CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

BACHELOR THESIS ASSIGNMENT

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Economics Policy and Administration

Business Administration

Thesis title

The Role of ICT and Big Data in Smart Digital Campus

Objectives of thesis

The objectives of this work are to identify the positive and negative effects of ICT and Big Data in smart digital campus. Consideration of the impact on different aspects of life, such as society as a whole, the education system, environmental transformation and much more.

Next Objectives
• Identify the state-of-the-art and propose a smart campus framework.
• Identify the essential elements and the most significant deficiencies in the Smart Campus dimensions and from the user point.

Methodology

The methodology of using open source public observation data in the AR/VR area does not suit my research for the diploma thesis. This is because, although it provides access to real-time data and feedback, it does not offer sufficient specific information for my purposes. Therefore, I decided to choose a new methodology: «The methodology will use quantitative research, in particular, in the form of a questionnaire. Quantitative survey questions will be defined as objective questions used to get detailed information from respondents about the topic of the survey. The target group in the practical part will be students and teachers of digital campuses».

**The proposed extent of the thesis**

30-40 pages

Keywords

Big data, ICT, Informatization, Society, education, development, environment, resources, infrastructure, smart, digital.

Recommended information sources

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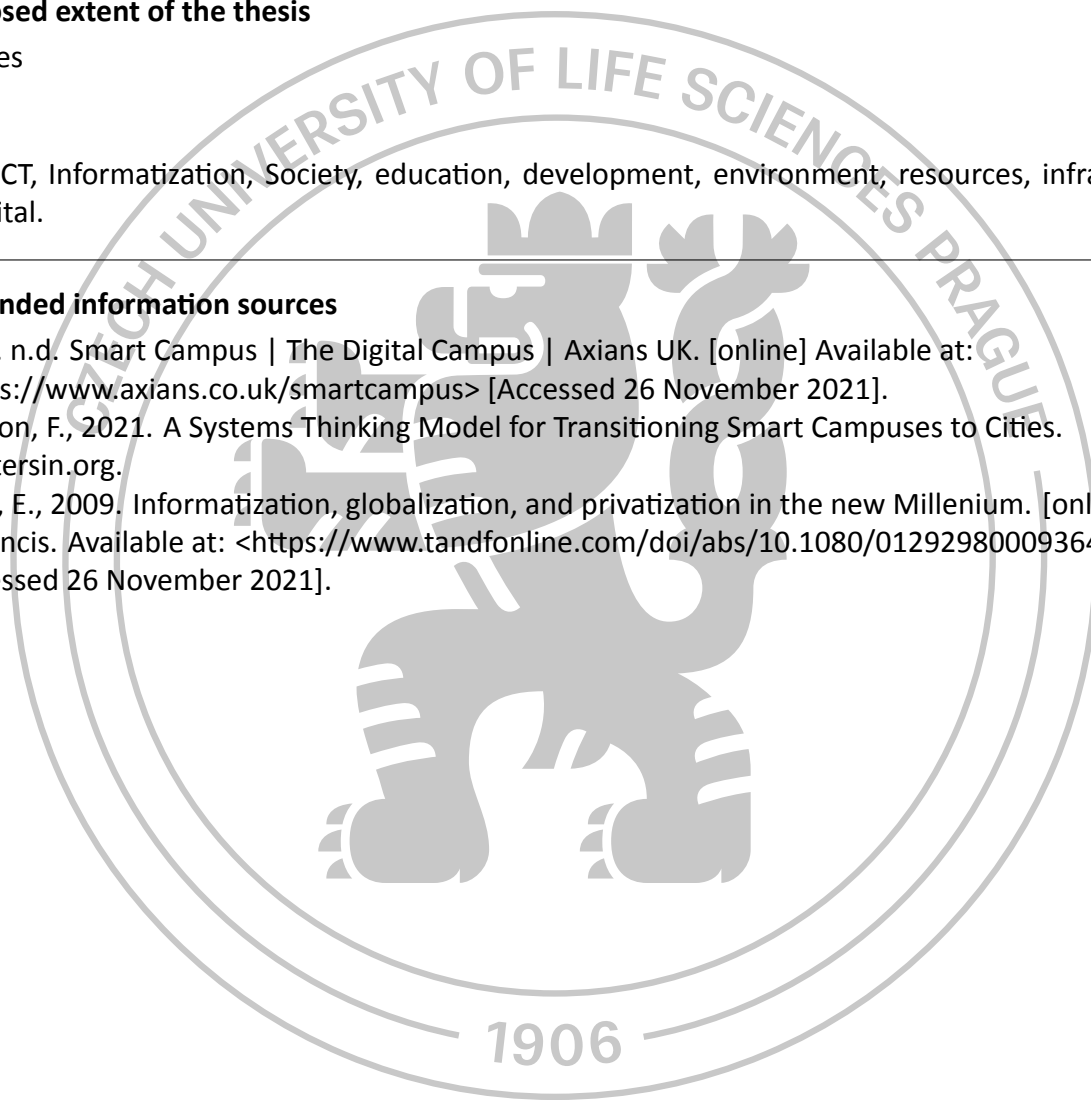
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Declaration

I declare that I have worked on my bachelor thesis titled "The Role of ICT and Big Data in Smart Digital Campus" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break any copyrights.

In Prague on 15.03.2024 _____

Beliankina Anna

Acknowledgement

I would like to thank Ing. Eva Kánská fot her advice and support during my work on this thesis. I also would like to thank the students who took part in my research work and my family for their support.

The Role of ICT and Big Data in Smart Digital Campus

Abstract

In today's quickly changing world, the integration of information and communication technology (ICT) and big data has revolutionized the way we connected with the world around us. Progresses in information technology and the ability to analyze vast amounts of data have driven to changes and improvements in many areas. Education is one such area that has profited from the integration of ICT and big data. Using these advances, educational institutions can make smart digital campuses that offer innovative teaching strategies, optimize administrative processes and improve the overall quality of education. The utilize of ICT and big data in education changing traditional learning environments into energetic interactive spaces that meet wants of today's learners. The main aims and objectives of this research are to recognize the benefits and challenges of integrating ICT and big data in a smart digital campus, investigate best practices for doing so, evaluate the impact on student performance and evaluate the potential for change the higher instruction segment.

Keywords: ICT, Big Data, Smart, Digital, Education

Úloha ICT a velkých dat v inteligentním digitálním kampusu

Abstrakt

V dnešním rychle se měnícím světě způsobila integrace informačních a komunikačních technologií (ICT) a velkých dat revoluci ve způsobu, jakým jsme propojeni se světem kolem nás. Pokrok v informačních technologiích a schopnost analyzovat obrovské množství dat vedly ke změnám a zlepšením v mnoha oblastech. Jednou z takových oblastí, která profituje z integrace ICT a velkých dat, je vzdělávání. S využitím těchto pokroků mohou vzdělávací instituce vytvářet chytré digitální kampusy, které nabízejí inovativní výukové strategie, optimalizují administrativní procesy a celkově zlepšují kvalitu vzdělávání. Využití ICT a velkých dat ve vzdělávání mění tradiční výukové prostředí v energické interaktivní prostory, které splňují požadavky dnešních studentů. Hlavními cíli a úkoly tohoto výzkumu je rozpoznat přínosy a výzvy integrace ICT a velkých dat v chytrém digitálním kampusu, prozkoumat osvědčené postupy pro tento účel, zhodnotit dopad na výkon studentů a vyhodnotit potenciál pro změnu segmentu vysokoškolské výuky.

Klíčová slova: ICT, Big Data, Smart, Digitální, Vzdělávání

Table of content

1   Introduction

In today's rapidly changing society, technology plays an important role. They penetrate into all aspects of a person's life, affecting the way they communicate, work and learn. This process towards digitalization is accompanied by the accelerated development of information and communication technologies (ICT) and big data analysis.

ICT penetrates our lives in a variety of forms, from the use of mobile communication applications to online learning and working on business projects through cloud services. They connect people, make vast amounts of information available, simplify everyday tasks, and even transform the way we are entertained.

Big data analysis opens up new possibilities in understanding different work processes and behavior. It allows you to identify problems in work and training, find informed solutions to eliminate obstacles and predict trends for the future. In education, data analytics helps to personalize the learning experience, tailor learning programs to individual student needs, and effectively manage educational resources.

In the field of education, smart digital campuses are gaining particular attention. These are innovative educational spaces in which technology creates a unique area for learning and research. Smart campuses promote innovative research and collaboration by offering faculty and students access to course materials, process management, and creative learning environments. They illustrate how technology can raise educational standards while providing greater accessibility and efficiency.

The use and understanding of technologies in education such as ICT and big data analysis becomes a necessity to prepare a new generation of specialists capable of working in the modern information society. As a result, big data analytics and ICT play a more important role in smart digital campuses than just access to information. They offer a fresh perspective on education, research and innovation, laying the foundation for the development of education in the 21st century.

2   Objectives and Methodology

2.1   Objectives

The objectives of this work are to identify the positive and negative effects of ICT and Big Data in smart digital campus. Consideration of the impact on different aspects of life, such as society as a whole, the education system, environmental transformation and much more.

Next Objectives

• Identify the state-of-the-art and propose a smart campus framework.

• Identify the essential elements and the most significant deficiencies in the Smart Campus dimensions and from the user point.

2.2   Methodology

Considering the chosen research goal, which focuses on identifying the positive and negative effects of information and communication technologies (ICT) and big data in the intelligent digital campus, a quantitative research method – a questionnaire – was selected as the primary research method. This method is suitable when conveying information about the representation of the observed phenomenon in society or a target group. In contrast to qualitative methods, research with quantitative data is evaluated using statistical tools and graphical illustrations. Questionnaire, as the primary instrument for quantitative research, was used because it is a simple and effective tool for collecting primary data.

In the presented bachelor's thesis, a survey was conducted on the use of ICT and big data in the intelligent digital campus. The research was carried out through anonymous questionnaire distribution. Respondents were briefed on the research purpose, confidentiality, and how to fill out the questionnaire. The provided questionnaire variant contained 15 questions.

Before data collection through the questionnaire, a pilot test involving representatives of the target group was conducted. The questionnaire was emailed to the representatives. The goal was to receive feedback on both the formulation and clarity of the questions. It was important to understand how much time it takes to complete the questionnaire and how well it functions technically. One of the respondents in the pilot testing suggested adding a question about personal data, while another suggested adding more response options to questions 11 and 14.

Therefore, the bachelor's thesis represents a research aimed at examining certain aspects of interaction between students and teachers in the educational environment. A survey was conducted among 100 respondents, including both students and teachers. The survey was organized by sending questionnaires to students' personal mailboxes and teachers' corporate mailboxes. This approach allowed for maximum coverage of the sample and obtaining diverse opinions from both sides of the interaction.

Special attention was given to the security of the obtained information. To ensure the confidentiality and anonymity of the data, each respondent could be assured that the information provided in the survey would be used exclusively for the current research and would not be shared with third parties. The survey analysis results will include statistical processing of the collected data, identification of main trends and patterns, as well as interpretation of results considering the set goals and hypotheses of the research. The conclusions drawn will have practical implications for developing recommendations to improve interaction between students and teachers in the educational process and creating a favorable educational environment.

3 Literature Review

3.1 Smart digital campus

Smart digital campuses are innovative learning environments that have emerged primarily due to the development of technology in the world and the growing needs of students. Smart campuses are an educational field in which campus life is optimized through modern technologies such as ICT and big data. A smart campus is a complex of several systems that range from a smart classroom that improves the learning experience for students to a smart campus that provides many common services in the entire campus environment (Yu, Z. et al., 2011). These campuses strive to create a smart learning environment where learning becomes more technologically advanced. The rise in the emergence of virtual universities has increased significantly in recent years due to the fact that students have a growing need for more modern and innovative learning (Jurva, R. et al., 2020).

In the context of running a smart digital campus, there are several aspects that play a key role. Firstly, ICT is information and communication technology that plays an important role in providing access to educational resources, helps create effective learning processes and ensures effective interaction between students, teachers and administrators. Currently, things like learning management systems, virtual classrooms, online resources and mobile applications, which allow learning to be more flexible, accessible and personalized, are becoming increasingly common parts of modern education.

At the same time, big data analysis allows universities to create new opportunities to improve educational processes and analyze data obtained through electronic sensors. With this analysis, universities can gain an understanding of student behavior, their preferences, performance and needs, moreover, it allows administrators and teachers to tailor curricula based on the needs and desires of students, as well as provide real-time guidance and support to students in achieving their educational goals.

However, a campus is essentially a social environment, where social interactions are very important (Yu, Z. et al., 2011). The main goal of a smart digital campus is to improve the learning process of students with the help of modern technology. This includes network upgrades, data processing, the use of e-platforms for independent learning, course recording and smart classrooms. One of the reasons for the emergence of a smart campus is social interaction, which reaches a new technological level, but still primarily represents

the social sphere (Jurva, R. et al., 2020). In a smart campus, every student or employee has access to information and data anywhere and at any time; moreover, learning can be provided throughout life and, with the capabilities of new technologies, learning can take place both offline and online. A Smart Campus can be considered to offer sophisticated services and individual information for students, teachers, researchers and visitors based on their profile.

3.1.1 Smart Building Technologies

Smart building technologies include a range of innovative solutions aimed at improving the functionality and sustainability of campus facilities. These include automated lighting, heating, ventilation and air conditioning systems, as well as occupancy sensors and energy management systems.

First of all, it is worth paying attention to our impact on the ecological environment, which is increasing every year, so more and more organizations, including universities, are resorting to a more environmentally friendly distribution of resources such as water, light and heating Sustainability education is the process of providing individuals with the necessary knowledge, skills, motivation, and attitudes to reverse the current trend towards an unsustainable future. Its goal is to achieve a balance between the well-being and advancement of human lives and the preservation, protection, and enhancement of ecosystems (Douglas, F. et al., 2024).

Effective allocation of finances is an important component of the university's success. It involves strategic planning, budgeting, financial reporting, and monitoring mechanisms to ensure that financial resources are utilized efficiently and transparently (Wilson, 2017). Therefore, it is important to understand that for universities, tracking energy consumption: water, light and heating in real time is a way to reduce costs and more environmentally friendly consumption.

3.1.2 IoT Implementation

In recent years, we have witnessed significant growth in the Internet of Things (IoT), fuelled by technological advancements, widespread internet connectivity, and increased adoption of smart homes integration of IoT applications across various industries such as education, healthcare, agriculture and transport. This upward trajectory is expected to continue due to the ongoing development of new technologies and continuous

advancement of IoT devices. he Internet of Things (IoT), commonly known as the Internet of Everything, is a network concept between software and machines in a global scope that aims to interact with each other (Soegoto, E.S. et al., 2022). The main idea of IoT is to integrate the Internet, mobile devices, machines, electronic equipment, and others so that they are connected in real-time and can be shared by users (Talari, S. et al., 2017).

Smart Campus is a university that uses technology to better its operations and the educational experience of its students while also gathering data and enhancing worker productivity. IoT solutions enable educational institutions to efficiently gather additional data from sensors and wearable devices, and subsequently make informed decisions and implement effective measures based on that data. The use of IoT devices to create a connected campus environment is one of the most notable examples of smart campus technology. IoT devices can be installed in a variety of campus locations, including classrooms, residence halls, and outdoor areas. In the process, each sensor that has been installed will send data from one node to another, where it will be processed to make decisions and can move other devices automatically according to system decisions (Rafdhi, A.A. et al., 2021).

Technology has a significant influence on education, affecting multiple areas such as student involvement in learning and the creation of educational material, as well as assisting educators in delivering customized curriculum and enhancing student achievement. Students can acquire knowledge by utilizing embedded sensors, QR codes, and various other technologies. The majority of IoT devices primarily rely on electricity, particularly for indoor smart applications. The application's stability can be achieved by establishing a connection through Wi-Fi for the purpose of data transfer. This will provide precise and reliable transmission of data at a high rate, while also ensuring efficient connectivity with energy-saving Internet of Things (IoT) devices.

3.1.3   Digital Learning Environments

As teaching is one of the most important activities in colleges and universities, more attentions were paid to smart classrooms (Yu, Z. et al., 2011). Smart classrooms are modern educational spaces that open up new learning opportunities. They use modern technology to help create a hands-on and interactive learning environment. Virtual reality (VR) is one of the most popular types of technology today, in which students can move to a

virtual workplace to adapt to the environment and remotely try out practical work. Currently, the field of education is getting closer to creating more and more high-quality and technologically advanced learning experiences for students (Jurva, R. et al., 2020). Alternatively, this can be facilitated by investing in technologies that can impact learning, for example, investing in mixed reality glasses and an equipped operating room will help medical students experience their knowledge in practice much earlier and be better prepared for real-life situations (Jurva, R. et al., 2020).

Since communication is one of the fundamental aspects of learning, nowadays communication is not limited only to the campus and providing communication opportunities not only in a face-to-face format, but also in an online format is an important aspect to meet the needs of a modern person. A smart digital campus must have Internet connection so that students, teachers and institutions can easily access online resources and collaborate with one another. This provides continuous access to a variety of online resources, independent learning and study, and also improves and speeds up communication between students and teachers (Cloud4Wi, 2024). Through the combination of Internet and traditional teaching, we have constructed a perfect education system combining networking, digitalization and individualization (Jia, Y., 2024). Access to the Internet is made possible by Wi-Fi networks, which provide Internet access to solve any problem at any time throughout the entire campus. This seamless connectivity ensures that learning isn't limited to the classroom (Cloud4Wi, 2024). Students can study and learn the material independently in their free time, if required and regardless of the schedule of seminars and lectures (Cloud4Wi, 2024).

Digital Environment can make learning more personalized to improve student productivity and satisfaction by enabling students to learn in their own environment. Teachers, in turn, can try different teaching formats to analyze and achieve these goals. Using the network platform for teaching, there is a huge difference with the traditional teaching mode, but this new teaching mode can faster attract students to learn, through the network to spread sports skills and sports knowledge, can drive the enthusiasm of students, at the same time can change students' learning habits and learning methods (Jia, Y., 2024).

3.2 ICT in Higher Education

ICT, in the context of a smart campus in higher education, has a significant role in enhancing the learning process by enabling the integration of new skills and methodologies. New technologies such as mobile devices, smart boards, laptops, virtual laboratories and many others are changing the methods of education, the way they learn and interact with content, as well as the student experience in schools and educational institutions (Haleem, A. et al., 2022). Due to the growing accessibility of technology, a rising number of educational institutions are adopting the usage of Information and Communication Technology (ICT) in their activities. Currently, the most renowned and highly sought-after ICT tools include learning management systems, virtual classrooms that utilize technologies like VR and AR, and educational applications and online resources that provide new learning opportunities for students.

Learning management systems enable universities and colleges to effectively oversee the learning process by giving access to course materials, assignments, assessments, and communication tools. This enhances convenience and accessibility for students. Virtual classrooms offer the chance for distance education, along with web-based lectures, workshops, and debates. Online applications and resources enhance students' accessibility to educational information and tools, enabling them to acquire knowledge at any time and from any location. Aside from the ability to communicate information anywhere, at any time, social media sites are also a fantastic source of producing networking possibilities to establish social activities and possibly new jobs (Haleem, A. et al., 2022).

The advantages of implementing Information and Communication Technology (ICT) in higher education are significant and should not be disregarded. Enhancing the availability of education is facilitated by distance learning and online resources, which is particularly crucial for students situated in rural regions or facing restricted educational options owing to health, psychological, or personal constraints. An important benefit of online learning is the flexibility it offers in the educational process. Students have the freedom to select their own learning speed and method of studying based on their own requirements and situations. The implementation of cutting-edge teaching methods and technologies fosters heightened receptivity in learning and cultivates the growth of analytical and profound cognitive abilities.

ICT is increasingly becoming a fundamental component of contemporary education, offering educational institutions and students fresh possibilities for efficient, profound, and adaptable learning, while also enhancing the overall quality of the educational process.

3.2.1   Learning Management Systems (LMS)

With increasing demand for personalized and streamlined learning come new challenges. The limitations of traditional teaching methods in meeting these evolving expectations have lessened the importance of finding innovative solutions that bridge the gap between traditional and modern approaches to education (Jain, M., 2023). The amount of information and data is increasing every day, so educational institutions need to keep pace with improving their systems in order to provide effective and up-to-date training.

A school LMS is a software used by educational institutions to enhance, manage, and plan the learning process for students (Jain, M., 2023). Learning management systems (LMS) have become an integral part of modern education, providing a centralized platform for course management, content delivery, student engagement, and assessment. LMS platforms such as Moodle, Blackboard, and Canvas allow instructors to organize course materials, host online discussions, administer quizzes and exams, and track student progress. Using LMS technology, universities and colleges can provide flexible and interactive learning experiences that meet the diverse needs and preferences of students. The subsequent are the principal advantages of Learning Management Systems (LMSs):

1. Blended Learning

Blended learning is the integration of internet education with traditional classroom instruction. This strategy enhances the overall learning system and provides supplementary advantages. It improves student efficiency, resulting in a more captivating learning experience in comparison to conventional approaches. Additionally, it enables students to engage in online learning, giving them the advantages of flexibility and convenience.

2. Gamification

Gamification is the integration of gaming aspects into the process of learning. By implementing gamification features into a Learning Management System (LMS), students can experience a feeling of accomplishment and advancement, akin to winning a game or progressing through levels. For example, students have the opportunity to advance to higher levels after successfully passing tests or earn higher grades upon finishing chapters.

3. Authentic Feedback from Students

Students can conveniently offer feedback by completing surveys and evaluating courses using a Learning Management System (LMS). The use of this transparent feedback system provides advantages to both students and educators, facilitating ongoing enhancements in the overall educational journey.

4. Individualized Instruction

Accommodating the varying learning speeds and capabilities of individual students might present difficulties in a conventional classroom setting. Nevertheless, a Learning Management System (LMS) supports individualized instruction, allowing teachers to deliver content in a manner that meets the specific requirements of each student. By assessing the rate of learning for each student, educators may provide teaching more efficiently and assist struggling students in catching up with their classmates.

5. Enhancing Efficiency

Acquiring a novel pedagogical approach and gaining proficiency in the corresponding software and its features can present difficulties. To be able to achieve an effective integration of an LMS, it is imperative to choose a platform that is easy for users to navigate and operate. An educational Learning Management System (LMS) should possess the quality of being easily accessible to students across all age groups, while also being user-friendly for instructors to manage. Workshops can be organized to instruct students, parents, and teachers on the functionalities of the Learning Management System (LMS), its advantages, and its potential in assisting them in attaining their objectives.

3.2.2   Mobile Learning Applications

In recent years, the usage of mobile devices and applications in smart campuses has grown in significance. With the development of wireless communication and smart phones, social networking sits are going mobile which promotes the emergence of mobile social networking (Yu, Z. et al., 2011). Students now expect to have access to information and resources wherever they are, at any time. In the modern world, it is more likely that every student, in addition to himself and his knowledge, brings with him an electronic gadget, it could be a phone, laptop or e-book, thanks to which he can access the Internet connection and stay in touch, both for communication and for teaching and learning (Oliveira, D.M., Pedro, L. and Santos, C., 2021). A variety of mobile applications created especially for use in educational institutions and smart campuses have resulted as a result of this.

The widespread adoption of mobile devices has given rise to novel modes of social engagement, effectively mitigating spatial constraints. As a result, individuals can now be contacted and connected at any time and in any location (Monteiro et al., 2017). The ability to easily access course materials, lecture notes, and other resources is one of the major advantages of mobile apps on smart campuses. Each university uses its own form of student communication and information collection tools such as Moodle and Joule to track student progress in courses, provided materials, tests and quizzes (Brohi, S., 2018). This can help students learn more by enabling them to study and get ready for class more efficiently. Additionally, mobile apps can provide students with immediate access to information like announcements and class schedules, which can enhance interaction and cooperation between students and teachers.

The role of phones as a means of communication is no longer relevant, in the modern world a gadget that we can put in our pocket and take with us to university plays a more significant role, since this gadget provides us with easy access to all academic and educational information (Oliveira, D.M., Pedro, L. and Santos, C., 2021). The use of mobile apps to enhance the overall student experience is another advantage of smart campuses. For instance, several mobile apps provide functions like personalized recommendations and reminders that can support students' motivation and engagement. Additionaly, mobile apps can give students access to campus resources like the library and student support, which can boost retention and satisfaction rates among students. Moreover, the availability of educational materials that we can access with one click on our smartphone has increased, and this accessibility also allows us to reduce the time spent searching for the necessary materials (Brohi, S., 2018).

Many opportunities to enhance the educational experience and enhance campus operations are presented by the use of mobile technologies on smart campuses. Following are some of the salient characteristics:

- Students, instructors, and staff can easily and quickly connect with one another with a mobile technology. They could include announcements about upcoming events, cancelled classes, emergency alerts, etc.
- Students' individualized learning can be facilitated by mobile devices. This could involve having access to individualized learning resources, individualized criticism, and individualized learning paths.

- Mobile technology allows students to interact more efficiently on group projects and assignments. This can feature group texting, real-time editing, and shared documents.

- Students can more easily explore the campus with the use of location-based services offered by mobile technology, such as maps and directions.

- Students may have access to crucial resources including library databases, course materials, and campus services thanks to mobile technology.

- Mobile technology can streamline digital grading, speed up turnaround times, and improve the effectiveness of grading procedures.

- By giving access to emergency services, surveillance systems, and other security features, mobile technology can improve campus security.

3.3   Big Data in Education

Big data refers to the large quantities of information that specialized procedures and techniques for analysis and extraction of important insights. Big data is essential in education because it allows for the gathering, examination, and application of data from students, educational materials, and educational procedures. Big data in education are changing methods and approaches across all areas of campus, finding solutions to close long-standing gaps and improving the way students learn for more effective results (Bakhrinovskaya T., 2023). The task of working with data and improving this work still remains relevant, since the main goal of working with data is to identify constant patterns, eliminate the reasons for ineffective work and model the future development system (Bakhrynovskaya T., 2023). Educational institutions accumulate significant volumes of data from various sources, including learning platforms, online courses, and learning management information systems. The data may encompass details regarding student achievement, engagement on the educational platform, outcomes of assessments and assignments, as well as input from both educators and learners.

As data collection and analytics methods advance, administrators will have more information to make projections for future enrollment and decisions about admitting prospective students (Maryville University, 2020). This can help an educational institution drive growth and plan the use of its resources, not just organization-wide but for specific programs and degrees (Maryville University, 2020). Big data analytics can uncover patterns, trends, and correlations among various elements of education, aiding in the

identification of effective teaching methods, the prediction of student outcomes, and the facilitation of well-informed decision-making.

The utilization of big data in education is diverse. Personalized learning analytics enables the customization of curriculum and teaching methods to cater to the specific requirements of each student, hence enhancing their motivation and efficiency in learning. Utilizing predictive modeling to assess academic progress can effectively pinpoint the likelihood of dropout and offer timely assistance to students facing challenging circumstances. Educational data mining techniques enable the extraction of novel insights from educational data, revealing concealed patterns and trends in the process of learning.

3.3.1 What Types of Data Are Used for Education?

Quantitative and qualitative approaches are used to obtain and process the resulting big data in order to obtain a holistic understanding of situations, on the basis of which further decisions will be made (Bakhrynovskaya T., 2023). These decisions can greatly influence the existing educational models, the effectiveness of faculty members, and the academic achievements of students. Moreover, the data gathered could significantly contribute to the comprehensive improvement of the technological infrastructure in educational institutions.

There are five main categories of data that are utilized to achieve the goals above:

- Personal information;
- Information about student engagement with digital learning systems;
- Reports on the effectiveness of learning materials;
- System-wide administrative data;
- Input data for forecasting.

Based on the information received, educational institutions can keep records of student data, and also get an answer to the question "What can be improved on campus" or "What measures should be taken in order to increase the level of student satisfaction and the level of success in working with course materials. Moreover, administrative information can also be obtained through big data analysis to improve university financial and business systems.

3.3.2 Decision Making and Data Analyses

Making decisions and analyzing data are crucial for enhancing the quality of instruction and giving students more possibilities on smart campuses. According to a recent IDC study funded by my organization, it was shown that 25% of necessary choices are not being made owing to operational difficulties related to data, analytics, and AI (Laluyaux, F., 2024). There is a lot of data accessible that can be studied to make wise decisions and enhance outcomes as a result of the increased usage of ICTs and big data in education. In an online education environment, many behavioral factors play a role, for example, analysis of student behavior can occur during recreational games, when a student finds it difficult to answer or when he takes a little longer to answer - all of this is important in order to analyze and suggest improvements or more effective approaches (Bamiah, M.A., Brohi, S. and Rad, B.B., 2018).

Student achievement and learning outcomes are an important area where data analytics can be employed in smart campuses. Examining student data, such as grades, attendance, and engagement indicators, allows educators to better understand student performance and point areas that can benefit from extra help. This can enhance academic achievement and lower the dropout rate.

Resource management is another area in which data analytics can be applied in smart campuses. The way to base decisions is very valuable for a person, however, when it comes to a large amount of data, the best solution would be to optimize the process of data analysis and decision making: adding intelligent technology will significantly simplify working with data and increase the efficiency of staff by redistributing time that can be transferred to other tasks and questions (Laluyaux, F., 2024). Administrators can learn how resources are being used and spot areas for improvement by examining data on campus utilization, such as student enrollment, energy use, and usage of the library. This could aid in waste reduction and resource allocation optimization, saving money and fostering a more sustainable campus environment.

In smart campuses, it is critical to have the appropriate tools and technologies to facilitate effective decision making and data analysis. By allocating resources towards data systems and infrastructure, providing training to staff on data analysis, implementing data protocols and standards, and utilizing data to guide decision-making, school business leaders can guarantee the efficient and effective utilization of resources and ensure that all students receive the necessary support for academic success (Education executive, 2023).

Decision intelligence is an innovative use of artificial intelligence (AI) that has the potential to revolutionize the way businesses operate in the future (Laluyaux, F., 2024).

3.3.3 Cloud Computing

Cloud computing is an excellent example of smart campus technology that can help colleges and universities to simplify their operations and improve their services. Cloud computing is being an alternate choice of computer and mobile users for the data storage and access (Giri S., 2019). Cloud computing refers to the delivery of computing resources and services over the Internet. Since the data is produced by users' devices, and collected through access points or the Internet, multiple network protocols are necessitated to guarantee the robustness of the system (Yu, Z. et al., 2011).

Cloud computing is an important tool that can help colleges and universities to reduce costs, increase effectiveness, and enhance their services. By using cloud computing technology, advanced education institutions can give students and faculty with access to the last operations and resources and deliver a further flawless and collaborative learning experience. Cloud computing platforms provide easy access, scalability, reliability, reconfigurability, and high performance from its resources over the Internet without complex infrastructure management by customers (Surbiryala, J. and Rong, C., 2019).

3.3.4 Campus Security

First of all, a smart campus must be equipped with all security measures in case of emergency. The safeguarding of smart campuses necessitates an exhaustive approach to cybersecurity, encompassing the establishment of security policies and procedures, as well as the implementation of technical security measures such as network monitoring, data security, physical security, and IoT device protection (Srhir, A., Mazri, T. and Benbrahim, M., 2023).

Campus security measures include surveillance cameras, access control systems, and emergency response systems that can be monitored in real time. Surveillance cameras allow monitoring the process throughout the entire campus in order to avoid unexpected events or problems in a short period of time. Access control systems allow restricting access to those who are not related to the campus. Alert systems that let students and campus staff know about an emergency such as a fire or a public order violation. It is also

important to conduct training and education on how to behave and how to act in such situations.

Particular attention should also be paid to protecting confidential data. Organizations, including smart campuses, must address privacy, confidentiality, and integrity requirements to protect sensitive information and maintain trust with stakeholders (Srhir, A., Mazri, T. and Benbrahim, M., 2023). Students' personal information such as names, addresses and grades must be protected to prevent access to this information by third parties who could use it to their advantage. Therefore, training school staff to ensure they understand the rules and regulations regarding confidential data is very important.

3.4 Integration of ICT and Big Data in Smart Digital Campuses

Information and communication technology (ICT) and big data are more common in educational settings in the quickly changing technological world of today. Smart digital campuses, which integrate these technologies to give students cutting-edge, immersive learning experiences, are developing as a new frontier in education. ICT and big data are changing the way we think about teaching and learning because they have the potential to improve collaboration, personalization, and accessibility. Although these technologies have many benefits, there are also particular difficulties and constraints that need to be taken into account. In this context, it's necessary to assess how ICT and big data are affecting students' learning experiences in a smart digital campus and look at how to maximize their benefits while limiting their drawbacks.

One of the key technologies for smart campuses is Internet of Things (IoT) devices. The Internet of Things provides the ability to store data online by connecting a variety of devices and sensors, allowing the information to be processed and the results used to measure or monitor various environments (Villegas-Ch, W., Pacheco, X.P. and Mora, S.L., 2019).These devices may include sensors, smart boards, wearables, and other smart devices that collect data about student behavior, learning, and the campus environment. This data can be used to analyze and optimize the educational process.

Another important technology is cloud computing, which allows you to access educational resources and applications from anywhere on the network. With the use of cloud computing, each user is able to create, edit and store files in the cloud according to their own needs (Paul, P. et al., 2023). Cloud platforms also provide a scalable and flexible

infrastructure for storing and processing large volumes of data required for real-time big data analytics. Modern education and research strive for flexibility, allowing one to overcome geographical distances and avoid time constraints (Al-Zoube, M., 2009). A variety of learning materials and meaningful lectures, including peer learning, can be easily achieved through the use of advanced IT tools such as cloud technology (Paul, P. et al., 2023).

Data analytics software also plays an important role in smart campuses. These software tools allow you to analyze data, identify patterns and trends, predict outcomes, and make informed decisions based on data. Using technology, institutions can streamline executive processes, optimize resource use, and reduce costs. Technology itself is changing the way we analyze information and make decisions in areas such as academic performance, technology effectiveness, faculty, and organizational interaction (Bahrynovska, T., 2022).

Artificial intelligence provides educators with the opportunity to improve the effectiveness of their teaching and create optimal conditions for student learning and development (UNESCO IITE., 2020). Artificial intelligence (AI) systems are also widely used in smart campuses to automate processes, manage data, and provide personalized support to students and faculty. By analyzing various data sources and generating insights that support the creation of personalized learning paths, AI can significantly reduce the time educators spend processing and collating such information (UNESCO IITE., 2020). This is especially important considering that this is a task that is almost impossible without the help of technology. An illustration of the successful integration of ICT and big data into a smart digital lot is the design to produce an intelligent system for covering pupil progress grounded on an analysis of their exertion in the literacy terrain. Data is collected using IoT detectors and also anatomized using data analytics and AI software to identify patterns and prognosticate pupil academic success. This system helps universities give individualized support to scholars and ameliorate the quality of education.

3.5 Challenges and Considerations

The operation of ICT and big data in smart digital premises isn't without challenges and limitations that must be taken into account to successfully apply systems and insure the safe and effective use of technology in educational surroundings. Understanding these challenges is paramount in developing strategies that not only address current obstacles,

but also pave the way for a more agile and sustainable integration of ICT and big data in shaping the future of higher education.

One of the main challenges is data protection and sequestration. With the increase in the volume of information collected and reused, the pitfalls of leakage of nonpublic data of scholars and preceptors increase. Sensitive data can be compromised or accessed by unauthorized individuals more and more often as technology advances and connections expand. This can lead to serious consequences, including identity theft, loss of money, and damage to the reputation of both individuals and the institution. There should be restrictions that do not require personal data concerning the most private aspects of a person's life, which excludes the possibility of creating a profile that could pose a threat to the individual in terms of ideology, race, sexual orientation, medicine, economics or any other aspects (Villegas-Ch, W., Pacheco, X.P. and Mora, S.L., 2019). Moreover, the information in the process must be properly protected and used exclusively for educational analysis, respecting the right to privacy, which is protected by legal norms and ensures the protection of home, documents and personal correspondence (Villegas-Ch, W., Pacheco, X.P. and Mora, S.L., 2019). This ensures that others cannot tamper with these elements without the owner's consent (Villegas-Ch, W., Pacheco, X.P. and Mora, S.L., 2019). Clear policies and procedures for data privacy and security must be established, together with frequent audits and reviews of the security systems, in order to reduce these risks. Also, ensuring that everyone understands the significance of securing sensitive information can help lessen the likelihood of security breaches by offering continuing education and training for users on data privacy and security best practices.

Cybersecurity also poses a major trouble to smart digital premises. The possibility of hacker attacks on structure, systems hacking and data theft requires careful monitoring and regular updating of security systems. A smart digital campus can also be a tempting target for cyber-attacks due to the sheer amount of accumulated data that endangers not only individual users, but the entire campus community. Deploying strong security features such as encryption, firewalls, and access controls is essential to protect against potential attacks.

The need to modernize structure and increase its capacity can pose a fiscal challenge for educational institutions. The costs of acquiring and maintaining new technologies can be significant, especially for educational institutions with limited budgets. There is also evidence that low-tech interventions for "instruction at the appropriate level" can significantly affect learning (Haleem, A. et al., 2022). Because low-tech solutions are less

expensive and funding restricts impoverished nations, careful investigation is required to establish whether high-tech or low-tech solutions are better or not (Haleem, A. et al., 2022). It takes specialized knowledge and technology, which can be expensive to acquire and maintain, to process, analyze, and protect this data. A large financial and human resource commitment may also be necessary to teach staff and students to use these technologies effectively. ICT and big data have the potential to revolutionize smart digital campuses, but before using either of these technologies, the related costs must be carefully considered. To make well-informed judgments on how to best optimize the educational experience and enhance institutional performance, benefits and costs must be balanced.

The issue of digital peak also requires attention. Some students come from low-income families and do not have cellphones in their homes; thus, they struggle in school (Haleem, A. et al., 2022). Access to the Internet can also be a significant problem; some students may simply not have it at home. Uneven access to technology and the internet can produce walls to literacy and development for scholars from low- income or remote areas.   Teachers may also have problems with technology since not all of them will have experience working with it and have an idea of how to work.

To overcome these challenges, strategies and stylish practices must be developed to insure security, data protection, and indifferent access to technology in educational surroundings. This may include regularly assessing system vulnerabilities, training staff on cybersecurity, enforcing data encryption mechanisms, and creating programs and enterprise to increase access to technology for all scholars. It's also important to pay attention to the ethical aspects of the use of technology and the development of programs and norms that insure respect for the principles of sequestration, equity and social responsibility in the educational process.

3.6   Future Directions and Opportunities

The future of smart digital premises aims to further integrate advanced technologies, enhance big data analytics capabilities and develop innovative educational technologies. "The global e-learning market size is expected to grow from $245.5 billion in 2022 to $278 billion in 2023, at a CAGR of more than 13%" (Debétaz , E., 2023). "By 2027, the market is projected to reach $462.6 billion, growing at a CAGR of more than 13%" (Debétaz , E., 2023). One of the main areas of development is to further ameliorate ICT structure, including the deployment of 5G networks, increased use of Internet of effects (IoT) devices

and the development of more effective results. This will ameliorate the vacuity and speed of data transfer, furnishing briskly and more accessible use of educational coffers and operations.

An important direction for farther development is also the strengthening of big data analytics in education. Advanced machine literacy and artificial intelligence algorithms will be used to more directly dissect learning data, prognosticate student success, and optimaze the educational experience. This opens up new openings for developing personalized educational programs, taking into account different literacy styles and students requirements, as well as optimizing the process of assessing progress and looking for future.

In addition, the future of smart digital premises will be associated with the active development of educational technologies. The preface of virtual and augmented reality, the expanded use of gamification in the educational process, as well as the development of interactive and adaptive literacy operations will produce further engaging and effective tutoring styles that promote active students engagement and the development of their skills.

Learning and teaching are examples of the opportunities of ICT and big data in a smart digital campus. The ongoing fourth "educational" revolution requires a revision of the traditional educational imperative, which implies a rethinking of such concepts as effective learning and subject learning, as well as going beyond the educational model of transferring knowledge from teacher to student (Bahrynovska, T., 2022). By using technology, schools can upgrade the learning experience for students and give educators with precious insights into student behavior, learning patterns, and achievement. Here are some of the ways that ICT and big data can profit learning and teaching on a smart digital campus.

• Personalized learning: Learning analytics can be used to dissect student data and give a personalized learning experience. This can help understand each student's learning requirements and tailor their teaching approach to suit their individual learning style.

• Real-time feedback: ICT can be used to give students with real-time feedback on their progress and performance. For advanced students, new opportunities for additional learning levels and assignments open up through communication with teachers (Debétaz , E., 2023). It is also an advantage for those who are struggling to learn and understand the

material and require additional assistance to help them stay engaged and motivated, and to identify areas where they need to focus their attention.

• Cooperative Learning: ICT can be used to promote cooperative learning by furnishing tools for online conversations, group systems and virtual events. This can help students work together and learn from each other indeed if they aren't in the same physical position.

• Access to digital resources: ICT can be used to give students with access to a wide range of digital resources such as e-books, online magazines and multimedia content. This can help students access information anytime, anywhere, and on any device.

As we move forward in this direction, new openings for further exploration, invention and collaboration arise. Research in the field of smart digital premises can be aimed at studying the effectiveness of new technologies and tutoring styles, assessing their impact on learning issues, and developing strategies for successful integration into the educational process. In addition, collaboration between universities, companies and government associations can facilitate the exchange of knowledge, coffers and experience in the field of smart digital premises, which will accelerate the process of their development and realize the eventuality for perfecting education and lot life.

4   Practical Part

4.1   Questionnaire

This chapter reviews and analyzes the data obtained on the basis of the questionnaire.
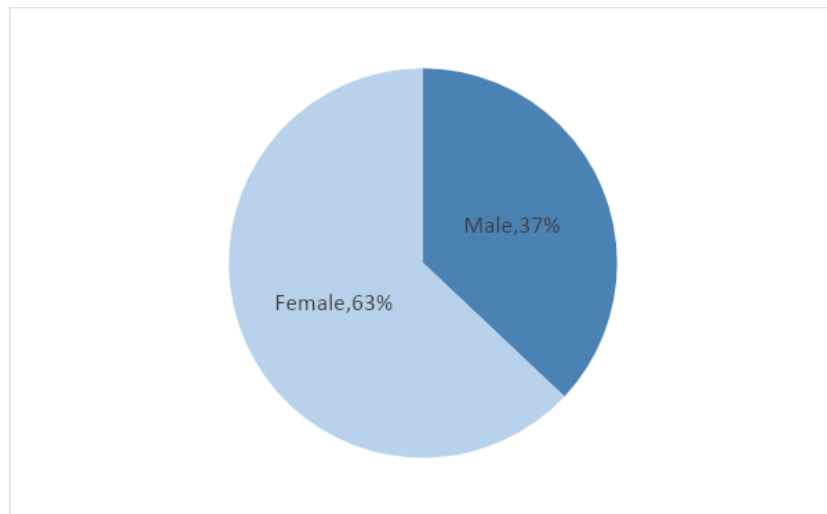
Figure 1. Indicate your gender

Source: own development

Based on the responses to the first question of the questionnaire, we can observe that the majority of respondents (63 individuals) are female, while the number of male respondents is significantly lower (37 individuals). Therefore, we can conclude that more female participants took part in this survey compared to males.
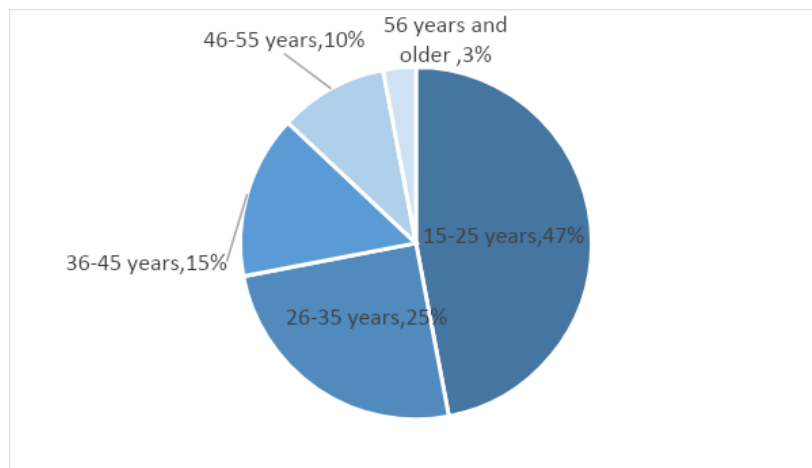
Figure 2. Specify your age

Source: own development

The survey results indicate that the majority of respondents (47 individuals) fall into the age range of 15 to 25 years. This suggests that young individuals are more interested in the use of ICT and big data in education. Additionally, we observe a decrease in the number of respondents as age increases—from 47 individuals in the 15 to 25 age group to 3 individuals in the 56 years and older category.

Based on this, we can infer that younger individuals are more open and receptive to the integration of new technologies into the educational process, while the older generation shows less interest in this topic. It is important to consider this when planning and implementing new technologies in the educational process to make education more appealing and effective for all age groups.
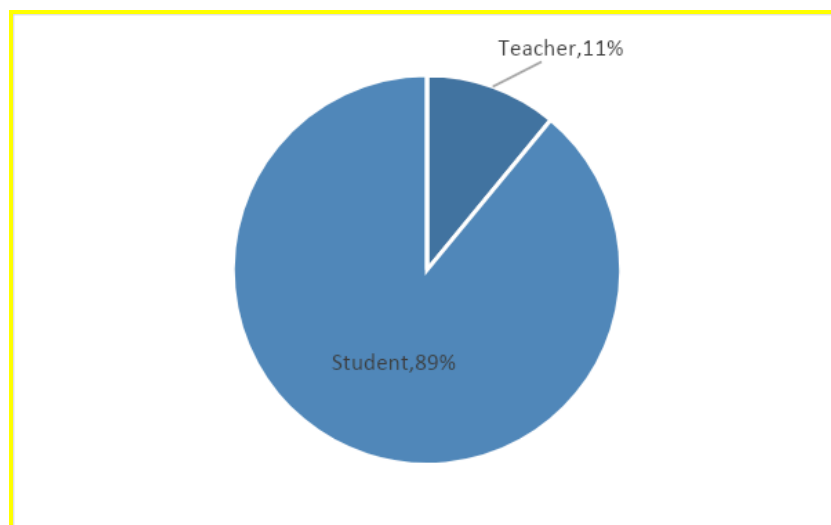
Figure 3. Specify your occupation

Source: own development

The figure 3 clearly illustrates the distribution of occupations among the respondents to this survey. A significant majority, 89%, identified themselves as students, making them the predominant group. In contrast, only 11% of the participants are teachers, highlighting a substantial disparity between the two groups. Notably, no respondents identified with occupations categorized as 'Other,' indicating a specific focus of this survey on the educational sector. This data could suggest a high level of engagement or interest from the student body, potentially for a study or feedback related to educational services, tools, or environments.
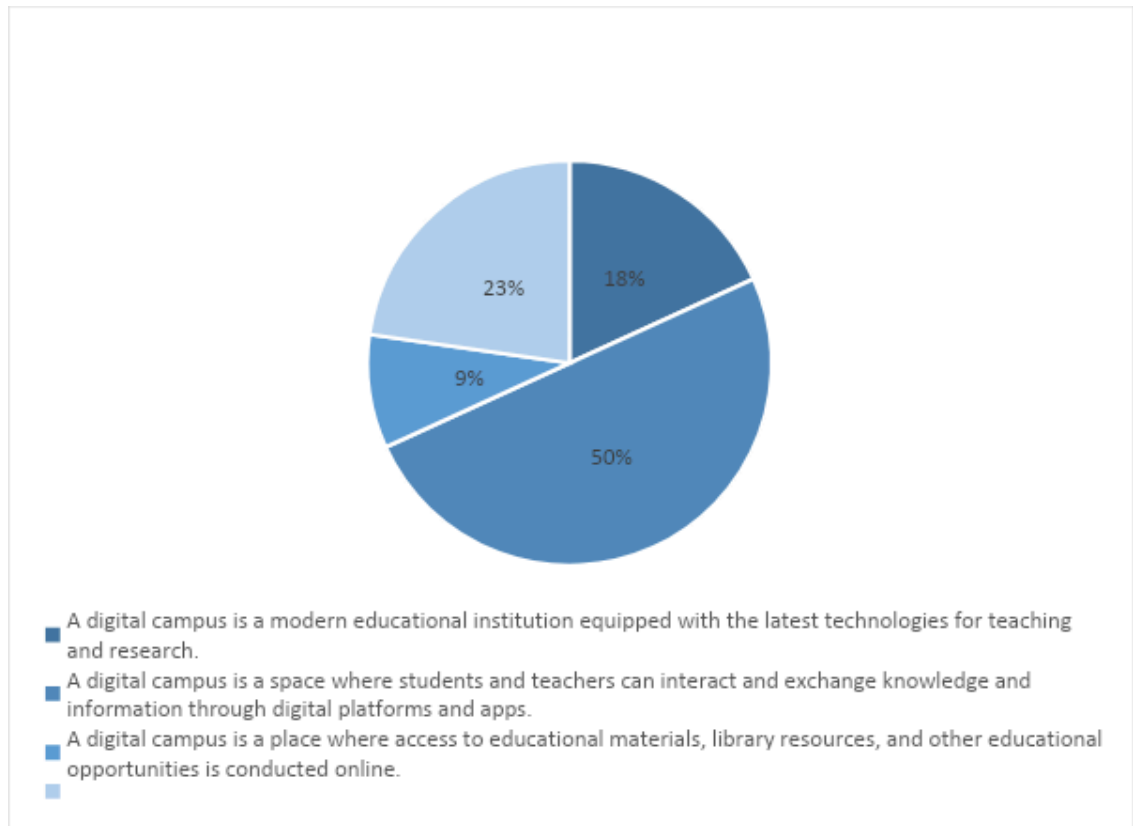
Figure 4. In your opinion, what does a digital campus represent?

Source: own development

Based on the survey results, we can draw the following conclusions. The majority of respondents (55 individuals) believe that a digital campus is a space where students and teachers can interact and exchange knowledge and information through digital platforms and apps. This indicates that, for them, it is important not only to use modern technologies but also to create a digital environment for knowledge exchange. A significant portion of respondents (25 individuals) considers a digital campus to be an innovative environment that utilizes various digital tools and technologies to improve the learning process and communication. This suggests that innovation and the use of advanced technologies in education are important to them.

A small number of respondents (10 individuals) see a digital campus as a place where access to educational materials, library resources, and other educational opportunities is conducted online. This indicates that convenient and fast access to educational resources through the internet is important to them. Another small portion of respondents (20 individuals) believes that a digital campus is a modern educational institution equipped with the latest technologies for teaching and research. This

underscores the importance of using advanced technologies in the educational process for them. In summary, we can say that, according to the majority of respondents, a digital campus is not just a technologically equipped learning space; it is a digital environment where communication, innovation, and online resource access are crucial.
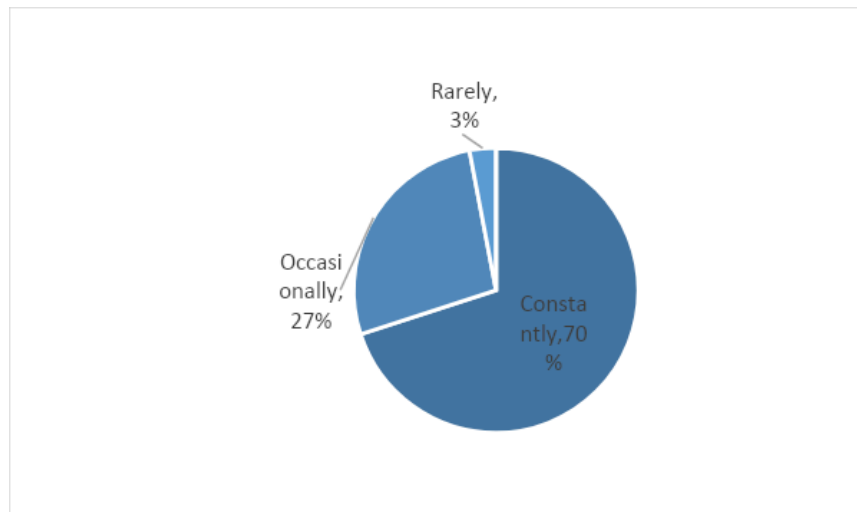

Figure 5. How often do you use the digital campus?

Source: own development

According to the survey results, the majority of surveyed students and teachers (70 individuals) use the digital campus constantly. 27 individuals occasionally use the digital campus, while only 3 individuals use it rarely. None of the respondents indicated that they never use the digital campus.

From this, we can infer that the digital campus is an essential tool for students and teachers, and they regularly use it to enhance their educational and learning processes. The constant use of the digital campus may suggest that it has become an integral part of their daily life in the educational institution.
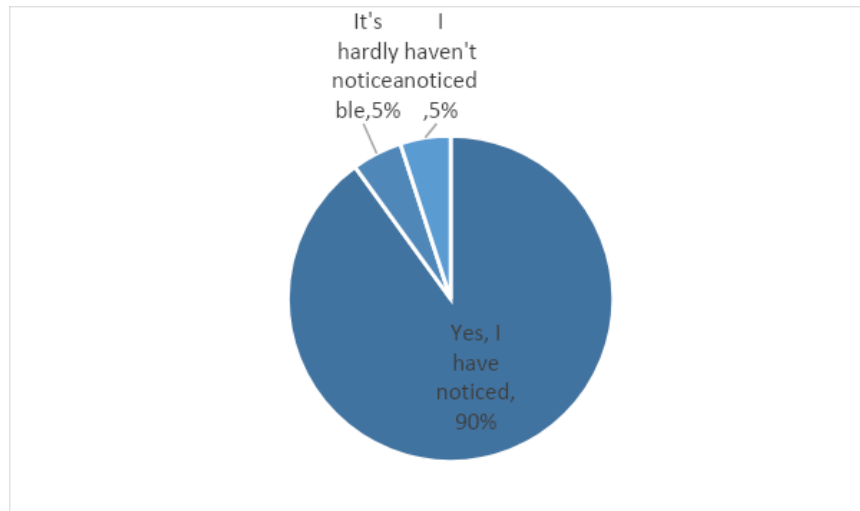
Figure 6. Have you noticed increased implementation of ICT in the digital campus recently?

Source: own development

The survey results show that the majority of respondents (90 individuals) have noticed an increase in the implementation of Information and Communication Technologies (ICT) in the digital campus recently. However, there are 5 individuals who claim that it's hardly noticeable, and another 5 individuals who haven't noticed such an increase.

We can conclude that there is indeed an ongoing increase in the implementation of Information and Communication Technologies in the digital campus. However, some individuals may not perceive it due to various reasons, such as limited attention to this process or restricted opportunities for using ICT. Overall, the integration of ICT in the intelligent digital campus is an important and necessary step to enhance the educational process and create a modern educational environment.
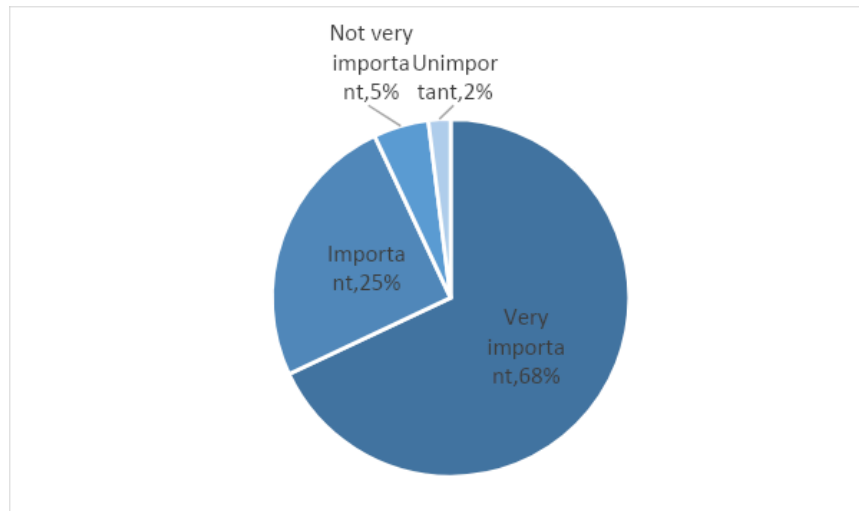
Figure 7. How do you evaluate the role of ICT in the intelligent digital campus?

Source: own development

Based on the survey results, we can draw the following conclusions. The majority of participants (68 individuals) consider the role of Information and Communication Technologies (ICT) in the intelligent digital campus to be very important. Another 25 individuals rated the role of ICT as important. A minority of participants (5 individuals) see the role of ICT as not very important. Only 2 individuals consider the role of ICT in the intelligent digital campus to be unimportant.

From these results, we can assert that the majority of survey participants attach significant importance to the role of ICT in the intelligent digital campus. With the popularization and development of modern technologies, ICT becomes an integral part of the educational process, playing a crucial role in enhancing the efficiency of learning and university management.
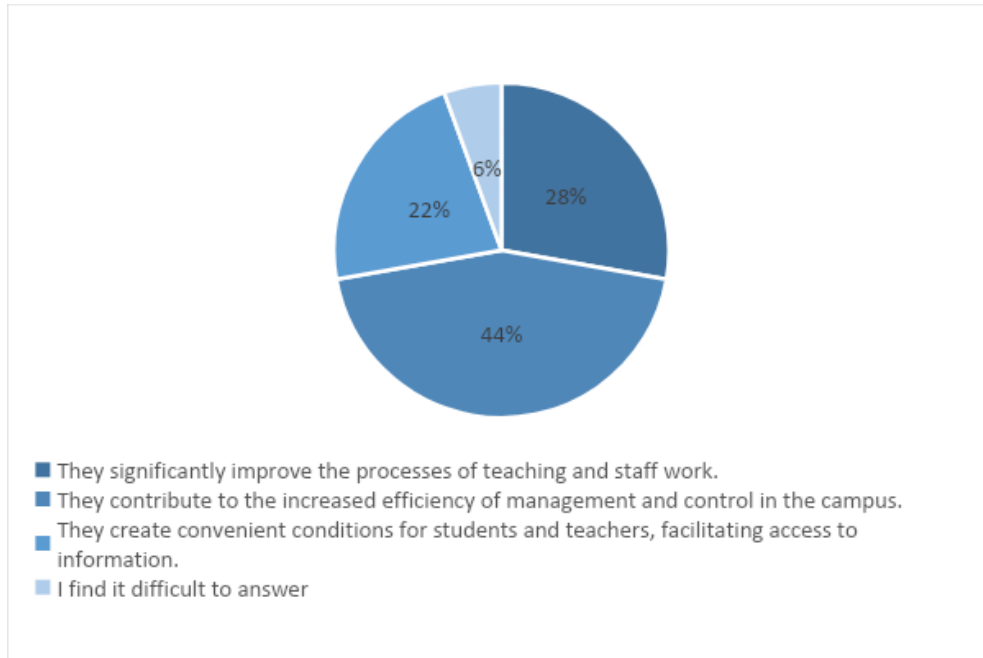
Figure 8. What role do ICT and big data play in the intelligent digital campus?
Source: own development

Based on the survey results, we can conclude that the majority of participants (40 individuals) believe that Information and Communication Technologies (ICT) and big data contribute to the increased efficiency of management and control in the campus. However, a significant number of respondents (25 individuals) also acknowledge that these technologies improve the processes of teaching and staff work. Some (20 individuals) noted that ICT and big data create convenient conditions for students and teachers, facilitating access to information.

From this, we can infer that in the intelligent digital campus, ICT and big data play a crucial role, contributing to the improvement of educational and operational processes, as well as enhancing management efficiency and improving access to information. However, some survey participants couldn't definitively determine the significance of these technologies, which is also an important aspect to consider in developing the digital campus development strategy.
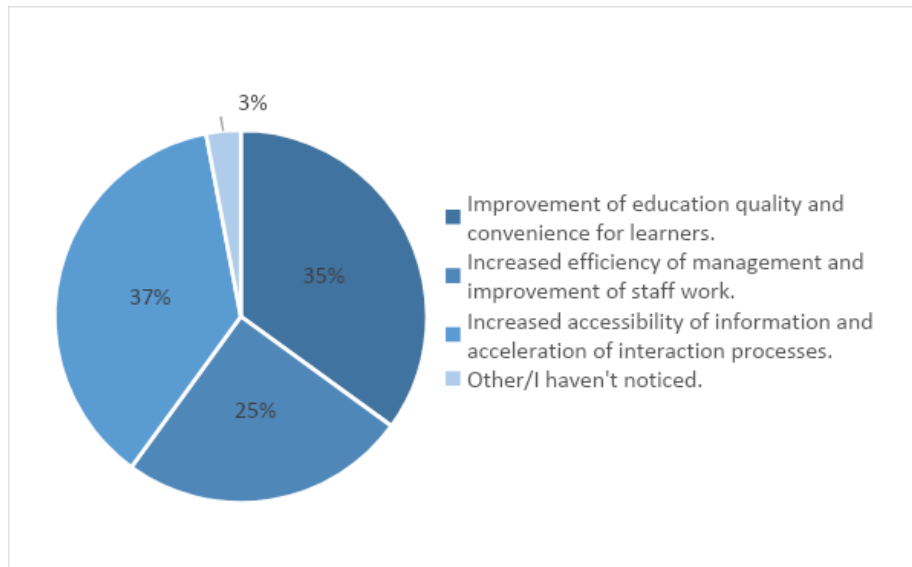
Figure 9. What positive effects of ICT and big data can be highlighted in the intelligent digital campus?

Source: own development

The majority of respondents believe that the use of Information and Communication Technologies (ICT) and big data in the intelligent digital campus leads to the improvement of education quality and convenience for learners, which is considered one of the main positive effects. Respondents also note that the use of these technologies allows for increased management efficiency and enhances staff performance, contributing to the more effective functioning of the campus. The improvement of information accessibility and acceleration of interaction processes is also considered a significant advantage of using ICT and big data in the digital campus.

It is important to highlight that a small number of respondents didn't notice positive effects or pointed out other important aspects. This feedback can also be taken into account in the development of a strategy for implementing technologies in the educational process. Thus, the use of ICT and big data has numerous positive effects in the intelligent digital campus, confirming their importance and necessity in modern education.
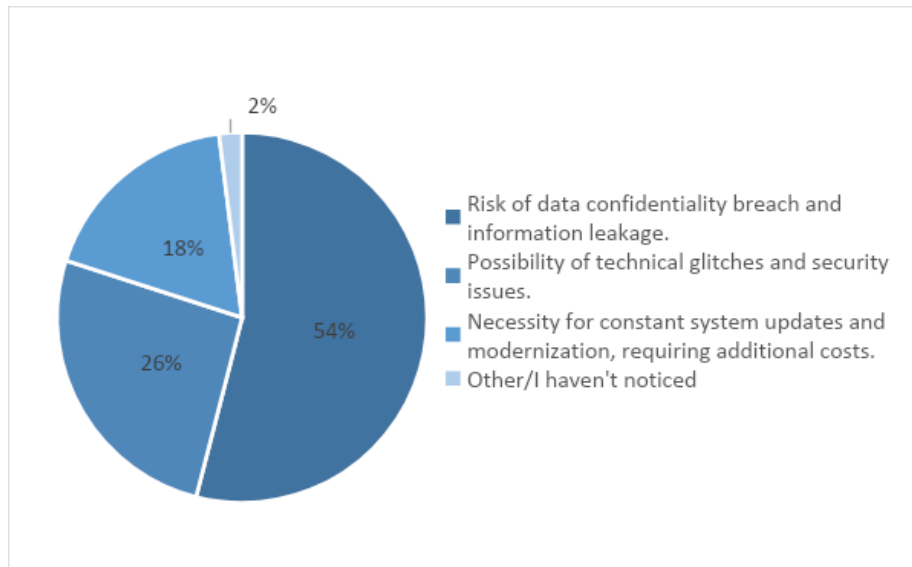
Figure 10. What negative effects of ICT and big data may arise in the intelligent digital campus?

Source: own development

Based on the survey results, we can see that according to participants, the main negative effect of Information and Communication Technologies (ICT) and big data in the intelligent digital campus is associated with the risk of data confidentiality breaches and information leakage. This is understandable since the intelligent digital campus stores a significant amount of personal and confidential information about students and staff. Respondents also highlight the possibility of technical glitches and security issues, which is another significant negative aspect that can impact the quality of education and the functioning of the digital campus.

The necessity for constant system updates and modernization, requiring additional costs, is also identified as a potential negative effect. Based on these results, we can conclude that when implementing ICT and utilizing big data in the intelligent digital campus, special attention should be given to security, data confidentiality, and system support to minimize the risks of negative effects.
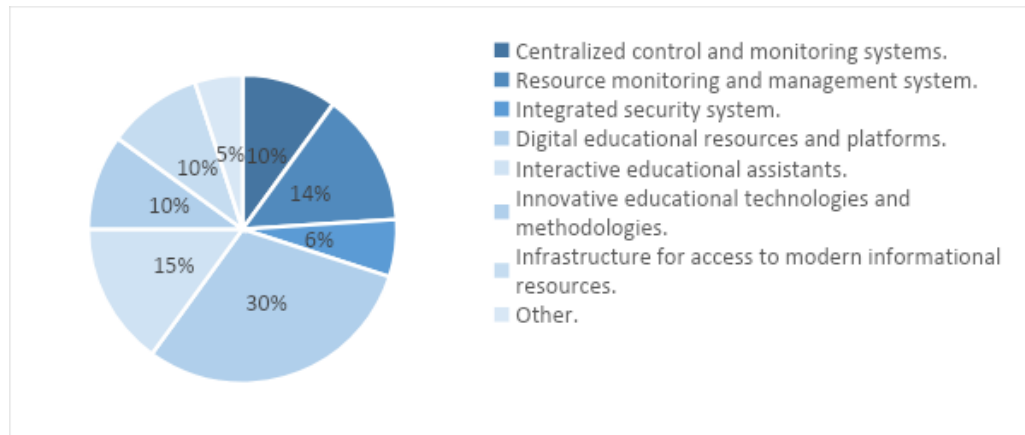
Figure 11. What key elements of the intelligent campus do you consider the most important?

Source: own development

Based on the survey results, we can conclude that the majority of respondents consider digital educational resources and platforms as the most important elements of the intelligent campus. This indicates that students and teachers recognize the significance of using modern technologies for learning and work within the university.

However, other important elements include the resource monitoring and management system, interactive educational assistants, and innovative educational technologies and methodologies. This suggests that a variety of technological tools can be beneficial in creating an intelligent digital campus. Thus, the survey results affirm the importance of using Information and Communication Technologies (ICT) and big data to build a modern, innovative, and effective educational environment. These technologies will help enhance the quality of learning, resources, and communication in the university.
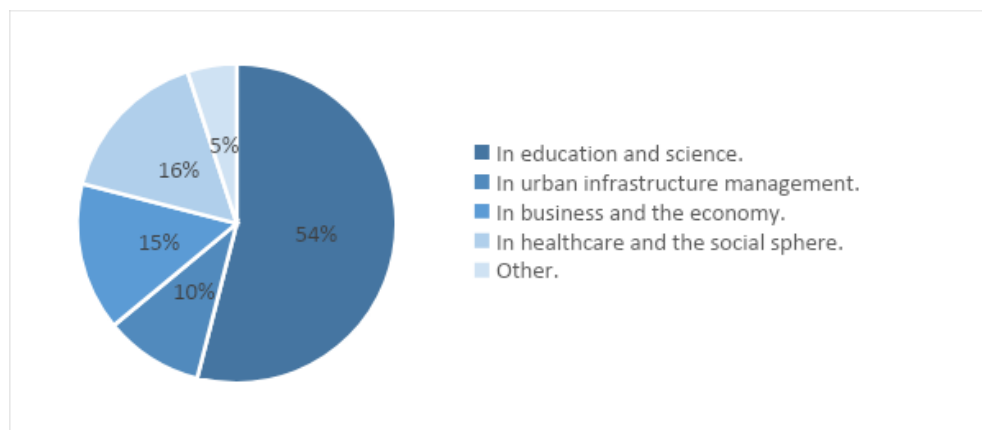

Figure 12. In which aspects of life do ICT and big data play a key role?

Based on the survey results, we see that the majority of respondents (54 people) consider Information and Communication Technologies (ICT) and big data to play a key role in education and science. Next, there are responses about the role of these technologies in healthcare and the social sphere (16 people), in business and the economy (15 people), in the management of urban infrastructure (10 people). There are also responses about the role of ICT and big data in other aspects of life (5 people).

So, we can conclude that in today's digital world, information and communication technologies and big data are of significant importance. They are actively applied in all areas of life, ranging from education and science to healthcare and the social sphere. This confirms the need for the development of new technologies and the improvement of digital literacy in society to effectively harness the benefits of digitization in the modern world.
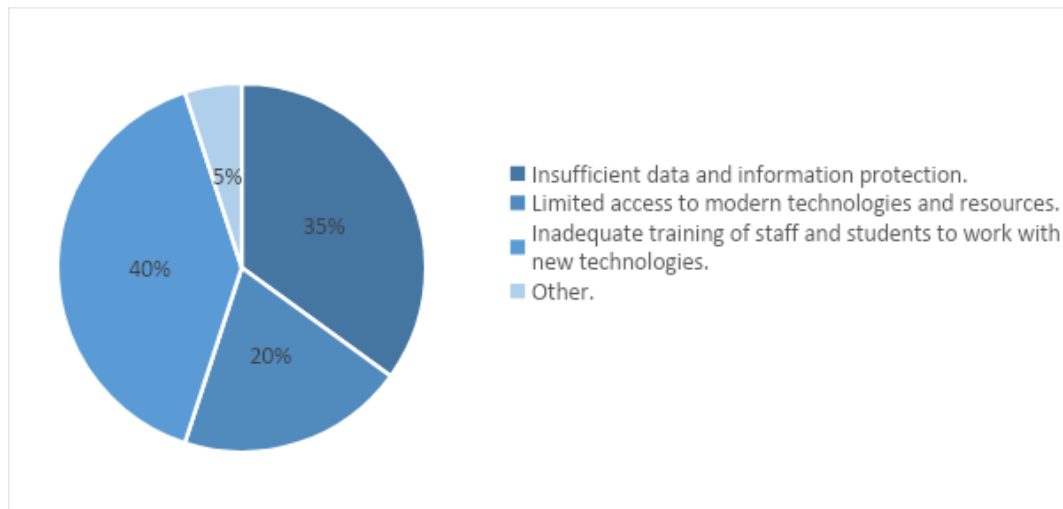

Figure 13. What shortcomings in the dimensions of the smart campus and from the user's perspective do you find most significant?

The survey results revealed that the most significant drawback in the dimensions of the smart campus and from the user's perspective is the insufficient training of staff and students to work with new technologies. The overwhelming majority of respondents (40 people) consider this issue crucial for the successful implementation of the digital campus concept. Also, notable issues include insufficient data and information protection (35 people) and limited access to modern technologies and resources (20 people). Five people

chose the "Other" option.

Based on the survey results, we can conclude the need to pay more attention to training staff and students in working with new technologies, as well as improving the data protection system and ensuring broader access to modern technologies and resources. The successful development of the smart digital campus will depend on addressing these identified shortcomings and enhancing the digital literacy of all participants in the educational process.
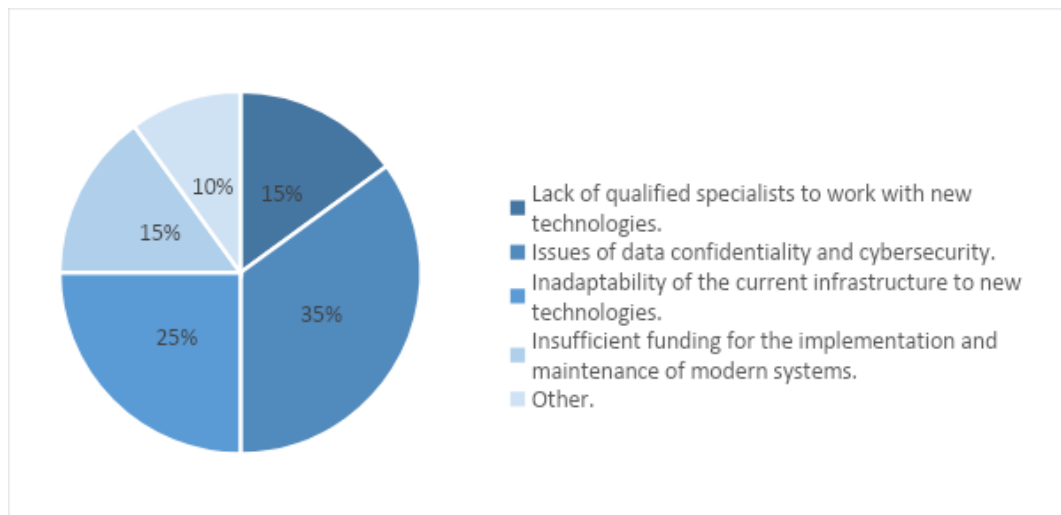

Figure 14. What challenges and problems do you think may arise when implementing ICT and big data in the smart digital campus?

Source: own development

The survey results have shown that the main problems that may arise when implementing ICT and big data in the smart digital campus are related to issues of data confidentiality and cybersecurity (35 people) and the inadaptability of the current infrastructure to new technologies (25 people). Respondents also noted a lack of qualified specialists to work with new technologies and insufficient funding for the implementation and maintenance of modern systems.

Based on these results, we can conclude that for the successful implementation of the smart digital campus, special attention needs to be paid to cybersecurity issues, as well as the training of qualified specialists and infrastructure updates. It is also important to ensure sufficient funding for the implementation and maintenance of modern systems for the efficient functioning of the digital campus.
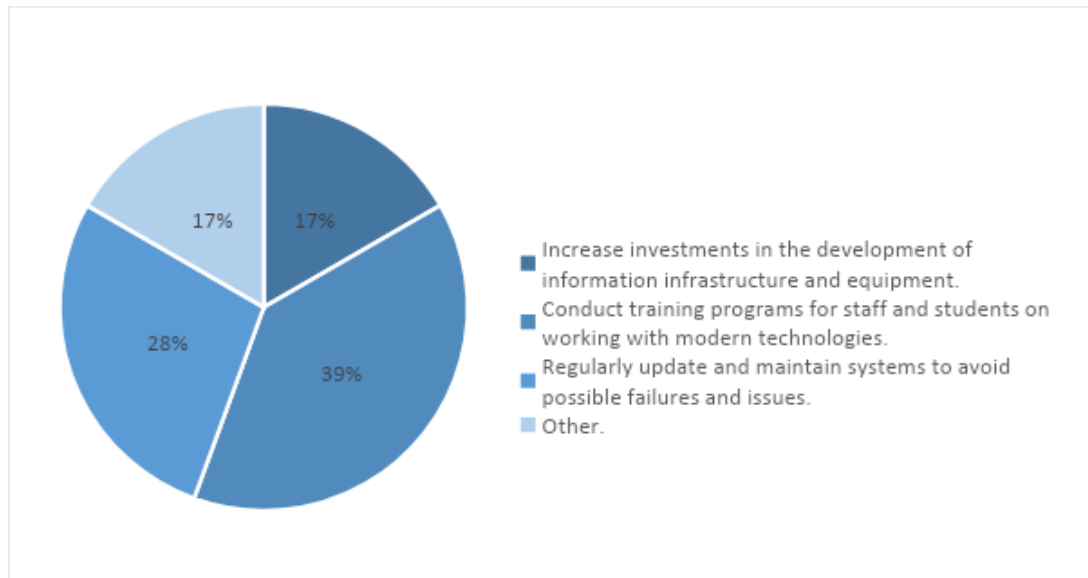
Figure 15. What changes and improvements would you suggest to enhance the efficiency of using ICT and big data in the smart digital campus?

Source: own development

The survey results have shown that the majority of respondents suggested conducting training programs for staff and students on working with modern technologies. This indicates that participants consider the growth of staff qualifications as a key factor for the successful use of ICT and big data in the smart digital campus. A significant number of people also emphasized the need for regular updates and maintenance of systems to avoid possible failures and issues.

Based on this, we can conclude that to enhance the efficiency of using ICT and big data in the smart digital campus, attention should be given to both training staff and students and updating and maintaining the information infrastructure. This will not only improve processes on campus but also increase the overall effectiveness of the educational process.

Moreover, it is important to increase investments in the development of information infrastructure and equipment to ensure the seamless operation of systems and enable the adoption of new technologies. Additionally, continuous improvement of processes and methods for working with digital technologies is crucial to stay ahead in the development of education. Thus, a combination of increased investments, conducting training programs, and regular updates of systems will help enhance the efficiency of using ICT and big data in the smart digital campus, ensuring a more qualitative and modern educational process.

5 Results and Discussion

The analysis of the survey results on the topic "The Role of ICT and Big Data in the Smart Digital Campus" allows for several important conclusions. Firstly, respondents' primary concept of a digital campus includes the idea of knowledge and information exchange through digital platforms and apps. This indicates that users of the digital campus value not only the presence of modern technologies but also the creation of a digital environment conducive to knowledge exchange for educational purposes.

Secondly, the results show that the overwhelming majority of surveyed students and teachers regularly utilize the digital campus. This reflects a high level of user activity in using digital technologies for learning, communication, and work in the educational environment.

The third conclusion is that most respondents have noticed an increase in the implementation of information and communication technologies in the digital campus recently. This indicates educational institutions' efforts to improve learning conditions, optimize the educational process, and enhance the efficiency of interaction among participants in the educational process.

However, it's worth noting that a small portion of respondents didn't observe an increase in the implementation of ICT in the digital campus. This might suggest the need for more extensive information provision and training for users on utilizing digital technologies for educational purposes.

Additionally, most respondents indicate that the use of ICT and big data contributes to increased efficiency in campus management and control, which is undoubtedly an important aspect of modern education. A significant portion of participants also believes that these technologies enhance the teaching and work processes of staff, undoubtedly influencing the overall quality of education.

The survey results also point out that the use of ICT and big data creates convenient conditions for students and teachers, facilitating access to information. This helps establish a favorable and comfortable environment for learning and working on campus.

In conclusion, it can be deduced that the role of ICT and big data in the smart digital campus is undeniably crucial and significantly influences the quality of education and convenience for its participants. The use of modern technologies becomes a necessary

condition for creating a contemporary educational space that contributes to the increased efficiency and quality of learning.

The survey results also show that the role of ICT and big data in the smart digital campus is immense and decisive. The majority of survey participants highlighted the importance of digital learning resources and platforms for studying and working at the university. This indicates that modern technologies play a key role in the process of education and science.

However, according to participants, the main negative effect of ICT and big data in the smart digital campus is the risk of breaching data confidentiality and information leakage. This aspect needs to be taken into account when developing and implementing new technologies in the educational process. The implementation of the concept of the digital campus without proper data protection can face serious problems and risks for students and university staff.

The most significant drawback identified in the survey results is the insufficient preparation of staff and students to work with new technologies. This indicates that for the successful implementation of the digital campus concept, special attention must be given to training and supporting users in working with ICT and big data.

It is also important to note that the main problems that may arise during the implementation of ICT and big data in the smart digital campus are related to issues of data confidentiality protection, the inadaptability of the current infrastructure to new technologies, a shortage of qualified specialists, and insufficient funding for the implementation and maintenance of modern systems. These problems require serious attention and solutions for the successful integration of ICT and big data into the smart digital campus.

Thus, the survey results attest to the importance of the role of ICT and big data in the smart digital campus, as well as the need for further development and improvement of digital technologies in education to ensure a comfortable and efficient learning environment.

6   Recommendations

1. Implementation of modern technologies in the educational process is recommended. It is suggested to use ICT (Information and Communication Technologies) and big data analysis to enhance the quality of learning and improve the efficiency of teachers' work. The use of ICT in education allows for the creation of interactive lessons, distance learning, and the utilization of online resources and educational platforms. This helps make education more accessible, engaging, and effective. Teachers can employ various programs and apps to create lessons, assess students' knowledge, conduct tests, and surveys.

Big data analysis in education enables the collection and analysis of information about students' learning processes, their successes, and challenges. Based on this data, individual students' needs can be identified, educational materials can be adapted to them, and personalized educational programs can be offered. Teachers can also use analytics data to evaluate the effectiveness of their work, identify strengths and weaknesses, and optimize the teaching process.

Thus, the use of ICT and big data analysis significantly improves the quality of education and enhances the efficiency of teachers' work, helping them adapt the educational process to individual student needs and enhance their professional competence.

2. Creating personalized educational programs. With the help of analytics data, curriculum plans can be adapted to individual student needs, taking into account their successes and interests.

To create personalized educational programs, it is first necessary to analyze data on students' successes, preferences, and interests. This can be done using various analytics tools, such as grade reports, tests, and surveys, as well as monitoring student activity on the educational platform. After collecting and analyzing data, it is possible to identify groups of students with common needs and interests to create individual educational plans for them. For example, students with high grades in mathematics may receive more advanced assignments and materials, while those facing difficulties may receive additional support and materials tailored to their level.

Additionally, not only the academic achievements but also students' interests and preferences in learning can be taken into account. For instance, if a student is interested in

programming, courses on this topic can be offered, even if it is not part of the standard curriculum. This helps stimulate students and increases their motivation to learn. Creating personalized educational programs helps improve learning by considering individual needs and interests, ultimately enhancing overall success and the efficiency of the educational process.

3. Monitoring students' academic performance. Using data to analyze learning outcomes allows for timely identification of issues and taking measures to address them.

Monitoring students' academic performance is a systematic process of collecting, analyzing, and interpreting data on students' academic achievements throughout the academic year. The purpose of such monitoring is to identify problematic areas in the educational process and take measures to address them. To conduct monitoring of academic performance, it is necessary to collect data on students' grades, attendance, completion of assignments, participation in exams and tests, as well as feedback from teachers and mentors. These data can be analyzed using statistical methods to identify trends and determine where issues arise.

Using data on students' performance allows for timely responses to emerging issues and taking measures to address them. Based on the analysis of learning outcomes, additional classes can be organized, individualized instruction can be provided, teaching methods can be adjusted, or the curriculum can be revised.

4. Development of the digital infrastructure of an educational institution. To ensure the effective functioning of ICT and big data analysis, appropriate equipment and software are necessary.

The following steps should be taken to develop the digital infrastructure of an educational institution:

●Provide suitable equipment, including computers, laptops, tablets, interactive boards, printers, scanners, and other devices necessary for efficient work with information technologies.

●Install software that allows teachers and students to use ICT in the educational process. This may include educational programs, word processing, spreadsheet, graphics, and video software, as well as specialized programs for data analysis.

●Ensure access to high-speed internet so that students and teachers can seamlessly use online resources, cloud services, and other technologies for learning and information exchange.

●Train teachers and administrative staff in the use of new technologies. Conduct regular training sessions and seminars to improve their skills in working with ICT and data analysis.

●Create digital courses and online learning to stimulate independent learning for students and provide them with the opportunity to explore new topics and technologies.

●Support the continuous update of equipment and software to maintain the efficiency of the digital infrastructure and align with modern trends in education.

Implementing all these measures will help enhance the quality of education, make the learning process more interactive and efficient, and prepare students for the digital era and the requirements of the modern job market.

5. Training teachers and staff of the educational institution in the use of ICT and data analysis. Enhancing the competence of the staff contributes to a more effective application of technologies in the educational process.

Deliberate and systematic measures are necessary for the successful training of teachers and staff of an educational institution in the use of Information and Communication Technologies (ICT) and data analysis.

Firstly, it is essential to develop a training program that includes both theoretical and practical aspects of using ICT and data analysis methods in the educational process. The program should be adapted to the specific needs of the educational institution and the goals of the training.

Next, organize training sessions and seminars for teachers and staff, providing them with the opportunity to familiarize themselves with new technologies, their application in the educational process, and acquire skills in working with data. It is crucial that the training is conducted by experienced teachers or specialists with practical experience in the field. It is also recommended to create special courses or online platforms for self-study of ICT and data analysis. This allows staff members to acquire the necessary knowledge and skills at their own pace and in a convenient format. For the effective application of new knowledge and skills in their work, it is necessary to provide support and guidance from the administration of the educational institution. It is important to create conditions for the practical application of acquired knowledge, for example, by organizing pilot projects or implementing new technologies in the educational process. Thus, training teachers and staff of the educational institution in the use of ICT and data analysis is a crucial step towards improving the quality of education and the efficiency of the educational process.

7 Conclusion

In this bachelor thesis, the goal was to identify the positive and negative effects of ICT and Big Data in smart digital campus. Consideration of the impact on different aspects of life, such as society as a whole, the education system, environmental transformation and much more. This goal has been successfully achieved, as evidenced by a comprehensive review of current literature, case studies, and theoretical frameworks that underline the critical role of these technologies in modernizing educational environments.

The thesis detailed how ICT and big data facilitate personalized learning through adaptive educational tools, provide real-time feedback to students, enable data-driven decision-making for campus management, and significantly improve operational effectiveness by automating administrative tasks. Furthermore, it addressed the paramount importance of campus security enhancements through technological measures and the utilization of big data for predictive analytics to foster a safe educational environment.

However, the exploration also acknowledged the challenges and risks associated with integrating ICT and big data into educational settings, including data privacy concerns, the need for substantial financial investment, and the demand for continuous technological upgrades and skilled personnel to manage these systems effectively.

By delving into these aspects, the thesis provided a balanced view of the opportunities and obstacles presented by the advent of smart digital campuses. It offered a solid foundation for understanding how these technologies are reshaping educational landscapes, driving efficiency, and creating more engaging, secure, and personalized learning experiences.

In the practical part of the bachelor thesis concerning the role of Information and Communication Technologies (ICT) and big data within the intelligent digital campus, the investigation meticulously examined how these contemporary technologies are reshaping the educational environment. Through a detailed survey encompassing both students and educators, data were collected and analyzed, shedding light on the present state and potential future of digital campuses.

The study underscores the critical importance of ICT and big data in enhancing educational processes, facilitating efficient campus management, and improving the overall learning experience for all parties involved. The survey results demonstrate a profound appreciation among participants for digital campuses as environments that not only

incorporate technological advancements but also promote interaction, innovation, and access to information. This highlights the pivotal role that digital resources and platforms occupy in education, aligning with the evolving expectations of today's digital era.

However, the research also brings to light the challenges and risks associated with integrating ICT and big data into the education sector, especially in terms of data security and the necessity for continuous updates and modernization of systems. Concerns regarding data confidentiality breaches and technical issues underscore the need for stringent cybersecurity measures and ongoing development of infrastructure to protect the digital campus ecosystem.

Moreover, the findings reveal a significant gap in the form of inadequate readiness among staff and students to effectively use these technologies. This identifies an urgent requirement for extensive training programs to enhance digital literacy and ensure all users are equipped to navigate and benefit from the digital campus opportunities.

In response to these insights, the thesis recommends a greater focus on investment in digital infrastructure, continuous user training, regular system maintenance, and a strategic approach to data protection. By tackling these key areas, educational institutions can not only overcome current limitations but also fully leverage the potential of ICT and big data in creating smarter, more efficient, and inclusive digital campuses.

The thesis affirms the transformative impact of ICT and big data on the educational landscape, advocating for their strategic implementation as foundational to the development of future-ready educational environments. As the educational sector progresses, it is crucial for institutions to adopt these technologies, mindful of their benefits and challenges, to foster an ecosystem that enhances learning, encourages innovation, and prepares both students and educators for the digital age's demands.

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9 List of pictures, tables, graphs and abbreviations

Appendix

1. Indicate your gender

A) Male

B) Female

2. Specify your age

A) 15-25 years

B) 26-35 years

C) 36-45 years

D) 46-55 years

E) 56 years and older

3. Specify your occupation

A) Teacher

B) Student

C) Other

4. In your opinion, what does a digital campus represent?

A) A digital campus is a modern educational institution equipped with the latest technologies for teaching and research.

B) A digital campus is a space where students and teachers can interact and exchange knowledge and information through digital platforms and apps.

C) A digital campus is a place where access to educational materials, library resources, and other educational opportunities is conducted online.

D) A digital campus is an innovative environment that utilizes various digital tools and technologies to improve the learning process and communication.

5. How often do you use the digital campus?

A) Constantly

B) Occasionally

C) Rarely

D) Never

6. Have you noticed increased implementation of ICT in the digital campus recently?

A) Yes, I have noticed

B) It's hardly noticeable

C) I haven't noticed

7. How do you evaluate the role of ICT in the intelligent digital campus?

A) Very important

B) Important

C) Not very important

D) Unimportant

8. What role do ICT and big data play in the intelligent digital campus?

A) They significantly improve the processes of teaching and staff work.

B) They contribute to the increased efficiency of management and control in the campus.

C) They create convenient conditions for students and teachers, facilitating access to information.

D) I find it difficult to answer.

9. What positive effects of ICT and big data can be highlighted in the intelligent digital campus?

A) Improvement of education quality and convenience for learners.

B) Increased efficiency of management and improvement of staff work.

C) Increased accessibility of information and acceleration of interaction processes.

D) Other/I haven't noticed.

10. What negative effects of ICT and big data may arise in the intelligent digital campus?

A) Risk of data confidentiality breach and information leakage.

B) Possibility of technical glitches and security issues.

C) Necessity for constant system updates and modernization, requiring additional costs.

D) Other/I haven't noticed.

11. What key elements of the intelligent campus do you consider the most important?

A) Centralized control and monitoring systems.

B) Resource monitoring and management system.

C) Integrated security system.

D) Digital educational resources and platforms.

E) Interactive educational assistants.

F) Innovative educational technologies and methodologies.

G) Infrastructure for access to modern informational resources.

H) Other.

12. In which aspects of life do ICT and big data play a key role?

A) In education and science.

B) In urban infrastructure management.

C) In business and the economy.

D) In healthcare and the social sphere.

E) Other.

13. What shortcomings in the dimensions of the smart campus and from the user's perspective do you find most significant?

A) Insufficient data and information protection.

B) Limited access to modern technologies and resources.

C) Inadequate training of staff and students to work with new technologies.

D) Other.

14. What challenges and problems do you think may arise when implementing ICT and big data in the smart digital campus?

A) Lack of qualified specialists to work with new technologies.

B) Issues of data confidentiality and cybersecurity.

C) Inadaptability of the current infrastructure to new technologies.

D) Insufficient funding for the implementation and maintenance of modern systems.

E) Other.

15. What changes and improvements would you suggest to enhance the efficiency of using ICT and big data in the smart digital campus?

A) Increase investments in the development of information infrastructure and equipment.

B) Conduct training programs for staff and students on working with modern technologies.

C) Regularly update and maintain systems to avoid possible failures and issues.

D) Other.