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Taking Up the Challenges Faced by Higher Education Institutions in Technology to Create Smart Campus

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ABSTRAK

Perguruan tinggi menghadapi tantangan besar dalam teknologi untuk menciptakan smart campus guna meningkatkan efisiensi, produktivitas, mutu, dan inovasi perguruan tinggi. Penelitian ini bertujuan menganalisis upaya perguruan tinggi dalam memanfaatkan teknologi menciptakan smart campus. Penelitian menggunakan deskriptif kualitatif dengan pendekatan fenomenologi. Data dikumpulkan melalui wawancara terbuka di empat perguruan tinggi. Subjek penelitian meliputi manajemen tingkat atas, manajemen tingkat menengah, dosen, dan staf. Data analysis was performed using Bogdan & Biklen which is called data reduction, the interconnection between data and verification. Hasil penelitian menunjukkan bahwa perguruan tinggi telah melakukan berbagai upaya dalam menghadirkan teknologi digital untuk menciptakan smart campus. Penelitian ini menggambarkan kemampuan perguruan tinggi dalam mewujudkan Smart Campus dalam 4 tingkatan yaitu adopsi, implementasi, integrasi dan optimalisasi. Namun tantangan terbesar adalah integrasi dan optimalisasi sistem yang digunakan untuk layanan pendidikan, penelitian dan pengabdian. Kemudian optimalisasi membutuhkan kebijakan yang melibatkan tujuan dan sasaran terkait integrasi, keberlanjutan teknologi dan peningkatan lingkungan belajar, sehingga akan menciptakan smart campus.

ABSTRACT

Universities face big challenges in technology to create smart campuses to increase higher education efficiency, productivity, quality and innovation. This research aims to analyze universities' efforts to utilize technology to create smart campuses. The research uses descriptive qualitative with a phenomenological approach. Data was collected through open interviews at four universities. Research subjects include top level management, middle level management, lecturers and staff. Data analysis was performed using Bogdan & Biklen which is called data reduction, the interconnection between data and verification. The research results show that universities have made various efforts to introduce digital technology to create smart campuses. This research describes the ability of universities to realize Smart Campus in 4 levels, namely adoption, implementation, integration and optimization. However, the biggest challenge is the integration and optimization of systems used for education, research and service services. Then optimization requires policies that involve goals and targets related to integration, technological sustainability and improving the learning environment, so that it will create a smart campus.

1. INTRODUCTION

Higher education today is undergoing significant transformations and facing various challenges. The key aspects that describe the current state of higher education include digital transformation. Technology is playing an increasingly vital role in higher education. Adopting online learning platforms, virtual classrooms, and digital tools to deliver courses and enhance the learning experience. Digital transformation is also influencing administrative processes, research methods, and communication channels within higher education institutions (Geng et al., 2019; Santos et al., 2019). The beginning of the pandemic in 2019 accelerated the adoption of blended learning approaches, combining in-person and online instruction. This hybrid model allows for flexibility, personalized learning, and a mix of synchronous and asynchronous learning activities. Blended learning has become a prominent feature of higher education, even as institutions transition back to more traditional modes of instruction (Holland et al., 2020; Turnbull et al., 2021) Higher education institutions are investing in support services, such as academic advising, career counseling, and mental health resources, to ensure students thrive academically, socially, and emotionally. Higher education has become more globalized, with increasing numbers of students studying abroad and international collaborations between institutions. Previous

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research remains there is a greater emphasis on fostering global perspectives, intercultural competence, and cross-border research collaborations to address global challenges and provide students with a diverse educational experience (Holland et al., 2020). Efforts to promote diversity, equity, and inclusion are gaining momentum in higher education. Institutions are striving to create inclusive learning environments, increase the representation of underrepresented groups among faculty and staff, and address systemic barriers to access and success (Nieminen, 2022; O'Leary et al., 2020). There is a recognition of the importance of equity in educational opportunities and outcomes. Therefore lifelong learning is becoming essential in the face of rapid technological advancements and changing job requirements. Higher education institutions are offering continuous learning opportunities, micro-credentials, and non-degree programs to meet the needs of learners at different stages of their careers. Lifelong learning is viewed as a means to stay relevant in a knowledge-driven economy (Lo & Stark, 2021; Maatuk et al., 2022). Another problem of Higher education institutions is facing financial challenges due to rising costs, decreasing public funding, and changes in enrollment patterns. Institutions are exploring alternative revenue streams, partnering with industry and community organizations, and adopting cost-saving measures to ensure sustainability and affordability. Based on alternative solutions today, research and innovation remain crucial to the advancement of knowledge and addressing societal challenges (Abuhmaid, 2011; Ko & Liu, 2021). Higher education institutions are investing in research infrastructure, interdisciplinary collaborations, and entrepreneurial initiatives to foster innovation and contribute to scientific, technological, and social advancements. Higher education today is marked by digital transformation, a focus on student success, globalization, efforts towards equity and inclusion, recognition of lifelong learning, financial pressures, and a continued emphasis on research and innovation (Cox, 2021; Mohamed Hashim et al., 2022; Peek et al., 2020). As the landscape continues to evolve, higher education institutions are adapting to meet the changing needs of students, society, and the workforce.

The integration of technology in higher education is increasingly recognized as a pressing need to enhance teaching, learning, and overall student experiences. There are several key reasons why technology is essential in higher education (Chan, 2023; Paudel, 2020). Technology enables access to vast amounts of information and resources. With the internet and digital libraries, students and faculty can easily access a wealth of scholarly articles, research papers, e-books, and educational materials from anywhere at any time (Bond & Bedenlier, 2019; Santos et al., 2019). This availability of information broadens the scope of learning, promotes independent inquiry, and fosters critical thinking skills. Technology facilitates interactive and engaging learning experiences. Digital tools such as multimedia presentations, simulations, virtual reality, and gamification provide opportunities for active learning, problem-solving, and skill development (Blau et al., 2020; Mohamed Hashim et al., 2022). These interactive experiences cater to diverse learning styles, promote student engagement, and create an immersive and dynamic learning environment. Technology enhances collaboration and communication. Online platforms, discussion forums, and video conferencing tools enable students and faculty to connect and collaborate beyond physical boundaries. This promotes collaborative learning, allows for peer feedback and support, and facilitates communication and collaboration among students and faculty members. The use of technology supports personalized and adaptive learning. Learning analytics, data-driven insights, and adaptive learning platforms allow educators to gather real-time information about student progress and tailor instruction to individual needs (Chatterjee & Chakraborty, 2021; Kamruzzaman et al., 2023). This personalized approach promotes self-paced learning, addresses learning gaps, and ensures that students receive the support they require to succeed. Technology needs to expand educational opportunities and access. Online and distance learning programs enable individuals who may not have access to traditional higher education settings to pursue their education remotely (Attard & Holmes, 2022; Iglesias-Pradas et al., 2021). This includes working professionals, individuals with mobility constraints, and students from remote or underserved areas. Technology bridges geographical barriers, making education more accessible and inclusive (Gill, 2020; Perales Jarillo et al., 2019). In today's rapidly evolving job market, digital literacy and technological skills are essential. By integrating technology into the curriculum, higher education institutions equip students with the necessary digital competencies, problem-solving abilities, and adaptability to thrive in the digital age.

Technology plays a vital role in supporting academic research and collaboration among universities in Pekanbaru (Hartati et al., 2021; Jagannathan et al., 2019). Online research platforms, such as Google Scholar or Scopus, allow researchers to access scholarly articles and publications. Collaboration tools, such as shared document repositories and virtual meeting platforms, facilitate interdisciplinary research and enable researchers to collaborate with peers globally (Barker et al., 2019; Dam et al., 2019). Leverage technology for effective communication and dissemination of information. Official university websites, social media platforms, and mobile applications provide students, faculty, and staff with updates on academic programs, events, announcements, and campus news. This enables efficient and timely

communication, ensuring that the university community remains informed and connected. This is very important to support technology in creating a smart campus in Pekanbaru. Previous research in Indonesia about smart campuses refers to Higher Education institutions (HEIs) that leverage advanced technologies and data-driven solutions to create an intelligent, connected, and sustainable environment for the campus community (Hidayat & Sensuse, 2022). It involves the integration of various technological systems and infrastructure to optimize operations, enhance the learning experience, promote sustainability, and improve overall campus management. The adoption of technology to create smart campuses in higher education, especially in Pekanbaru poses several challenges that need to be addressed for successful implementation. Understanding these challenges is crucial for identifying potential barriers and devising effective solutions. One significant challenge is the need for adequate infrastructure to support advanced technologies. This includes robust network connectivity, sufficient bandwidth, scalable data storage, and reliable hardware and software systems. Insufficient infrastructure can hinder the implementation and functionality of smart campus initiatives (Gaidelys et al., 2022; Mitrofanova et al., 2019). Other challenges explained in this research are to enhance the knowledge about how HEIs in Pekanbaru can create a smart campus by focusing on technology. This research aims to analyze the efforts of higher education institutions in Pekanbaru in utilizing technology to create smart campuses.

2. METHODS

This research method using qualitative research with a phenomenology approach aims to provide a detailed, comprehensive description of the challenge in Technology faced by HEIs in Pekanbaru. It explores the subjective experiences, perspectives, and interpretations of individuals regarding a specific phenomenon. Phenomenological research seeks to uncover he underlying structures and essences of the phenomenon as experienced by participants. Data Collection in-depth interviews with all participants including top management, middle management in faculty members, and staff Information and Technology. Population and sample determined by Slovin were conducted in four universities in Pekanbaru. Using Open-ended. Data collection and instrumens as show in Table 1.

Table 1. Data Collection and Instruments

No	Variable/Dimension	Phase	Amount of Questions	Code
1	**Digital Leadership**	**Adoption Stage**		
	Technology	Awareness and Understanding	12	AU
	Uitilization	Funding and Resources	10	FR
	Smart Campus	Training and Capacity Building	12	TRB
2		**Implementation Stage**		
	Digital Leadership	Technical Integration	10	TI
	Technology	Technical Support	8	TS
	Uitilization	Change Management	6	CM
	Smart Campus			
3		**Integration Stage**		
		Pedagogical Alignment	8	PA
		Digital Literacy	7	DL
		Green Environment	5	GE
	Digital Leadership			
4	**Technology**	**Optimization Stage**		
	Uitilization	Evaluation and Feedback	8	EF
	Smart Campus	Scalability and Sustainability	6	SS
		Innovation and Future-Readiness	7	IFR
	Digital Leadership			
	Technology			
	Uitilization			
	Smart Campus			

Questionnaires are included to allow participants to provide detailed responses and insights. Data analysis was performed using Bogdan & Biklen which is called data reduction, the interconnection between data and verification (Hubermann, 2013). This data collection reduced into final phase of data table. This phase can be describe as show in Figure 1.

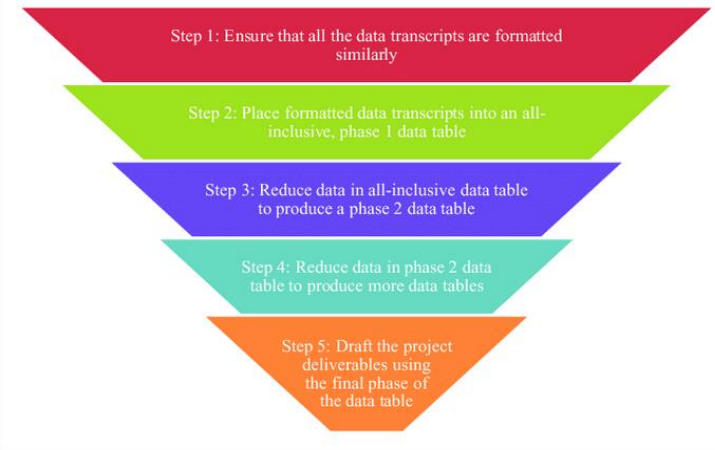

Figure 1. Step of Data Reduction Method

Overall participant identities are kept secret and matters related to participant responses to research data are kept confidential and do not affect future participant results.

3. RESULT AND DISCUSSION

Results

The complex Challenged in HEI, especially in Pekanbaru faced various aspects of Technology. A comprehensive problem plan needs to involve assessing the existing infrastructure and identifying areas that need improvement. This includes upgrading network connectivity, expanding bandwidth capacity, investing in robust hardware and software systems, and ensuring data storage capabilities meet the requirements of a smart campus. Allocating sufficient resources and establishing a timeline for infrastructure development are key steps. Another thing is also changing the management strategies, To overcome resistance to change and ensure successful technology adoption, a problem plan should incorporate change management strategies. This includes clear communication about the benefits of technology adoption, involving stakeholders in decision-making processes, providing training and support, and creating a positive and inclusive culture that embraces technological advancements.

HEIs also struggle with integration systems. A problem plan for system integration involves identifying compatible systems and applications, establishing data standards and protocols, and developing an integration roadmap. Collaborating with IT teams, conducting thorough testing and troubleshooting, and ensuring data synchronization are important steps to overcome system integration challenges. Nevertheless, financial sustainability plays a significant role to solve in technology. A problem plan for financial sustainability includes exploring funding options, such as grants, partnerships, and cost-sharing initiatives. Developing a comprehensive budget that considers upfront costs, ongoing maintenance, and future upgrades is crucial. Additionally, evaluating the return on investment and cost-effectiveness of technology solutions can help prioritize spending and allocate resources efficiently. Supporting technology and creating a smart campus is needed for an organizational cultural transformation. A problem plan for transforming organizational culture includes fostering a culture of innovation and technology adoption. This involves providing training and professional development opportunities to staff, encouraging collaboration and knowledge sharing, and recognizing and rewarding innovative practices. Creating cross-functional teams and establishing clear channels of communication can also facilitate cultural transformation. Technology in creating the smart campus amplified the challenges itself. In this research, the challenges in technology are categorized into four main stages: adoption, implementation, integration, and optimization, while introduced four levels of digital technology into digital awareness, requirement, collaboration, and transformation. Every Stage in this research describes how HEIs faced the challenges and solve the problems. The result spread into data reduction from the participants as follows:

Adoption Stage

Adopting technology in Higher Education Institutions (HEIs) refers to the integration and utilization of various technological tools and solutions to enhance teaching, learning, research, administration, and overall campus operations. Technology adoption in HEIs encompasses a wide range of areas and initiatives aimed at improving the educational experience, increasing efficiency, and supporting innovation in higher education. While the adoption of technology in Higher Education Institutions (HEIs) brings numerous benefits in creating smart campuses. There are also several challenges that institutions may face during the process. These challenges the institution's resources, infrastructure, culture, and readiness for change. Awareness and understanding new technology are sometimes hard, HEIs also need Funding and resources and nevertheless, training and capacity building is effectively helping faculty members and staff adopt technology. The result of data reduction for adoption stage HEIs in Pekanbaru showed in Table 2.

Table 2. Result of Data Reduction Adoption Stage in Technology Faced by HEI

Indicator	Interconnection HEIs with indicator	Challenge and Solution
Awareness and Understanding	Educating stakeholders about the benefits and potential impact of the technology, overcoming resistance to change, and addressing concerns or misconceptions.	HEIs overcome resistance to change by promoting and motivating faculty, staff, and students to adopt the technology.
Funding and Resources	Securing adequate financial resources to invest in technology infrastructure, equipment, software licenses, training, and support.	HEIs estimate budget significant investments in technology by creating innovations each year
Training and Capacity Building	Providing comprehensive training programs to build the necessary skills and competencies among faculty, staff, and students to effectively use the technology.	HEIs provide programs to enhance capacity building in technology

Implementation Stage

Implementing technology in Higher Education Institutions (HEIs) involves several stages, and each stage poses its own set of challenges. Navigating these challenges requires a collaborative and iterative approach, involving a dedicated implementation team, effective communication, ongoing stakeholder engagement, and a commitment to adapt and learn from the process. By addressing these challenges, HEIs can successfully implement technology and maximize its potential to enhance teaching, learning, and institutional effectiveness creating a smart campus. There are at least three indicators for these problems regarding the implementation stage in technology: technical integration, technical support, and change management. These criteria of challenges faced by HEIs can be delivered by data reduction shown in Table 3.

Table 3. Result of Data Reduction Implementing Stage in Technology Faced by HEI

Indicator	Interconnection HEI with indicator	Challenge and Solution
Technical Integration	Ensuring compatibility and seamless integration of new technology with existing systems, networks, and infrastructure.	HEIs work closely with IT professionals and experts to ensure the compatibility and integration of new technologies
Technical Support	Establishing robust technical support mechanisms to address hardware or software issues, troubleshooting, and timely assistance to users	HEIs establish a dedicated help desk or service desk to provide technical support to faculty, staff, and students.
Change Management	Managing the transition process, facilitating effective communication, and addressing any resistance or concerns among stakeholders during the implementation	HEIs engage stakeholders, including faculty, staff, students, and administrators, through regular communication channels such as email updates, newsletters, or dedicated information sessions.

Integration Stage

Integrating technology into Higher Education Institutions (HEIs) offers numerous benefits that positively impact various aspects of teaching, learning, research, and administration. But these things never come easily, there are also things to solve. Addressing these challenges requires pedagogical alignment, digital literacy, and Green Environment refining integration strategies in creating a smart campus. HEIs can create support structures, provide resources, and foster a culture of innovation to facilitate the successful integration of technology into their educational ecosystem. Table 4 described the data reduction of the HEIs integration stage in technology.

Table 4. Result of Data Reduction Integration Stage in Technology Faced by HEI

Indicator	Interconnection HEIs with indicator	Challenge and Solution
Pedagogical Alignment	Ensuring that technology supports the desired learning outcomes and aligns with instructional strategies and curriculum requirements	Faculty members collaborate with instructional designers and technology experts to identify appropriate technologies and integrate them into their instructional approaches. This integration ensures that technology is used purposefully to facilitate active learning, collaboration, critical thinking, and problem-solving skills.
Digital Literacy	Promoting digital literacy skills among faculty, staff, and students to effectively leverage technology for teaching, learning, research, and administrative tasks.	HEIs-made programs cover a range of topics, such as basic computer skills, internet usage, productivity tools, online collaboration platforms, digital communication, information literacy, data management, and digital security. Training is tailored to the specific needs and roles of faculty, staff, and students, ensuring they acquire the necessary skills to leverage technology effectively.
Green Environment	HEIs increasingly taking initiatives to create a green environment and transition toward smart campus	HEIs educate and raise awareness about environmental sustainability through various educational initiatives. This includes integrating sustainability topics into the curriculum, organizing workshops and seminars, hosting sustainability-focused events, and promoting student-led sustainability initiatives. HEIs empower students, faculty, and staff to become environmentally conscious and actively participate in sustainable practices. It still needs policy to ensure sustainability.

Optimization Stage

The optimization stage in technology for Higher Education Institutions (HEIs) involves fine-tuning and maximizing the benefits derived from technology integration, especially for smart campuses. It focuses on refining existing systems, practices, and processes to enhance efficiency, effectiveness, and overall outcomes. However, during this stage, HEIs may encounter several challenges including evaluation feedback, Scalability, and Sustainability, Innovation and Future-Readiness. In this Table 5 data reduction can described how HEIs faced the challenge.

Table 5: Result of Data Reduction Optimization Stage in Technology Faced by HEI

Indicator	Interconnection HEIs with indicator	Challenge and Solution
Evaluation and Feedback	Conducting regular assessments to measure the effectiveness and impact of technology on student learning outcomes and overall institutional goals.	HEIs actively seek feedback from stakeholders, including students, faculty, administrators, and staff, regarding the impact of technology on learning outcomes and institutional goals. Collaborative partnerships with stakeholders allow for ongoing dialogue, idea sharing, and the co-creation of evaluation strategies but consistency is needed.
Scalability and Sustainability	Developing strategies to scale up technology implementation across the institution and ensuring	HEIs develop technology adoption frameworks or guidelines that establish standards, policies, and best practices for technology implementation, but it still

Indicator	Interconnection HEIs with indicator	Challenge and Solution
	long-term sustainability, including budget planning and regular technology updates.	needs adjustment according to the development of technology.
Innovation and Future-Readiness	Encouraging a culture of innovation, staying abreast of emerging technologies, and adapting to evolving educational needs and trends.	HEIs foster collaborations and partnerships with industry, research institutions, and other educational organizations to stay abreast of emerging technologies and trends. These collaborations provide opportunities for knowledge sharing, joint research, pilot projects, and the exchange of best practices. Collaborations with external entities enable HEIs to access expertise, resources, and insights into emerging technologies. It still needs policy to ensure sustainability.

Discussion

Technology has revolutionized the concept of higher education campuses, leading to the emergence of smart campuses (Bae et al., 2021; Desai & Kim, 2023). A smart campus integrates advanced information and communication technology into the physical and virtual environment, creating an interconnected ecosystem that enhances various aspects of campus life (Lv et al., 2021; Salas‐Pilco et al., 2022). Technology plays a vital role in supporting academic research and collaboration among universities in Pekanbaru. It has transformed the research landscape by making it easier for scholars, scientists, and researchers from different institutions to work together, share knowledge, and advance their fields of study. Some key aspects of how technology facilitates academic research and collaboration such as the internet has made it possible for researchers to access a vast amount of information and scholarly resources online. Databases, academic journals, e-books, and research articles are readily available, enabling researchers to stay updated with the latest developments in their field. Technology provides a wide range of collaborative tools such as video conferencing, email, and project management software (Bhushan et al., 2021; Pumptow & Brahm, 2021; Rysavy & Michalak, 2020). These tools allow researchers from different universities to communicate, share ideas, and collaborate on research projects regardless of geographical distances. High-performance computing and data storage capabilities have revolutionized data-driven research. Researchers can share large datasets with colleagues across the globe and use powerful analytical tools to process and analyze data efficiently. Online platforms and social networks have given rise to virtual research communities where scholars can discuss ideas, seek feedback, and connect with experts in their fields. Websites like ResearchGate, Academia.edu, and LinkedIn play a significant role in fostering academic networking. Tools like Google Docs and collaborative writing platforms designed for researchers make it easy for multiple authors from different institutions to contribute to research papers and publications in real-time. This streamlines the publication process.

Technology enables the creation of virtual laboratories and simulations, allowing researchers to conduct experiments and simulations remotely. This is particularly valuable in fields like physics, chemistry, and biology. Many universities and research institutions promote open access publishing and utilize preprint servers, which are online platforms where researchers can share their work before formal peer review. This accelerates the dissemination of research findings. Technology aids in the application, management, and tracking of research grants and funding opportunities. Universities can efficiently allocate resources to collaborative research project. Technology breaks down international borders and facilitates global collaboration (Errida & Lotfi, 2021; Garzoni et al., 2020; Hartati et al., 2020; Yang & Baldwin, 2020). Researchers from universities in different countries can come together to work on projects that address global challenges. technology has revolutionized the academic research landscape by providing tools and platforms that facilitate communication, collaboration, data sharing, and information access. This not only accelerates the pace of research but also broadens the scope of collaboration among universities, leading to more innovative and impactful discoveries.

In the Adoption stage of technology, the first thing in adoption technology is awareness and understanding of how technology has an impact on HEIs. This is a significant challenge that needs to solve by a certain effort involving all stakeholders in University. It is important educating stakeholders about the benefits and potential impact of the technology, overcome resistance to change, and address concerns or misconceptions. HEIs integrate technology-related courses and subjects into their curriculum

(Abuhmaid, 2011; Fominykh et al., 2022). According to previous research offering programs that focus on emerging technologies, HEIs educate students about the benefits and potential impact of these technologies (Ahmad, 2019). This equips students with the necessary knowledge and skills to drive technological advancements and become advocates for change in their respective fields. HEIs conduct public outreach programs to raise awareness about the benefits and potential impact of technology. These campaigns can include seminars, workshops, webinars, and community events where HEI representatives share information and engage in discussions with stakeholders. By directly interacting with the public, HEIs can address concerns, dispel myths, and demonstrate how technology can enhance various aspects of society (Cohen-Shacham et al., 2019; García-Morales et al., 2020). HEIs overcome resistance to change by promoting and motivating faculty, staff, and students to adopt the technology.

By leveraging partnerships, government support, philanthropy, and internal budget allocation, HEIs ensure they have the necessary financial resources and technological infrastructure to drive innovation, research, and educational excellence. HEIs incorporate technology-related expenses into their annual budget planning process (Lim et al., 2019; Nwajiuba et al., 2020). They allocate a portion of their budget specifically for technology infrastructure, equipment, software licenses, and ongoing support and maintenance. This ensures that financial resources are earmarked for technological investments and that they are prioritized alongside other institutional needs. HEIs actively pursue grants and external funding opportunities to support technology investments (Abbas, 2020; Chryssou, 2020). They identify and apply for grants offered by government agencies, private foundations, and industry organizations that are specifically geared toward technology-enhanced education. These grants can provide substantial financial resources to support infrastructure upgrades, equipment purchases, and software licenses. HEIs estimate budget significant investments in technology by creating innovations each year through research and education.

By offering a range of training approaches, HEIs ensure that individuals can access the necessary support and resources to adapt to new technologies and leverage them for enhanced learning, research, and productivity. HEIs organize professional development workshops and training sessions to enhance the technological skills of faculty, staff, and students. These sessions cover various aspects of technology, including software applications, hardware operation, digital tools, online teaching platforms, and data analysis. Workshops can be conducted by internal IT departments, instructional designers, or external experts brought in specifically for training purposes. But it also has the challenge, Faculty, staff, and students often have busy schedules, making it challenging to allocate sufficient time for comprehensive training programs. HEIs need to find ways to accommodate training within existing commitments, strike a balance between training and other academic responsibilities, and ensure that training sessions are efficient and focused to minimize disruption.

In the Implementation stage, there is the first thing that technical integration needs attention in HEIs to pursue a smart campus. HEIs Ensure compatibility and seamless integration of new technology with existing systems, networks, and infrastructure. HEIs conduct thorough technology planning and assessment processes to evaluate the compatibility of new technology with existing systems, networks, and infrastructure. This involves identifying the technical requirements of the new technology and assessing its compatibility with the institution's current infrastructure. By considering factors such as network capacity, hardware capabilities, and software compatibility, HEIs can make informed decisions regarding the integration of new technology (Abbas, 2020; Salas‐Pilco et al., 2022). HEIs employ experienced IT professionals to handle the integration of new technology systems with existing infrastructure. These professionals ensure proper system integration, data migration, and data synchronization between the new and existing systems applications for example SIAKAD, CMS, and LMS. Through meticulous planning and execution, HEIs aim to minimize disruptions, data loss, and compatibility issues during the integration process.

HEIs implement change management strategies to guide stakeholders through the transition process. This includes developing a comprehensive change management plan that outlines the objectives, timeline, and communication strategies especially in RENSTRA (Strategic Plan) HEIs establish a change management team or committee responsible for overseeing the transition, addressing concerns, and ensuring effective implementation (Hidayat & Sensuse, 2022; Weiss et al., 2021). HEIs engage stakeholders, including faculty, staff, students, and administrators, through regular communication channels such as email updates, newsletters, or dedicated information sessions. HEIs provide comprehensive training and support to stakeholders during the transition. This includes training sessions, workshops, documentation, and online resources to help stakeholders understand the new initiative, acquire necessary skills, and navigate any changes in processes or workflows. Ongoing support mechanisms, such as help desks or user support centers, are established to address questions, troubleshoot issues, and provide timely assistance.

In Integration Stage, the first important thing is Pedagogical Alignment. HEIs Ensure that technology supports the desired learning outcomes and aligns with instructional strategies and curriculum requirements. HEIs ensure that technology supports the desired learning outcomes and aligns with instructional strategies and curriculum requirements. Through a thoughtful and collaborative approach, technology becomes a tool that enhances teaching and learning, enabling students to achieve the intended learning outcomes effectively. Implementing technology in teaching and learning can face resistance from faculty, students, or administrators, and there is a need to improve technology (Fatayah et al., 2022; Suryana et al., 2018). Some individuals may be hesitant to adopt new technologies or prefer traditional instructional methods. Overcoming resistance to change requires effective communication, professional development, addressing concerns, and demonstrating the value and benefits of technology integration. HEIs provide faculty development programs and training opportunities focused on integrating technology into instruction. These programs equip faculty with the skills, knowledge, and strategies to effectively use technology in support of desired learning outcomes (Arisandi et al., 2022; Hartman et al., 2019). Faculty development may include workshops, seminars, online courses, and communities of practice that emphasize pedagogical approaches and effective technology integration. HEIs conduct thorough needs assessments and analyses to understand the specific learning outcomes, instructional strategies, and curriculum requirements of different programs or courses (Guangul et al., 2020; Rahiem, 2020). This involves gathering input from faculty, curriculum committees, instructional designers, and other stakeholders to identify the key goals and objectives that technology should support. These programs cover a range of topics, including basic computer literacy, information literacy, digital communication, online collaboration, critical thinking, and cybersecurity. HEIs conduct technology orientation sessions and onboarding programs for new faculty, staff, and students. These sessions introduce individuals to the technology infrastructure, digital tools, learning management systems, and other essential technologies used within the institution. HEIs integrate digital literacy into the curriculum to ensure that students develop the necessary skills to leverage technology effectively in their academic pursuits (Abbas, 2020; Reddy et al., 2022; Valverde-Berrocoso et al., 2021). Digital literacy components may be embedded into courses across various disciplines, focusing on information evaluation, digital research, ethical use of technology, digital content creation, and digital citizenship. By integrating digital literacy into the curriculum, HEIs promote the application of technology skills in an academic context. HEIs promote digital citizenship initiatives that emphasize responsible and ethical use of technology. These initiatives educate faculty, staff, and students about issues such as online privacy, information security, digital rights and responsibilities, cyberbullying, and digital footprint management. By fostering a culture of responsible digital behavior, HEIs ensure that technology is utilized in a safe, ethical, and respectful manner.

Each stage of this technology challenge faced by HEIs, especially in Pekanbaru combines all the resources from stakeholders, including students, faculty, administrators, and staff, regarding the impact of technology in creating a smart campus. The most challenging is in the integration stage and optimization stage. It is quite a challenge how HEIs develop technology frameworks or guidelines that establish standards, policies, and best practices for technology implementation (Hartati et al., 2022; Saripudin et al., 2019). And also Innovation and Future-Readiness in the optimization stage, Most HEIs in Pekanbaru need to continually adapt to new technologies and avoid investing in technologies that may become quickly outdated. This requires staying updated on emerging trends and making informed decisions about technology adoption. Failure to keep up with evolving technologies may result in investments in outdated or ineffective solutions, negatively impacting the institution's ability to adapt and innovate toward a smart campus (Kucharska & Rebelo, 2022; Salamun et al., 2021). This research has differences from any other research in this paper. This research explained how HEIs struggle, adopted, and adapt to technology especially aligning to smart campuses. The problems in this research describe in detailed stages of technology challenges. This research also gives various solutions for Implementing technology in teaching, learning, research, and innovations. The innovation or novelty in this research can be described in that these detailed stages can be used for HEIs in technology challenges creating smart campuses. From the first adoption stage, implementation stage, integration stage, and optimization stage, HEIs can be measured in how technology impacts the HEIs toward smart campuses. As we know that smart campus is a goal for almost all universities in Pekanbaru.

4. CONCLUSION

The role of technology in creating a smart campus is multi-faceted and encompasses various aspects. technology serves as the foundation for a smart campus, enabling connectivity, automation, data-driven decision-making, and enhanced learning experiences. It empowers educational institutions to

optimize resources, improve operational efficiency, promote sustainability, and create an engaging and collaborative environment for students and faculty. The challenges of universities in Pekanbaru also have faced all over universities in Indonesia. By taking care of all technology stages in this article, HEIs are suggested to support technology development frameworks or guidelines that establish standards, policies, and best practices for technology adoption, implementation, integration, and optimization. HEIs need to establish a vision and strategic plan for creating a smart campus. This involves setting goals and objectives related to technology integration, sustainability, and enhancing the learning environment. A smart campus for smart HEIs creates an innovative and connected educational environment that enhances teaching and learning experiences, supports sustainable practices, promotes collaboration, and prepares students for the digital age.

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