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Role of Innovative Technologies for Enhancing Sustainability in Higher Education of Afghanistan: A Review Paper

Abdul Baseer Safi[1*]; Hamza Atifnigar[1]

[1]*Department of English, Faculty of Language and Literature, Laghman University, Afghanistan*
[*]*Corresponding Email: Abn.safi@live.com, Phone Number: +9377 722 0910*

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Abstract

Innovative technology is a dire need of contemporary education society in bringing paradigm changes in higher education by ameliorating learning experiences, improving accessibility, and reinforcing sustainability. In Afghanistan, a country confronting different educational challenges, the application of technologies such as Adaptive Learning Technologies, Cloud Computing, Artificial Intelligence, Mobile Learning the Internet of Things, and Gamification can address such issues and contribute to the sustainable development of higher education. Hence, this paper aims to investigate the role of these technologies in the higher educational sector of Afghanistan, particularly exploring their utility, potential advantages, challenges, and implications to further support educational sustainability. To support this research, the investigators collected keywords related to the innovative and digital technologies in higher education and their effects on sustainability form different international reliable databases such as Scopus, Web of Science, Science Direct, Taylor and Francis. After critically synthesizing various research papers, it is concluded that ALT, CC, ML, IoT, AI, Blockchain, and Gamification offer promising solutions to many concurrent challenges toward higher education of Afghanistan. Finally, this provides suitable recommendations for policy makers, teachers, and higher educational institutions on the integration of these technologies to achieve sustainable education improvement in Afghanistan.

Keywords:. Adaptive Learning Technologies, Artificial Intelligence, Blockchain, Cloud Computing, Mobile Learning, Gamification.

Introduction

As the world is rapidly advancing in digital technologies in higher education has garner important attention due to their advantages to changing education practices, boosting learning outcome, and supporting sustainability goal. In such a competitive world, every university is striving to adopt technologies within their landscape thus it becomes increasingly significant to them. Such technologies such as Adaptive Learning Technologies, Cloud Computer Services, Mobile Learning, Artificial Intelligence, Blockchain, and Gamification play a significant role in developing educational processes and outcomes. Such

technologies cater novel solution to traditional education challenges and present opportunities for enhancing the efficiency, accessibility and effectiveness of higher education systems globally.

Besides the existence of some technologies such A specialize system for Kankor Exam, and Higher Education Management Information System HEMIS which are available to all universities of Afghanistan with the purposes of managing teachers', students', and managers' activities and duties. However, it is extremely important to further investigate innovative technologies and apply them within landscape of higher education of Afghanistan to further enhance sustainability. Still, Afghan public universities face different challenges such as infrastructure, different level of digital literacy, and of need for advanced education quality and accessibility. Adopting innovative technologies can address these challenges through the provision of effective solutions which in line with suitability objectives and support the development of a strong educational framework. Knowing such challenges could be effectively applied in Afghanistan's context is important for developing strategies that enhance sustainable educational practices and alleviate the overall quality of higher education in the country.

In the literature, it is underlined that different digital technologies have brought paradigm changes in higher education. However, the most effective ones are: adaptive learning technologies have offer a personalized learning experience with the provision of individual learner needs and learning paces (Dziuban et al., 2018). Cloud computing provides cost-effective and accessible solutions for data storage and computational needs, facilitating accessibility to resources and cooperation across different higher education institutions (El-Masri & Tarhini, 2017). Mobile enables flexible learning opportunities and supports sustainability (Kukulska-Hulme, 2012). Internet of Things provided students and teachers with a promising smart classroom and improved data-driven decision-making (Delande & Vanderdonckt, 2021). AI in online learning improves teaching methods and supports remote education (Li & Su, 2020). Blockchain technologies present secured and transparent data storing, addressing issues related to data integrity and certification (Tapscott & Kaplan, 2019) and gamification plays a significant role in engaging elements that encourage students' learning experiences (Deterding et al., 2011).

There is a great interest in the integration of innovative technologies across higher educational institutions around the world in terms of sustainability and educational advancement. This study investigates several technological improvements and their implication for the higher educational sector of Afghanistan, concentrating on Adaptive Learning Technology (ALT), Cloud Computer (CC), Mobile Learning (ML), IoT and Massive Open Online Learning (MOOC), Artificial Intelligence (AI), Technology Acceptance Model (TAM) and Block chain technologies.

One of the engaging tools that helps students stay motivated to learn and meet their academic objectives is gamification. Gamification is the application of features of game design to non-gaming situations to increase student and instructor enthusiasm and engagement. Through the use of points, badges, and rankings, gamification may enhance student engagement and learning outcomes in higher education institutions. The use of gamification techniques to Afghan university students has the potential to enhance the interactive and pleasurable nature of the learning environment (Hamari et al., 2018). Internet availability, tool accessibility, and user and practitioner adoption of positive habits are all necessary for gamification.

Thus, this study fills the gap in the existing literature through the provision of detailed synthesis and analysis of effective applications, advantages, challenges, and recommendations for integrating innovative technologies among higher education institutions in Afghanistan. The main purpose of this review paper is to deeply discover the effective and innovative technologies that could enhance sustainability in higher education in Afghanistan. Furthermore, this study provides the current state of such technologies and their implication for best educational practices and this study seeks to present understandings and practical recommendations that can guide policymakers, teachers, and universities in applying these technologies. Throughout the following section, a comprehensive literature is described about the innovative technology for enhancing sustainability in higher education of Afghanistan. The ideas are sequentially organized, synthesized and at the same contextualized each findings to the context of Afghanistan's higher education system.

Material and Method

This research aimed to compile and analyze existing knowledge on integrating innovative technologies in higher education, particularly focusing on sustainability within Afghanistan. A comprehensive literature review was conducted, utilizing databases such as Scopus, Google Scholar, Taylor & Francis Online, and Web of Science. Search terms like "Innovative technologies" and "Digital technologies" were employed to capture a broad range of relevant studies. The selection criteria for the literature were stringent: only peer-reviewed journal articles, conference proceedings, and studies related to the adoption of innovative technologies in higher education, particularly within Afghanistan and neighboring regions, were included. Exclusion criteria filtered out papers unrelated to higher education or technological innovation and non-English articles unless reliably translated. The selection process involved screening titles and abstracts, followed by a full-text review to ensure alignment with the research focus. Data extraction focused on key points from each study, including the types of technologies discussed (e.g., adaptive learning, cloud computing, IoT, AI, gamification), their adoption in higher education, and their implications for sustainability in Afghanistan. Challenges and opportunities associated with these technologies were also identified. The extracted data were organized thematically, allowing for a structured analysis of how these technologies can enhance sustainability in Afghanistan's higher education sector. The analysis employed comparative methods to assess the contributions of different technologies to sustainability, considering their broader implications for educational quality, accessibility, and operational efficiency. The researcher's expertise in Afghan higher education added depth to the analysis, discussing potential challenges and opportunities for implementing these technologies within Afghanistan's unique context. This methodology provides a robust foundation for understanding the role of innovative technologies in promoting sustainability in Afghan higher education and offers valuable recommendations for future research and implementation.

Innovative Technologies for Enhancing Sustainability in Higher Education of Afghanistan

Following are a detailed discussion of the potential innovative technologies synthesized from existing literature that are efficient to be utilized in the landscape of Afghanistan's higher education. Such adoption of innovative technologies across higher educational institutions has the advantage of significantly improving the educational setting in Afghanistan, particularly the adoption of Artificial Intelligence (AI), Technology Acceptance Model (TAM), Gamification, and blockchain technology. Our discussion explores how these technologies address existing challenges in Afghan higher education and underlines their advantages and limitations.

Adaptive Learning Technologies

After reviewing several publications, it is determined that, when properly applied, adaptive learning technologies (ALT) may also be a game-changer for Afghan colleges. ALT is a system that personalizes the education experience by adjusting learning materials to each student's needs, aligning well with the education goals of fostering an inclusive and effective learning environment (Castañeda & Selwyn, 2018). With ALT, students can adapt the course material to their individual requirements, resulting in a unique learning environment not possible in traditional classroom settings. Students can also receive timely support, resources specific to their needs, and the pertinent feedback they need (Vrasidas & McIsaac, 2001). Furthermore, these innovations often take place on a web-based platform. The program can assist students in their learning process and contains all of the pertinent information about the class. The software can decide on the optimal course of action for the pupils while they do their work on the platform. Every adventure is customized for each student according to their particular requirements (Huang & Shiu, 2012).

Applications used in ALT

There are several applications and platforms used under Adaptive Learning strategies across higher educational institutions such as Smart Sparrow, Geekie, and Knewton Alta which are discussed below:

Smart Sparrow

Higher education is experiencing the rise of new models, including for-profit universities, massive open online courses (MOOCs), and competency-based learning. Among these, adaptive learning stands out as a personalized, technology-driven approach that adapts to both teachers and students. Smart Sparrow, an Australia-based adaptive e-learning platform, is at the forefront of this trend. Founded by Dror Ben-Naim, Smart Sparrow allows institutions and educators to create adaptive tutorials tailored to individual student needs within existing coursework (Martin & Connor, 2017). The platform adjusts content based on student responses, offering "adaptive pathways" that cater to different knowledge levels. It also provides analytic dashboards, known as Knowledge Analytics, to help instructors track student performance and identify challenging concepts (Jones & Bomash, 2018; Klein et al., 2020; Martin & Connor, 2017). Afghan Universities may also use Smart Sparrow to develop

adaptive learning pathways that adjust to the individual needs of each student. As students interact with the course material, the platform adapts the content based on their responses, ensuring that advanced learners can progress more quickly while those who need extra help are directed to additional resources. For example, a biology course might use Smart Sparrow to create different learning paths for students based on their grasp of fundamental concepts. Students who demonstrate a strong understanding can move on to more complex topics, while others receive additional tutorials to reinforce their knowledge.

Geekie

Brazilian students may use Geekie, a subscription-based artificial intelligence (AI) learning platform, to assist them get ready for their high school diploma examinations. The platform tracks each student's progress and shares this information with their teachers. At the start, students complete a brief test and a survey that asks about their educational goals, preferred universities, and subjects they want to focus on. Based on this information, Geekie customizes a curriculum tailored to each student's needs. For instance, a student aiming for a math degree might receive extra content in economics. As students work through the platform, Geekie continuously adjusts the curriculum to match their progress and how well the system understands their learning patterns. It collects and analyzes data (using Big Data and Data Mining technologies) to refine the learning experience further. Additionally, Geekie collects data on the competences needed for harder courses, which is subsequently examined and incorporated into the platform by specialists in education. This guarantees

Cloud Computing in Higher Education

Cloud computing is the primary approach for providing resources and services, and it is thought to be the future of technology. The flexibility, capacity, cost-effectiveness, and collaboration capabilities of this technology have made it widely accepted by both government and commercial businesses. Because of these features, cloud computing is essential for users and organizations, especially higher education institutions (Vilkova & Lebedev, 2020). Additionally, cloud computing seems as an innovative concept in emerging nations where people are beginning to recognize its benefits. This technology presents the ideas of standardizing facilities in a single location, consolidating hardware and software, and exchanging data (Chimmalee & Anupan, 2022; Hussein Alghushami et al., 2020). Mostly to financial benefits, higher education institutions are migrating more and more too cloud-based systems (Klug & Bai, 2015). The ownership model in the cloud environment is more economical. In addition, higher education institutions are becoming more and more familiar with cloud computing, especially when they include e-learning platforms into their everyday activities (Al Ajmi et al., 2017). Higher Education Institutions may now enable to use cloud-based e-learning, which improves administration and student achievement. For professors and students, cloud services provide a cost-effective opportunity. Cloud computing has grown in growth and maturity, delivering additional services to both consumers and businesses (Karafil & Oguz, 2019).

Digital classrooms, collecting and storing data, research and communication, student services, and administration are just a few of the many aspects of cloud computing that are explored below.

Virtual classrooms

In order to assist distant learners, online interactive learning—also known as virtual classrooms—influences the multifaceted concept (Schullo et al., 2007). Through direct engagement with instructors, these environments stimulate students, give the essential support and direction, and cultivate a feeling of social presence and shared responsibility. With capabilities like rapid surveys, software exchanging, interactive whiteboards, audio, video, and text chat, online classrooms replicate in real time the events in traditional classrooms (Martin & Parker, 2014). Digital classrooms, like traditional classrooms, provide feedback, building relationships and timely explanation and information during group activities, managed pace and discipline, and the development of community and group cohesiveness (Schullo et al., 2007).

Many essential apps are used in online classes to support virtual education, including:

Zoom: Offers conference rooms with interactive whiteboards, screen sharing, video conferencing, and recording options. It is frequently utilized for online meetings, webinars, and live courses. (Dantes et al., 2022).

Microsoft Teams: provides breakout rooms, file sharing, chat, video conferencing, and Office 365 integration. Utilized for group projects and distance learning, it is linked with Microsoft Office applications. (Grynyshyna et al., 2023).

Google Meet: Offers chat, screen-sharing, and video conferencing functions. Because of its integration with Google Workspace, it may be used for in-person conferences and training sessions. (Dash et al., 2022).

Moodle: An educational management tool including grade tracking, assignments, tests, and forums. It helps for organizing student communications, projects, and the course material (Cole & Foster, 2007).

Blackboard: An educational management system with grade tracking, discussion forums, quizzes, and content management for courses. It facilitates communication, evaluations, and program administration. (Little-Wiles & Naimi, 2011).

Canvas: An assignment-based, conversation-based, learning management system with grading features. It is employed to engage students and convey course information (John, 2021).

Jamboard: A digital whiteboard that facilitates quick cooperation. It is applied in brainstorming sessions, group projects, and visual instruction (De La Cruz & Katiuska, 2023).

Google Drive/Docs: Supports online storage and cooperative management of documents. It is used for document sharing and teamwork on assignments and projects.(Tukur et al., 2021).

Data Storage and Management

Higher education institutions' data management and storage practices include a number of key elements. Traditional physical systems like Storage Area Networks and Network-Attached Storage are examples of data storage solutions. Affordable cloud storage choices like Amazon S3 and Google Cloud Storage are also available. To protect against data loss, periodic backups and disaster recovery solutions, such as Veeam Backup & Replication, guarantee that data can be restored in an emergency.

Common applications used in data storage and management include:

Cloud Storage Services:

Microsoft Azure Storage contains Blob, Table, and File Storage; Google Cloud Storage offers Scalable Solutions; and Amazon Web Services (AWS) offers a variety of alternatives such Amazon S3, EBS, and Glacier(Santoso, 2017).

Backup and Disaster Recovery:

Acronis Backup and Backup & Rotation provide all-inclusive data protection and recovery solutions(Kendari, 2015; Santoso, 2017).

Data Management Platforms:

Database management solutions like Oracle, Microsoft SQL Server, and MySQL handle structured data, while data warehouses like Amazon Redshift, Google BigQuery, and Snowflake facilitate large-scale data storage and analytics (Ilić et al., 2021).

Data Security Tools:

Data is protected by encryption and threat prevention with McAfee Total Protection and Symantec Data Loss Prevention (Benjelloun & Lahcen, 2019; Ryan, 2004).

Collaboration and Sharing Tools:

For file storage and collaborative document management, Microsoft 365 offers SharePoint and OneDrive, whereas Google Workspace contains Google Drive and Docs (Herrick, 2009; Lake, 2022).

Data Integration and Analysis:

Effective analysis and interpretation of data are made possible by Tableau and Power BI, which are utilized for business intelligence and data visualization (Suravajhala et al., 2016).

Mobile Learning (ML)

Mobile learning enhances remote learning by providing education anytime, anywhere through the use of mobile technologies. Numerous studies on mobile learning have been conducted, with a focus on user acceptance, efficacy, and challenges encountered by both learners and institutions. Technology acceptance frameworks, including the Technology Acceptance Model (TAM) and the Unified Theory of uptake and Use of Technology (UTAUT), play a major role in predicting the uptake of m-learning. Important factors including performance expectations, effort expectations, and social effect have a big impact on students' attitudes and behaviors surrounding mobile learning. Understanding these components is essential to tailoring m-learning solutions to Afghan needs and expectations. Afghanistan has several obstacles to the implementation of mobile learning, such as

inadequate technology, security concerns, and a dearth of learning resources. The inefficiency of m-learning deployment is exacerbated by unstable internet access and outdated technology. Positive perceptions of m-learning are necessary for its acceptance and are influenced by a variety of factors, including performance and effort expectations. Encouraging Afghans to adopt such perspectives might boost m-learning's effectiveness and student acceptance.

Implications for Afghanistan

Adopting MCC might benefit Afghan higher education institutions in several ways, including: Better Access and Flexibility: By addressing geographical and infrastructural barriers, MCC may improve access to educational resources and support learning in isolated or neglected parts of Afghanistan. Cost-Effective Solutions: MCC may help universities with limited funding by lowering costs, which allows them to offer modern teaching resources without having to make large upfront expenditures. Improved Learning Environment: By using MCC, instructors and students may benefit from a more adaptable and dynamic learning environment that helps them both meet their learning goals.

The Internet of Things in Higher Education

The network of living things connected by the Internet, or the "Internet of Things," is changing a number of industries globally, including education. The incorporation of IoT offers a tremendous potential to improve educational quality, efficiency, and connection for Afghanistan's higher education system (Pervez et al., 2018). However, there are a number of issues that must be resolved before IoT can be successfully implemented in Afghan universities.

The opportunity the IoT to transform Afghan education depends upon its ability to improve learning environments and streamline university administration. By managing attendance, measuring student involvement in real time, and providing individualized learning experiences, smart classrooms with sensors, interactive whiteboards, and connected devices may improve student engagement and customize instruction to meet individual requirements. Through the integration of devices like tablets, computers, and smartphones that gather and analyze data on student performance, the internet of things also facilitates interactive learning. This allows teachers to modify their lesson plans to better suit the needs of different learning styles and enhance academic results. IoT may also improve resource management in higher education by tracking important assets like lab equipment and keeping an eye on facilities to save energy. This lowers operating costs and improves sustainability. IoT further supports data-driven decision-making by enabling universities to evaluate data from connected devices to identify students who may be at risk, obtain insights into student performance, and improve administrative procedures like grading and course registration (Liu et al., 2017). IoT may also improve resource management in higher education by tracking important assets like lab equipment and keeping an eye on facilities to save energy. This lowers operating costs and improves sustainability. IoT further supports data-driven decision-making by enabling universities to evaluate data from

connected devices to identify students who may be at risk, obtain insights into student performance, and improve administrative procedures like grading and course registration.

Recommendations for Effective IoT Integration

Afghanistan's higher education system needs to concentrate on a few essential efforts in order to overcome these challenges. Infrastructure spending is crucial, and this includes modernizing technology and extending internet connectivity to remote locations. Universities who want to purchase IoT-compatible hardware and data management systems should look for financing and collaborations. Building capacity and providing staff and professors with IoT technology management training are also essential. Learning and innovation may be improved by integrating IoT into the curriculum and encouraging student-led initiatives. Furthermore, establishing thorough security procedures and moral standards will guarantee privacy and data security.

Use of AI in Online Learning in Higher Education

Globally, education is changing as a result of the incorporation of Artificial Intelligence (AI) into e-learning. Afghanistan's higher education system is highly impacted by this change. Although artificial intelligence (AI) offers many benefits, using it at Afghan universities poses with challenges

Understanding the Technology Acceptance Model (TAM)

TAM focuses on two main aspects: perceived usefulness and perceived ease of use. Perceived utility gauges how much a user thinks a piece of technology will enhance their performance, whereas perceived ease of use gauges how simple a user considers a piece of technology to use. These ideas influence users' views toward the technology, which in turn influences how they actually use it as well as how much they want to use it. To determine if teachers and students in Afghanistan's higher education system will employ ChatGPT and learning management systems (LMS), these TAM aspects are crucial. If these tools turn out to be practical and easy to use Determining whether instructors and students in Afghanistan's post-secondary education system will make use of ChatGPT and learning management systems (LMS) requires an understanding of these TAM elements. When people think these technologies are practical and simple to use, they are more likely to be accepted (Davis, 1989).

Applying TAM to Enhance Technology Adoption in Higher Education

A number of strategies should be utilized by Afghanistan's higher education system in order to successfully adopt the Technology Acceptance Model (TAM). In the first place, infrastructure has to be improved. By making investments in dependable internet and cutting-edge technology, companies like ChatGPT and Learning Management Systems (LMS) may improve their usefulness and encourage users to embrace them. In addition, to improve educators' and students' confidence in adopting new technology, extensive training and capacity building are required. A greater adoption rate can result from this training's ability to enhance users' opinions of its utility and usability. Third, by adapting LMS and educational technology to the unique requirements of Afghan users, localizing content and

tools may increase their relevance and utility and encourage adoption more widely. In the end, encouraging government guidelines and rewards that promote the use of technology in the classroom can have a good impact on behavioral intentions and make adoption easier (Fırat, 2023).

Gamification in Higher Education

Gamification is the use of game mechanics and elements of design in non-gaming settings. It has become more popular in educational settings across the world. This strategy aims to increase learners' motivation and engagement by introducing components like badges, progress bars, leaderboards, and points (Liu et al., 2017; Wiggins, 2016). Even though gamification has many advantages, there are specific prospective and difficulties with using it in Afghanistan's higher education system that should be carefully considered.

Block chain Technology in Higher Education

Blockchain technology, which has the ability to completely change a number of industries, presents exciting new opportunities for higher education. Blockchain addresses important difficulties connected to data management, such validation and storage, by enabling decentralized apps that securely store data without depending on third parties using shared algorithms and encrypted group signatures. However, there are advantages and disadvantages to blockchain adoption in Afghanistan's higher education sector.

Advantages

For higher education, blockchain technology has a number of important advantages. Initially, thanks to its immutable ledger, which safely and openly keeps academic data like degrees and certificates, it improves transparency and combats fraud. This capacity guarantees the reliability of academic credentials and lessens the problems associated with fake qualifications. Furthermore, blockchain simplifies administrative procedures by employing smart contracts to automate activities like student enrollment and credential verification. This automation lessens the administrative load on institutions while also increasing process efficiency. Additionally, by generating enduring, verifiable records of academic accomplishments, blockchain technology enhances record-keeping. This ensures the correct recording of academic records and makes credit transfers between schools easier.

Conclusion

In the quest to enhance sustainability and effectiveness within Afghanistan's higher education sector, integrating innovative technologies offers transformative potential. The Internet of Things, AI, gamification, cloud computing, mobile learning and mobile cloud computing, adaptive learning, the TAM, and blockchain technology were all reviewed in this review paper. Each of these technologies has contributed in a different way to the advancement of educational practices in Afghanistan. ALT promise personalized educational experiences tailored to individual needs, bridging gaps and promoting equity in limited-resource settings. CC services offer inaccessible, economical solutions for managing educational resources, supporting collaborative learning, and reducing infrastructure costs, enhancing operational efficiency and accessibility. ML and mobile

cloud computing extend educational opportunities to remote areas with varying internet access levels, while IoT introduces smart classrooms and data-driven decision-making to improve resource management and interactive learning environments. AI enhances online learning through personalized instruction and automated support, addressing scalability and resource limitations. Understanding TAM helps identify factors influencing technology adoption, ensuring smoother integration and user satisfaction. Gamification makes learning more engaging and motivating by incorporating game design elements, enhancing student participation and outcomes. Blockchain technology ensures transparency and security in academic record-keeping, addressing issues related to counterfeit diplomas and data integrity.

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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