augmentation COVID19-CT database images based on Keras DenseNet-201 model for transfer learning, we fine tune the parameters learning rate and freeze layer on many occasions and input the attributes extract from DenseNet-201 prototype in to Sofmax classifiers for classification. We have tested on 78 samples from 112 test images. 36 images for covid and 38 images for non-covid. The model shows 90.94 % testing accuracy for this dataset. At last, the exploratory aftereffects of accuracy, review, F1-Score, support, normal, full scale normal and weighted normal are displayed in the Table I. Precision for covid and non-covid percentage are 83% and 100% sequentially. Moreover, the confusion matrix of DenseNet-201 model for results is shown in “Figure. 8”. we have covid and non-covid images are 36 and 38 respectively. Horizontal axis constitutes as guessed label (Covid, NonCovid) and vertical axis denoted as accurate label (NonCovid, Covid). In the testing, it was correctly identified 36 non-covid images (TN) and misidentify 10 covid images (FN) into non-covid image out of total samples. 28 covid images are correctly identified as covid (TP) and none of the images are wrongly identified as non-covid (FP) for whole testing samples. The computational time for model takes around 40 to 49 seconds processing time per each during training and only 18 seconds for testing of 74 samples. In this process, used Jupyter notebook as editor tool interface and python for coding language. Operating system is Mac OX.

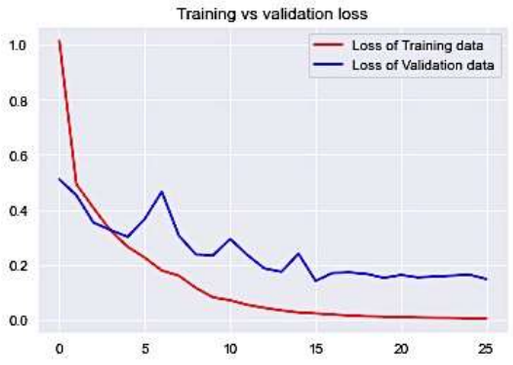

Figure 6: Training and validation loss.

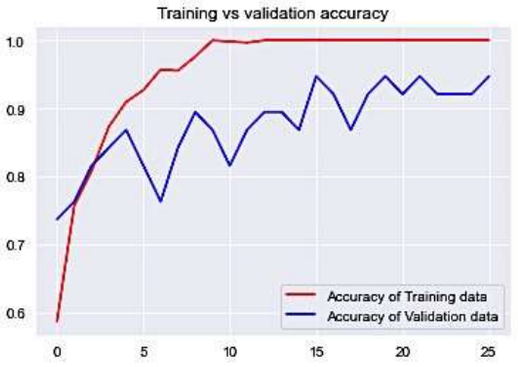

Figure 7: Training and validation accuracy.

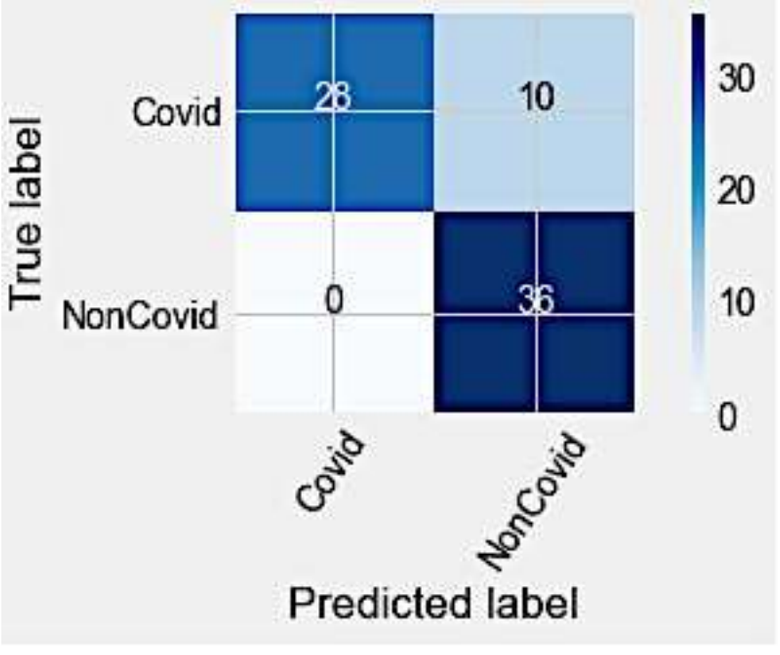

Figure 8: Confusion Matrix for covid and non-covid.

Table 1: The precision, recall, and F1 – score for covid-19 classification

Title	Precision	Recall	F1- Score	Support
Covid	0.83	1.00	0.97	36
Non Covid	1.00	0.83	0.95	38
Average			0.94	74
Macro Average	0.94	0.95	0.95	74
Weighted Average	0.94	0.93	0.95	74

Conclusion

This paper proposed a method of COVID-19 chest images classification based on Keras DenseNet-201 transfer learning for chest CT figures from the COVID19-CT database. In isolated, the method of COVID-19 images classification found on emigration learning can fulfil higher accuracy. In addition, the Keras DenseNet-201 model based on transfer learning performs better in covid and non-covid Images classification on COVID19-CT Dataset. Hear we used less amount of data for training, validation and testing but this model appear higher accuracy rather than which methods are already used to identify the covid 19 for smaller dataset. The model shows 90.94% testing accuracy on 78 samples and Precision for covid and non-covid are 83 percentage and 100 percentage respectively. Moreover, this method is only for Keras DenseNet-201 architecture for covid and non-covid chest images in

COVID19-CT database to get higher performance and is unsuitable for other methods and database pictures. we will supplementarily scrutiny on increasing performance and ensemble learning with a smallest dataset in upcoming research work.

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