Journal of Theoretical and Applied Information Technology
15th September 2024. Vol.102. No. 17

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

SUSTAINABLE DEVELOPMENT OF SCIENTIFIC RESEARCH INFRASTRUCTURE FOR QUALITY AND INNOVATIVE HIGHER EDUCATION IN THE FIELD OF INFORMATION TECHNOLOGY

LUCIANA TOTI[1], ELDA CINA[2]
[1] Aleksander Moisiu, University, Durres, Albania
[2] College Of Engineering And Technology, American University Of The Middle East, Kuwait
[1]lucianatoti@uamd.edu.al, [2]Elda.Cina@aum.edu.kw*

ABSTRACT

The scientific research of the twenty-first century necessitates robust infrastructure, as well as seamless interaction between the acquired academic knowledge and innovative technical services enabled by digital technologies. Research Infrastructure (RI) embodies a symbiotic relationship among scientific, social, and material dimensions, providing directions for new strategies development. With the help of connections and collaborations with industry, business, and international institutions, universities enhance their laboratory capabilities, thereby advancing scientific research. This constructive interaction forms a self-reinforcing cycle benefiting all stakeholders involved. Drawing from collaborative experiences, with partner universities across numerous EU-funded projects, we advocate for scientific researchers to keenly identify contemporary needs and meet the expectations of diverse stakeholders. Research infrastructure is the only way to optimize the identification of these needs. This paper aims to identify pathways for attracting investments to establish essential RI aligned with contemporary demands while assessing the impact of RI on societal, economic, and scientific domains. This effort will guide the rapid transition of the Albanian and Western Balkan Universities towards future-oriented institutions. Additionally, our objective is to delineate a strategic framework and establish qualitative and quantitative benchmarks for sustainable RI development, providing a replicable case study for universities in the Western Balkans.
Keywords: *Scientific Research, Research Infrastructure, Digital Technologies, Stakeholder Engagement, Sustainable Development*

1. INTRODUCTION

In today's rapidly evolving technological landscape, the field of Information Technology (IT) plays a crucial role in driving innovation and shaping the future. As the demand for skilled IT professionals continues to surge, the need for high-quality and innovative education has never been more pressing. Research infrastructure (RI) plays a pivotal role in advancing academic institutions and enhancing higher education, particularly within the Information Technology (IT) field. RI stands as a cornerstone in the advancement of higher education. It serves as the backbone for fostering academic excellence, innovation, and transformative learning experiences, nurturing the next generation of IT professionals.

By maintaining and improving the IR conditions, academic institutions can stay at the forefront of emerging trends. They can explore innovative technologies and conduct groundbreaking research that addresses complex challenges faced by industry. Central to achieving this goal is the development of a robust scientific research infrastructure. Sustainable development of research infrastructure not only supports cutting-edge research but also enhances the quality of education, fostering an environment where students and faculty can thrive. Through strategic investments in research infrastructure, universities can differentiate themselves as hubs of innovation, attracting leading researchers and industry partners eager to collaborate on transformative projects, strengthen their research capabilities, elevate the quality of education, and position themselves as global leaders in driving technological innovation and societal change. This article explores the strategies and benefits of building and maintaining sustainable research infrastructure in IT education, emphasizing its impact on academic excellence and innovation, and preparing students to meet the challenges of a dynamic digital world. The study will include a real

example to illustrate the impact RI has in improving the quality and innovation in higher education, especially in the Information Technology field.

Through this paper the below terms will be used:

Research Infrastructure (RI): Research Infrastructure refers to the facilities, resources, and services that enable scientific research and innovation. It includes physical spaces like laboratories and research centers, digital tools like cloud computing and data management systems, and networks that facilitate collaboration among researchers, industry, and educational institutions. In this article's context, RI also encompasses partnerships between universities and industries, fostering innovation and technological advancement, especially in the Information Technology field.

Sustainable Development: Sustainable Development in the context of Research Infrastructure refers to the creation and maintenance of systems and resources that can support long-term research goals without exhausting financial, technological, or environmental resources. It emphasizes continuous improvement and adaptability to future demands while balancing economic, social, and environmental considerations. Sustainable RI ensures that future generations of researchers and students can benefit from the investments made today without depleting key resources.

Digital Technologies: Digital Technologies refer to electronic tools, systems, and devices that generate, store, and process data. In the context of the article, this includes technologies such as cloud computing, big data analytics, artificial intelligence, virtual reality, and the Internet of Things (IoT). These technologies support the modernization of research infrastructure by enabling large-scale data collection, efficient processing, and innovative solutions for research and education.

Polygon of Knowledge: This metaphorical term refers to the collaborative relationship between universities, industry, research centers, and other stakeholders. It signifies a multi-faceted approach where knowledge is shared and developed in a cooperative environment, benefiting all parties involved. The "polygon" suggests the interconnectivity and multiple dimensions of this collaborative effort, emphasizing the importance of partnerships in enhancing research infrastructure and innovation.

The rest of the paper is organized as follows: Section 2 introduces a list of the main contributions of RI in higher education development emphasizing the importance of robust research infrastructure, its impact on student learning, research capabilities, and innovation. Section 3 includes methodology and strategies for developing sustainable research infrastructure, taking the experience of Aleksander Moisiu University, Durres as a case study. Section 4 discusses challenges and solutions in higher education towards developing and maintaining sustainable research infrastructure. The paper concludes with sections 5 Conclusions and 6 Future Research Directions.

2. LITERATURE REVIEW

To ensure the most sustainable Scientific Research Infrastructure, we must rely on the Digital Research Infrastructure, which enables large-scale, efficient, and secure data collection and calculations. Such resources require users and specialists to develop and maintain them. A range of studies have explored the development and enhancement of research infrastructure in higher education. Let us see how different authors evaluate the results of scientific research and the infrastructure needed for it. Scientific researchers point out that digital research infrastructure is critical to accelerating science, and yet, these digital public goods are often unsustainably funded. Solving this problem requires an assessment of the intrinsic value of research results and greater investment in time and effort to effectively fund the maintenance of digital infrastructure [1].

The studies related to making a Research Infrastructure, conditions, and strategies to transform service into an Infrastructure, identify the competitive disadvantages for publicly funded infrastructure projects regarding the way of implementation and the resources invested in development and marketing. They suggest that the results have practical importance, especially for individuals, communities, and organizations that want to create research infrastructures, as well as for funders and policymakers that want to support innovative and sustainable infrastructures.

The authors of [2] emphasize the need for an infrastructure that integrates and curates data from various sources to allow researchers have access to a multitude of data sources. Other studies focus their attention on specific county needs. [3] focuses on the current strengths and investment needs of research

infrastructure in Ireland, while [4] discusses the sustainable development of research institutes in Chinese higher education, highlighting the importance of establishing a clear development direction. [5] underscores the role of graduate education in enhancing university research, particularly in STEM disciplines, and suggests innovations to address challenges such as financial support, diversity, and career preparation. The study reveals how new developments in digital research infrastructure are changing our expectations of research. A specific platform, the Humanities Network Infrastructure, is explored as an example of how digital technologies enable the co-production of the archive and at the same time expand the possibilities for endless discoveries [6]. The author of [7] concludes that the "Open Science" Policy is motivated by the desire to increase the excellence and quality of research. Studies show that the problems lie not only in research evaluation and academic crediting systems but also in the politics-research practice divide. These problems must be solved in terms of participation in policymaking and in the production of scientific knowledge itself. The authors of [8] point out that the shift to a new form of research practice was driven by the development of new digital technologies that offered researchers new ways to communicate and disseminate their work and to collaborate with colleagues, and new forms of research measurement and evaluation became possible.

As researchers began to use digital infrastructures, increased data was available about researchers and their work. Other authors focus on the point of view that the basic data that are created by the actions of the research community should be resources for the community, supporting decision-making for the community as well as providing value-added services to private enterprises [9]. The authors of [10] discuss the importance of digitalization in higher education and how it's managed by central authorities. It explores how different disciplines, like medicine and law, approach digitalization differently, leading to varied strategies such as digital transformation and innovation. The findings emphasize that these strategies can significantly impact educational practices, sometimes leading to substantial transformations. In [11] the authors discovered that the rapid transformation of educational infrastructure signals is a critical turning point for the education system, particularly in engineering education. The study highlights the unique combination of factors accelerating the digitalization of education, leading to a lack of standardized methods for assessing innovation effectiveness and managing digital transformation centrally. They also discuss the significance of student self-training in digital transformation, emphasizing the prevalence of internet use for learning and the correlation between study methods, motivation, and academic performance. [12] aims to enhance the integration of Massive Open Online Courses (MOOCs) into continuous teacher training, leveraging their potential benefits for professional development.

T
he authors developed a conceptual framework tailored to the Portuguese context, addressing the lack of such frameworks in the literature. Through literature review, interviews, and data analysis involving trainers and focus groups, they validated the framework, underscoring MOOCs' potential as cost-effective solutions for teacher training, particularly highlighted during the COVID-19 pandemic. The study emphasizes the need for guiding documents to facilitate MOOC development and implementation in continuous teacher training, promoting their recognition as quality training systems. This and many other research highlight how much impact and how important it is for higher education institutions to keep an updated research infrastructure.

3. METHODOLOGY

This paper is organized based on an in-depth analysis regarding the current situation of the scientific research infrastructure in university environments, the problems encountered, the needs and challenges to fulfill the EU requirements, and to improve it with the most innovative technologies [13], [9]. Updating the conditions of scientific research for academic staff and students, facilitating and improving learning methods, as well as solving the problems of time, we must find the right and most efficient ways.

This study adopts a mixed-methods approach, combining both qualitative and quantitative research methods to comprehensively assess the impact of Research Infrastructure (RI) on higher education in the field of Information Technology (IT), with a focus on Albanian and Western Balkan universities. The selected methodology ensures that the research questions and objectives are thoroughly addressed by examining both the subjective experiences of stakeholders and the measurable outcomes of RI development.

1. Qualitative Approach

The qualitative component of this study involves the use of case studies and in-depth interviews to explore the current state of RI and its evolution over time. Key stakeholders, including faculty members, university administrators, industry partners, and policymakers, are interviewed to provide insights into the strengths, challenges, and future needs of RI in the region.

The case studies focus particularly on the developments at Aleksander Moisiu University and other universities participating in EU-funded RI projects. These case studies highlight the collaborative efforts between academia, industry, and international institutions, and examine how these efforts have improved research capabilities, curriculum design, and student engagement.

Data Collection for the Qualitative Approach is based on:

- In-depth interviews with key stakeholders such as academic staff, students, and industry collaborators.
- Document analysis of reports from international projects, including those funded by the European Union.
- Case study observations from projects like DIMTV (Development and Implementation of Multimedia and Digital Television) and VTECH (Accelerating Western Balkan's University Modernization by Incorporating Virtual Technologies), which serve as models for RI development.

Control Methods for Qualitative Research:

• Standardized Interview Protocol: All interviews follow a structured guide with predefined questions to ensure consistency across different stakeholders and reduce interviewer bias.

• Triangulation: Data from interviews is cross-verified with document analysis (e.g., project reports, collaboration agreements) and case study observations. This triangulation ensures that the findings are not influenced by the perspectives of any single source.

• Purposive Sampling: Key participants are selected based on their direct involvement in RI development and implementation. This ensures that data is collected from individuals who have relevant knowledge and experience, minimizing the influence of irrelevant or uninformed

2. Quantitative Approach

The quantitative part of this study involves the use of surveys and questionnaires distributed to students, faculty members, and administrative staff. The surveys are designed to measure the perceived impact of RI on educational quality, research outcomes, and student preparedness for the workforce. Quantitative data is also collected on specific metrics, such as the number of research projects, publications, industry collaborations, and technological advancements introduced as a result of improved RI.

Data Collection for the Quantitative Approach is based on:

- Surveys distributed to faculty and students, focusing on their experiences with the new research facilities, labs, and digital platforms introduced as part of the RI.
- Statistical data on the number of projects, collaborations, publications, and student enrollments before and after the implementation of RI improvements.
- Performance indicators of RI-related developments, such as student success rates, industry engagement, and the number of new study programs aligned with technological innovations.

Control Methods for Quantitative Research:

• Random Sampling: To avoid sampling bias, a random selection of participants (students, faculty, and administrative staff) is surveyed. This ensures that the findings are representative of the wider university population and not influenced by specific subgroups.

• Pre-Test of Survey Instruments: Surveys are pre-tested with a small group of participants to ensure that the questions are clear, unambiguous, and yield consistent responses. This helps to eliminate misunderstandings or confusion that could introduce variation.

• Control Variables: Key control variables, such as the participants' experience with RI (e.g., access to labs, participation in projects) and their academic background (e.g., years of study or employment), are collected to account for potential differences in their responses. This allows for adjusting the analysis to control for individual-level differences that could skew the results.

• Standardized Survey Timing: All surveys are distributed within a specific time frame following significant RI developments to control for variations in perception due to differing exposure times.

3. Data Analysis

Qualitative Analysis: The data from the interviews and case studies will be analyzed using thematic analysis to identify patterns and trends in the development of RI, focusing on key themes such as stakeholder engagement, technological innovation, and sustainable development. This analysis will provide a deeper understanding of how RI affects educational practices and research capabilities.

Quantitative Analysis: The survey data will be analyzed using descriptive and inferential statistical methods. Comparisons will be made between pre- and post-RI development periods to assess the overall impact on education quality, research output, and student engagement. Correlation analysis will be conducted to examine the relationship between RI investments and key performance metrics.

Control Methods for Quantitative Research:

- Random Sampling: To avoid sampling bias, a random selection of participants (students, faculty, and administrative staff) is surveyed. This ensures that the findings are representative of the wider university population and not influenced by specific subgroups.
- Pre-Test of Survey Instruments: Surveys are pre-tested with a small group of participants to ensure that the questions are clear, unambiguous, and yield consistent responses. This helps to eliminate misunderstandings or confusion that could introduce variation.
- Control Variables: Key control variables, such as the participants' experience with RI (e.g., access to labs, participation in projects) and their academic background (e.g., years of study or employment), are collected to account for potential differences in their responses. This allows for adjusting the analysis to control for individual-level differences that could skew the results.
- Standardized Survey Timing: All surveys are distributed within a specific time frame following significant RI developments to control variations in perception due to differing exposure times.

4. Suitability of Research Design

This mixed-methods design is well-suited to answering the research objectives. The qualitative component provides detailed insights into the challenges and successes of RI development, while the quantitative component offers measurable evidence of its impact on higher education in IT. By combining these methods, the study can not only assess the current state of RI but also suggest future directions for sustainable development.

UAMD is Albania's newest public higher education institution (founded in 2006). Despite its existence for less than 2 decades, it has seen extraordinary growth making it competitive not only among Universities in Albania but also in the EU in a very short period. All this is due to the importance they have given to the RI, especially in the Information Technology area. In less than a decade they have been able to extend collaborations with a considerable number of Universities of the Western Balkans and the European Union, which have significantly improved the research infrastructure in the information technology, multimedia and digital television, and computer science fields.

For the first decade of its existence, the UAMD was not research-oriented but mainly teaching-oriented focusing on investing in delivering high-quality education and instruction to students, enhancing curriculums, and acquiring qualified academic and supporting staff. Therefore, the development in infrastructure and research period after 2018 is reflected in this study. The impact of the national and international collaborations on the development of the university especially the Faculty of Information Technology during 2018 - 2024 serves as a guide to the proposed model the higher education can follow to increase research infrastructure capacities for sustainable development. UAMD has participated in multiple international projects financed by the European Union, thanks to which not only the academic capacities are raised, but the infrastructure is improved for the benefit of students, faculty, administrative staff, and the entire community. The efforts of the faculty members to expand cooperation with the industry sector, business, and scientific research centers inside and outside the country through conferences, workshops, and meetings among colleagues at national and international levels have developed the possibility of implementing the polygon of knowledge between the University and other stakeholders. With the continuous effort in national and international scientific research project applications, the conditions for the development of professional practices have been created and the practical skills of students are improved through professional simulation programs. UAMD is a partner institution in more than 110 National and International Projects, as well as a leading Institution

in a few of them. There are 9 key elements to enhance the development of research infrastructure capacities in higher education as illustrated in Figure 1.

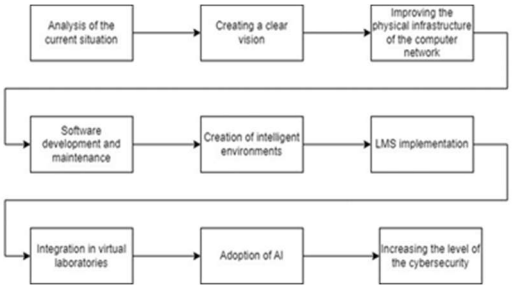


Figure 1. Key elements for continuous improvement of the scientific research infrastructure.

3.1. Analysis of The Current Situation

The analysis of our research infrastructure commenced in 2018, a time when instructional delivery primarily relied on projectors. Lectures were held in auditoriums where students engaged in tasks assigned by their lecturers' paper-based. Every course culminated with a course project that students were required to prepare with their personal resources and present independently, albeit under the continuous supervision of their lecturers. Access to computer laboratories, where students could work on course-related exercises, was infrequent due to the insufficient number of lab facilities available to the Faculty of Information Technology. This scarcity was a significant concern for the academic staff, prompting them to seek funding through national and international projects consistently The goal was to improve the teaching methods, the development of academic spaces, and the scientific research equipment. These approaches were made to enhance the students in terms of theoretical knowledge and skill in their field so that students can gain effective education.

3.2 Creating a Sharp Vision for The Future

The vision for the future must be adapted to the mission and values of the university and consider the needs and expectations of students, lecturers, and all staff. The development towards a clearer vision takes place in contemporary universities, where students better understand the values and needs of society, create connections, and exchange experiences with students and academic staff from the countries of the region and beyond. Based on UAMD's mission: To encourage and develop critical and analytical thinking, as well as a sense of responsibility and commitment to man, community, cultures, events, and various issues that concern the individual and the community the investment in research infrastructure would contribute as follows:

- *Critical and Analytical Thinking*: Having access to well-equipped research facilities gives students the tools they need for in-depth study and analysis. With laboratories, libraries, and advanced technology at their disposal, students can tackle complex problems, analyze data, and reach well-founded conclusions. This environment nurtures critical thinking by letting students rigorously test and explore their ideas.
- *Sense of Responsibility and Commitment to Humanity*: Many research projects address urgent societal issues like healthcare, environmental sustainability, social justice, and technology ethics. By engaging in these projects, students gain an understanding of the broader impacts of their work and develop a sense of responsibility to make a positive difference. Strong research infrastructure supports initiatives that aim to solve real-world problems, encouraging a commitment to the greater good.
- *Community Engagement*: Research facilities enable universities to partner with local communities, government agencies, and non-profits on various projects. These partnerships allow students to apply their knowledge in real-world situations, benefiting the community directly. Through these experiences, students gain a deeper understanding of community needs and learn the importance of contributing to societal well-being.
- *Cultural Awareness and Sensitivity*: Research often involves examining diverse populations, cultural practices, and global issues. With the right resources and support, students can conduct studies that broaden their perspectives and appreciation for different cultures and viewpoints. This exposure is crucial for fostering cultural awareness and sensitivity, which are essential for responsible global citizenship.
- *Addressing other Issues*: A strong research infrastructure supports multidisciplinary studies that cover a wide array of topics, from technological advancements to social challenges. Engaging in interdisciplinary research helps students approach problems from multiple angles, enhancing their critical thinking and innovative problem-solving skills. This comprehensive approach prepares students to tackle complex issues affecting individuals and communities.

Enhancing research infrastructure in higher education is closely tied to the mission of developing critical and analytical thinking and fostering a sense

of responsibility towards society. By providing the necessary resources and environment, research infrastructure empowers students to deeply engage with their studies, address significant societal issues, and grow into thoughtful, responsible, and innovative leaders. Within the Information Technology Faculty in UAMD, creating national and international collaborations with other higher institutions and industrial parties has resulted to be the best practice to apply this vision and achieve a significant impact on RI development.

3.2.1. The exchange of experiences in the field of scientific research

Exchanging experiences among universities greatly improves the quality of education and research in many ways. When universities share their best practices in teaching, curriculum design, and research methods, they can adopt successful strategies that enhance learning and research outcomes. These exchanges often lead to collaborative research projects, where institutions combine their resources and expertise to make discoveries that wouldn't be possible alone. Faculty and staff also benefit from being exposed to different academic cultures and educational approaches, which can lead to better teaching methods and innovative research practices.

Resource optimization is another key benefit. Universities can learn from each other how to use their facilities and technology more efficiently, saving money and improving educational results. When it comes to curriculum development, understanding what other institutions are doing can inspire improvements in one's own programs, like adding new courses or interdisciplinary approaches to stay current. Student exchange programs are a big part of this too. They allow students to experience different educational environments, broadening their academic and cultural horizons, and improving their adaptability and problem-solving skills.

Exposure to different teaching styles and technologies can inspire universities to innovate in their own classrooms, making learning more engaging and effective. Experience exchange also helps universities set benchmarks, highlighting areas where they can improve and providing examples of higher standards. Collaborative projects often lead to higher-quality research outputs, such as joint publications and shared data.

Additionally, these exchanges promote a global perspective, enriching research topics and educational content to prepare students for a connected world. Access to funding can also improve, as many grants prefer projects involving multiple institutions.

Finally, by sharing experiences, universities can tackle common challenges like budget constraints and student engagement issues more effectively. In short, exchanging experiences fosters a culture of continuous improvement, benefiting students, faculty, and the entire academic community. In this regard, the Information Technology Faculty at UAMD considered collaboration with other national and international Universities for staff and student mobility. At UAMD, during the last years, about 447 students, faculty, and administrative staff have been part of this experience, as shown in figure 2 and figure 3.

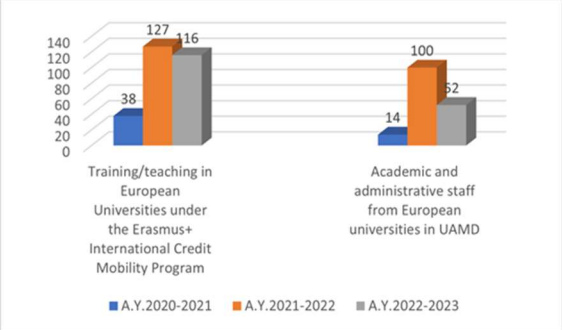


Figure 2. Mobility of academic and administrative staff

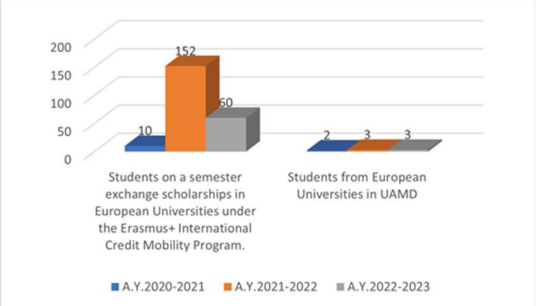


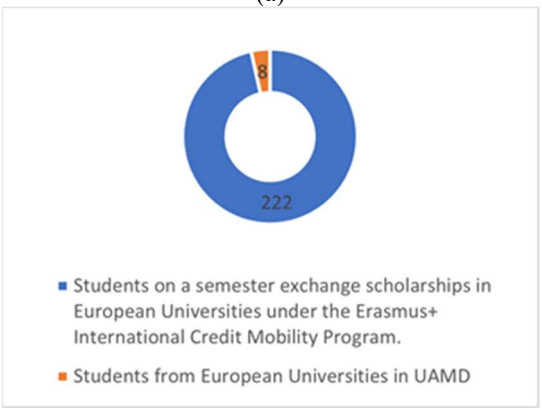
Figure 3. Mobility of students

Figure 4 shows the total number of students, and staff who received international experience during 2018-2023.

As it is clear in the chart below, the number of students and staff who have received training or educational experience is greater than that of the

administrative and academic staff who came to UAMD.

(a)



(b)

Figure 4. (a) Summary of mobility of academic and administrative staff, (b) students

3.2.2 Cooperation with European Partners in Information Technology

- *DIMTV project*

During the 2018-2019 academic year, ITF at UAMD was selected as the project leader for the Erasmus project: CBHE-JP "Development and Implementation of Multimedia and Digital Television" (DIMTV). This project aimed to contribute to the improvement of the current situation in Albania and Kosovo, specifically in reducing the level of unemployment and the lack of specialists in the field of Multimedia (MM). The project partners involved public and private universities from Albania, Kosovo, Slovenia, Estonia, the Czech Republic, and local industry. Figure 5 illustrates the CBHE-JP project partners.

Figure 5. DIMTV project partners

To achieve this, UAMD proposed 3 new Professional Master programs in MM: Production and Post-Production, Image Processing, and 3D Animation. The program would be conducted in cooperation with scientific researchers of partner universities from EU countries to produce new specialized professionals with state-of-the-art knowledge. The main challenges arising from this project are illustrated in Figure 6. There are three main challenges: Improving the current bachelor curriculum and creating new curriculums for the new master programs, following up with the accreditation process, and preparing a sustainability plan in the field of Multimedia.

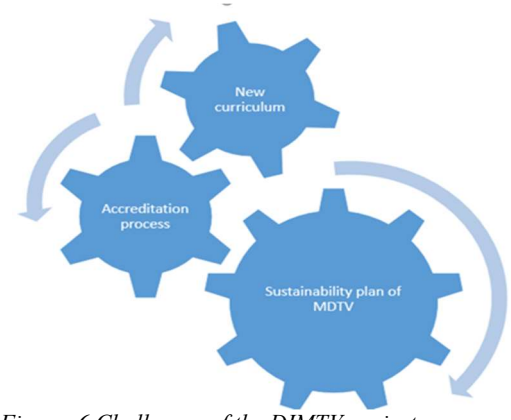


Figure. 6 Challenges of the DIMTV project

Throughout this project, several milestones were achieved concerning students, faculty, and administrative staff among the participating universities such as:

- Update the current curriculum of MDTV
- Creating a new curriculum for the master's program
- Designing and offering new courses at three of the participating universities
- Designing educational materials, and catalogues for the bachelor and master programs both for Albania and Kosovo
- Accreditation of programs
- External evaluation report for UAMD's BCH and PM programs

Furthermore, this project has had a significant impact on scientific research infrastructure and the development of the sustainability plan in the field of

MM. DIMTV project provided Albanian and Kosovo Universities with a state-of-the-art curriculum and enhanced professional development among academic staff with training in the field of MDTV by EU faculty partners and experts from the industry. Part of the achievements of this project included long-term collaboration agreements with public and private institutions, preparations of textbooks for the MM curriculum in Albanian language, a considerable number of practical courses that use a hands-on approach, and enrichment of the library with 40 new titles. The MM laboratory is equipped with modern technology and an audio-visual studio, used as an asset of UAMD in the function of the Institution, students trained and certified by international institutions. A few textbook preparations are achieved as a collaboration and knowledge unification of three universities, UAMD, Epoka University, and UBT Pristina; A great achievement resulting from this project is that all students have been employed upon graduation and there have been considerable new students enrollment every academic year. The achievements of scientific research in terms of academic and infrastructural aspects are presented in Figure 7.

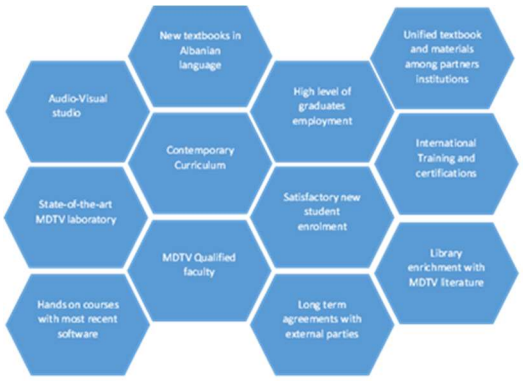


Figure 7. Indicators of the sustainable development of education in the field of MM

- *VTECH project*

The academic staff of the Information Technology Faculty (ITF) of UAMD, having a clear vision for the future of education, was able to apply and win a second project leader for "Accelerating Western Balkan's University Modernization by Incorporating Virtual Technologies" (VTECH) from 2019 to 2022. The main goal of the project was the conception of virtual technologies and innovative ideas for the first time at Western Balkan Universities. Albanian Universities and those from Kosovo aimed to:

- Achieve Capacity building of academic staff to incorporate Virtual Technologies in Teaching
- Develop teaching methodologies aided by technology and/or ICT tools
- Equip students with competencies to use/access tools, software, and platforms
- Increase interaction between professors and students
- Increase the level of understanding and reduce the grasping time and the effort that students need to learn information by using 3D concepts instead of 2D ones.

Cooperation between public and private Universities from Albania, such as UAMD, UET, Polis University, and Epoka University; Kosovo universities: Prishtina University, the UBT Prishtina, as well as European partner Universities (Figure 8), makes it possible to accelerate the modernization of Western Balkan Universities.

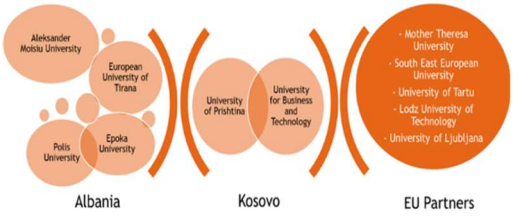


Figure 8. Consortium of the VTECH project

The collaboration between UAMD's academic faculty and partner universities proved successful in enhancing both scientific research infrastructure and updating teaching methodologies. More specifically:

- +10 academic staff from each university have been trained to develop and use VT in their daily university work.
- Administrative staff at each higher education institution (HEI) has been trained to support VT teaching at their universities
- VT-supported courses have been introduced at partner HEIs equipping students with transferable skills in innovative and critical thinking
- Creative spaces and VT labs have been opened to the partner and other HEIs in the region, contributing this way in the regional higher education capacity building
- Joint academy - industry thesis supervision, open days, and round tables with industry have been organized as effective tools in establishing and strengthening the links among students, alumni, industry, and academia

- Sustainable future networks contribute effectively to both the Higher Education sector and industry in partner countries.

The inclusion of virtual technologies in academic life aims to increase the efficiency of teaching and learning methods, contributing to the increase of the general cultural and professional level towards a digital society in the Western Balkan countries.

- *STARS Alliance*

With the vision for the future Universities, which generate innovative knowledge that society, industry, and sectors need to develop new ideas. UAMD signed an agreement with the Stars EU Alliance, an inter-institutional collaboration between 9 complementary European Universities to establish channels of collaboration initiatives. This collaboration is expected to serve as an accelerator of regional growth and empower students and future educators to actively participate in the social, cultural, and economic advancement of society by educating citizens.

Since the European University modus operandi encourages partners to work together on shared projects under a single identity while respecting their individuality, we think it is especially well-suited to achieving our objective. In our vision, academic institutions would share their resources and capabilities, take advantage of synergies and mutually beneficial relationships, and collaborate with local actors in real and virtual cooperation structures (co-creation environments) where people may interact, debate, learn, and create.

UAMD is attempting to enhance the number of dual degrees offered by universities in various European Universities. The Faculty of Political and Legal Sciences has so far enhanced the number of programs offered at the Bachelor's, Master's, and Doctorate levels with five universities from Italy, France, and Poland. There is a continuous effort to expand these cooperation agreements in other faculties of UAMD.

3.2.3 The design and development of an Alumni information system

Having an Alumni Information system is essential for higher education institutions to maintain strong relationships among their graduates and the institution. It contributes to enhancing their reputation and supports their professional growth [14]. In this regard, an initiative to design and implement an Alumni Management System was taken from a group of the academic staff of ITF [15]. The proposed model considers innovating data management in a faster and more efficient way. The system has a threefold purpose: alumni staff will collect and maintain current updated information on graduated students; the graduate student will be able to interact with businesses, and organizations can select potential candidates for their vacancies. With the help of the current IR, the faculty has increased the value of the university in the public and educational domain, as well as helping students to go easy and successful in the labor market. IR helps ITF lecturers present the design and development of an Alumni Information System.

3.3 Improving the physical infrastructure of the computer network

After creating a sharp vision of the creation of scientific research infrastructure, it is necessary to consider the establishment of a powerful computer network infrastructure with high-speed Internet and the appropriate IoT tools for data collection to aid the research development [16], [17].

A well-organized physical infrastructure of the computer network creates the conditions for good practices and ease in the transfer of knowledge [18], [19]. Continuously improving technology in education leads to innovative teaching methods transforming traditional to smart universities, using intelligent methodologies and digital libraries [20–23]. With the continuous effort of the ITF academic staff at UAMD to enhance the RI through local and international collaborations, the faculty network has been extended with their laboratory infrastructure with 3 brand new laboratories equipped with high performant PCs, significantly improving the infrastructure for the benefit of the academic staff in the premises of scientific research according to the standards of European Universities.

3.4 Software development and maintenance

The factors mentioned above must be supported by software applications for the sustainable development of scientific research infrastructure. Computer systems should have high performance and be part of the Cloud network and scalar capabilities in modeling, simulation, and data analysis.

- *E-learning initiative*

Technological developments made it possible to "walk clockwise" during the COVID-19 pandemic. Thanks to various programs and platforms, it became possible to continue life in education and

other life sectors. Today's online learning environment has technologically developed, and it supplements traditional learning by offering a broad range of online resources to a large audience [24]. A questionnaire was developed to measure the performance of this process for professional education in Albania [13]. The study showed that approximately 60% of teachers used several digital platforms simultaneously or at various times to conduct distance learning. The percentage distribution among digital platforms adopted by teachers during the COVID-19 pandemic is shown in Figure 9. The study shows that most of the teachers have tried to use all the platforms they could find available to conduct distance learning classes.

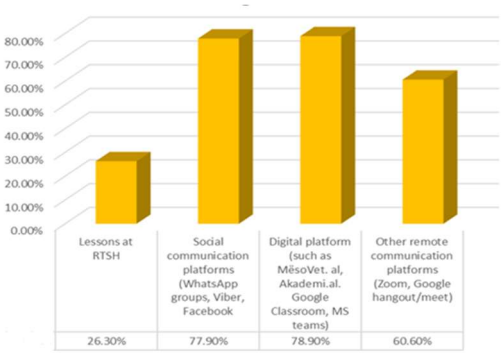


Figure 9. Used combined platforms [8]

From the collected information, it can be noticed that the most preferred means for digital learning were Google Classroom, MS Teams, and Zoom mostly because of the tools and the free subscription these global platforms provide.

Other platforms that had less impact on the education process but were constantly used for communication between educators, students, and parents were Instant message platforms such as WhatsApp, Facebook, and Viber. A small contribution was also provided by the National television broadcast programs; however, these programs were not focused on higher education.

Similar studies have been conducted in other countries [25–28] reinforcing the findings of the study and the global approach toward online tools impact on education. Through e-learning initiatives, traditional teaching and learning are enriched in multiple ways such as enhancing teaching techniques, increasing access to resources, increasing student participation and engagement, providing personalized learning experience, broadening educational opportunities, increasing flexibility and convenience, improving collaboration and communication, and more.

- *Curriculum continuous improvement*

In reference to curriculum updates and improvement to serve the contemporary trends in technology, UAMD is aiming to incorporate IoT devices to create virtual prototypes for the port of Durres and the industry in general thanks to its participation in the international EU project "Green Transformation of IoT for the academic society and business-oriented ecosystem" (IoT-ECO). In this regard UAMD will be granted a Microsoft Azure license, creating the conditions for the creation of an IoT HUB and the development of the software infrastructure. The scientific research of lecturers and students will represent the models of the ecosystem and green transformation towards a sustainable economy. Agriculture, tourism, and energy are the main sectors where the IoT Hub will serve as a tool for innovation and transformation, being supported by the digitization process for sustainable economic development following the Sustainable Development Goals of the 2030 Agenda [29].

- *Industrial Internship collaborations*

Lecturers, students, and specialists in the field of Information Technology in ITF in cooperation with the "Crystal System" are developing the 3D EDV Enterprise Digital Visualization platform, which through 3D visualization aims to increase efficiency in the evolution of the organization and reduce costs for training, management, and the development of other activities within the organization Figure 10.

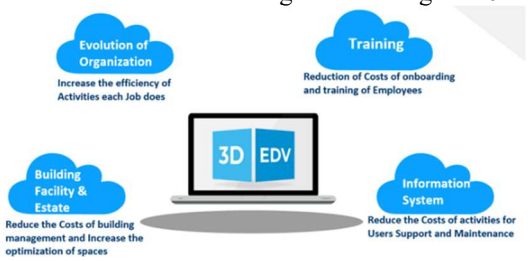


Figure 10. 3D EDV Enterprise Digital Visualization platform

- *Institutional-level projects*

In accordance with the vision and mission of the institution, ITF is developing several internal projects to provide continuous improvement of the software infrastructure, such as: "Design and Implementation of the Aluminum Database for the Information Technology Faculty", "Development of an academic incubator and its implementation at Aleksandër Moisiu University (UAMD)", and projects to strengthen the cooperation between students and lecturers in scientific research.

3.5 Creation of Intelligent Environments

The application of intelligent environments in higher education is a growing area of interest, with a focus on enhancing the learning experience. Multiple studies collectively underscore the potential of intelligent environments to transform higher education, but also the need for further research and practical solutions to overcome implementation challenges from early studies [30] [31] both emphasize the potential of intelligent learning environments to surpass traditional methods and improve user experience, respectively. Another study [32] highlights the potential of intelligent buildings to create productive and sustainable learning environments, but also identifies cultural and process barriers to their implementation. The authors of [33] extend this discussion to the specific context of the Czech Republic, proposing visions for intelligent assistance in graduation thesis preparation, smart lecture halls, and smart university campuses. In [34] the research presents cases of how green student center design may be connected to environmental attitudes and offers direction for the intentional design and use of green student centers as influential facets of the total environment on college campuses. The ITF in UAMD enjoys several smart environments thanks to the efforts of the academic staff in scientific research projects and funding from the EU through the Erasmus+ CBHE projects.

"Accelerating Western Balkan's University Modernization by Incorporating Virtual Technologies" (VTECH) project has contributed to the first virtual reality laboratory built in UAMD premises, where students and academic staff from Albania and the countries of the region are trained (figure 11). This environment includes not only the space for the conception of virtual reality for students in different areas but also promotes the scientific research of the academic staff in the field of IT, making possible the transfer of knowledge from current classic laboratories to laboratories with virtual technology.

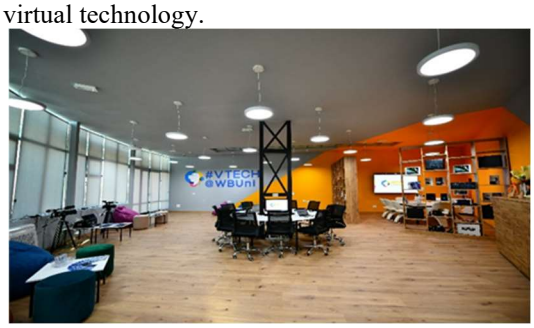


Figure 11. VR Laboratory was built in UAMD in 2020.

The "Development and Implementation of Multimedia and Digital Television" (DIMTV) project, made possible the construction of a Multimedia laboratory on the premises of UAMD with the most contemporary technology in the Multimedia field. In this laboratory, students can implement their MM projects in production and post-production, signal processing, and 3D animation. An audio-visual studio with the most modern technologies of the moment was also installed. Through its premises, students performed their radio shows and developed multimedia productions, which are innovations not only for Albania but also in the region (evidenced by the specialists of the Audiovisual Media Authority). The infrastructural improvements that occurred in the university between 2019-2022 due to international project collaborations funded by the EU Commission have encouraged the staff to continuously seek for more national and international projects collaborations.

3.6 LMS Implementation

Learning Management Systems (LMS) can help improve knowledge delivery and facilitate distance learning. A learning management system can support peer collaboration by providing students with the capacity to create their own project sites [35]. Through these systems, students' progress in the theoretical conception of the subject or the realization of tasks can be evaluated even in impossible conditions, such as pandemics, wars, weather disasters, and more. These platforms also have a wide impact on library tools [36], and course management and improvements for faculty through web and mobile platforms [37–39].

The primary software management system at UAMD is called PITAGORA. This is a platform managed by the Ministry of Education that provides the features required by the administration's back office and end users (lecturers, students, etc.) to oversee the student's entire academic journey, including course enrollment, evaluation through graduation, and transfers between universities. Thus, PITAGORA oversees both the administrative and pedagogic domains at UAMD. However, UAMD currently makes use of two other additional LMS systems provided by the EU research fund:

- Moodle Platform ENGINE – is an E-learning system, used for course management. One of the key objectives of the ENGINE project is to develop new, modular e-learning courses for Partner HEIs' innovative curriculum and to provide a platform for sharing knowledge

between Albanian HEIs and program partner institutions. The features of this platform are being used, such as lecture presentations and course materials, instructions for laboratory work, and quizzes for student self-control.

- Kalcess.net platform – is an interactive platform that connects academic institutions, students, and businesses, used for innovation and collaborative projects among UAMD and its Balkan partner Universities and businesses.

Throughout these 2 LMS systems, UAMD has facilitated the process of course management, student assessments, and communication.

3.7 Integration in Virtual Laboratories

Multiple studies show that with the integration of virtual reality laboratories, Universities are increasing the learning experience and satisfaction of their students [35–37]. They emphasize the potential of VR in experimental and subject teaching, highlighting its ability to create immersive and realistic learning environments. This is further supported by [43], who underscores the benefits of VR in creating engaging and interactive learning experiences, particularly in technical curriculum design and during the COVID-19 pandemic.

The Virtual Reality laboratory at UAMD is being exploited by the FIT for several purposes such as conducting lectures, workshops, student conferences, meetings with secondary school students, and ad-hoc meetings with partner universities in the region. Students of this faculty are using it to create several virtual applications. Since the laboratory is new only a few projects have been completed: An ancient Durres historical landscape application, aimed to enhance the attraction Ancient city of Durres.

A safe electrical laboratory is also developed by the students to help minimize electrical hazards during laboratory time. The students of Multimedia and Digital Television are using the "Storytelling Lab" for creative thinking and multimedia productions.

To evaluate the impact of VR in the West Balkan Universities a survey was conducted among 815 teachers/researchers and students from Albania, Kosovo and North Macedonia, Slovenia, Poland, and Estonia[44]. The questionary used direct questioning through closed and open-ended questions.

According to the results, 59% of the participants in the questionnaire think that virtual technologies have a high impact on their field of education as is shown in figure 12.

.

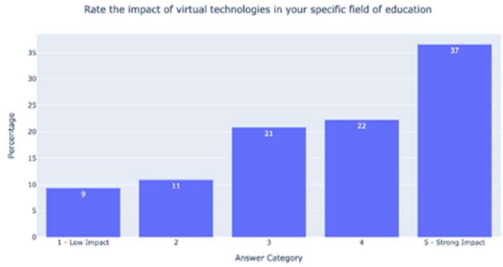


Figure 12. The impact of virtual technologies on the specific areas of education

3.8 Adopting Artificial Intelligence

From early studies, AI has been exploited by educators [45] at a slow pace, however, it was the release of OpenAI's revolutionary tool ChatGPT that completely transformed the vision of the education process. Studies show that the application of AI tools in higher education can significantly enhance teaching and learning experiences [46], [47]. However, the use of these tools also raises concerns about their impact on traditional assessment methods and the need for ethical guidelines [48], [49]. Sullivan et al. [50] in a review of 100 different publications on the use of ChatGPT showed that so far, the threats are still dominant compared to the opportunities this platform offers for education. These concerns are mostly a result of the short time AI is being exploited in education and no proper rules and regulations have been developed. Despite these challenges, AI tools such as cognitive tutors have been shown to improve learning outcomes [49]. Therefore, while the use of AI tools in higher education holds great promise, it is important to carefully consider their implications and ensure their responsible use.

As a new tool, AI is still at the beginning of its journey also in UAMD. Small steps have been taken by the academic staff to exploit its benefits. Initiatives such as using AI algorithms in their research to improve different areas of society [51], [52], and creating applications to improve work management, network management, startup development, etc. At [53] the authors use natural language processing techniques to build a corpus for Albanian Speech Recognition to aid the usage of internet resources by students with difficulties in foreign languages.

3.9 Increased Cyber Security

The importance of cybersecurity in higher education, particularly in research infrastructure, is underscored by scientific researchers, who emphasize the need for awareness, training, and solid policies to protect against cyber threats [54]. The institutions highlight the critical role of security measures in safeguarding information assets, particularly in the context of online learning systems [55]. Researchers stress the need for robust risk mitigation techniques and strategies, providing a classification of common cyber threats in higher education [56], [57]. Higher education institutions are considered lucrative targets for cyber-attacks [58]. These institutions manage a large amount of sensitive data and valuable research making them very attractive to cyber criminals, so they propose a generic model that will serve security practitioners as a starting point for security research [59] [60]. Considering that data of students, staff, and university assets is a sharp problem, it requires solutions from IT specialists and scientific researchers. Through the analysis of the current state, the forecast for the solution of the problems on the preservation of the confidentiality of the data up to the level of national security, scientific researchers and IT specialists should find the right solutions, considering the characteristics of Albanian society with a significantly large number of cyber-attacks over the last years [61]. So far there is not any clear framework aiding the protection of higher education data. UAMD but also the majority of the higher institutions in Albania do not have a proper cyber security policy for their institution. In the current state, UAMD is proposing a cybersecurity policy to be implemented in the near future. This policy will serve as a safeguard for the sensitive data, will protect intellectual property, and ensure the integrity of academic and administrative operations. The proposed framework is centered around four key pillars: Protect, Detect, Respond, and Recover. The "Protect" pillar focuses on implementing stringent access control measures and securing network infrastructures to prevent unauthorized access. The "Detect" pillar emphasizes the importance of continuous monitoring and advanced email security protocols to identify and mitigate potential threats swiftly. The "Respond" pillar outlines the necessity of a well-defined incident response plan, enabling institutions to react promptly and effectively to cybersecurity incidents, minimizing damage and downtime. Lastly, the "Recover" pillar highlights the critical role of regular data backups and recovery strategies to ensure business continuity and data integrity in the aftermath of an attack. The policy framework is based on 7 key components:

1. Governance and leadership – To establish clear roles and accountability for cybersecurity oversight, led by a designated cybersecurity professional
2. Risk Management - Conduct regular cybersecurity risk assessments prioritizing and implementing risk mitigation strategies aligned with institutional goals.
3. Data Protection and Privacy - Implement encryption, access controls, and secure data handling practices adhering to privacy regulations and standards (e.g., GDPR, CCPA).
4. Incident Response and Work Continuity - Develop and test incident response plans for timely threat detection and mitigation ensuring work continuity in the event of a cybersecurity incident.
5. Compliance and Training - Monitor and comply with cybersecurity regulations and frameworks, providing ongoing cybersecurity training and awareness programs for all stakeholders.
6. Infrastructure and Network Security - Deploy multi-layered security measures for networks, systems, and cloud services to secure endpoints and implement strong authentication mechanisms.
7. Collaboration and Partnerships - Engage in partnerships with industry and peer institutions for threat intelligence sharing and participating in collaborative cybersecurity initiatives to strengthen defenses.

The institution has recommended methods to safeguard and maintain data integrity for internal and external stakeholders. The goal is to create an academic environment free from cyber threats and criminal activity. Interest groups will benefit from improved cyber security policies, including students, faculty, and administrative personnel above anything else.

The effective establishment of cyber security capacities, their improvement and development, the consolidation of defensive and responsive capabilities, an increase in awareness and professionalism, and strengthening cooperation and coordination with national and international institutions will all contribute to ensuring a safe online environment in Albanian universities.

The future of cybersecurity and enhanced sustainability will center on the ongoing development of abilities via cyber training, exercises, and education. To improve mutual aid and formation exchange in assault prevention, mitigation, and recovery online safety. The "Strategy For Cyber Defence 2024-2028" has been accepted by the Albanian government. Advancements in technology should be the aim, along with collaboration and coordination with academic institutions. We can respond faster than threats and vulnerabilities

4. DISCUSSION

Considering the exploited literature and the journey UAMD has followed in recent years we conclude that scientific research and research infrastructure have a mutual connection that can only be developed in parallel. To find the right strategy for sustainable RI development, we need to define qualitative and quantitative indicators to see changes over time. They are the most appropriate and effective tools for monitoring and evaluating the strategy and steps proposed in this study regarding the sustainable development of the research infrastructure in university life as in the figure below (figure 12).

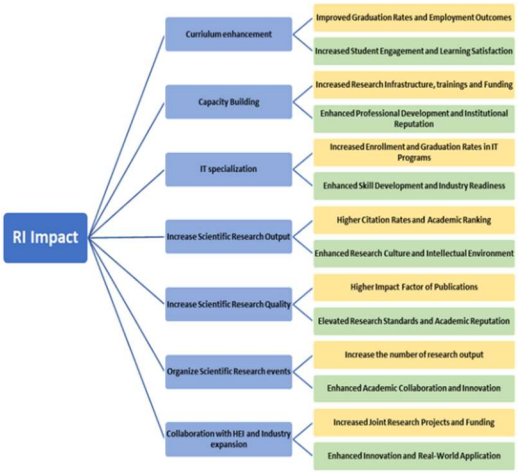


Figure 12. Impact of the RI, quantitative and qualitative indicators for higher education

Figure 12 includes the qualitative and quantitative impacts RI has in the life of higher education institutions. The RI's impact is long-term and is widely affecting in the academic, scientific, and social aspects. Interest groups related to RI are students, academic staff and administrative staff, universities within the country and internationally, as well as in industry. In quantitative terms RI impact can be felt in the increasing the number of new study programs in line with technological developments, the number of specialized students, rising academic capacities, increasing wide range of activities such as workshops, training, and conferences, the number of publications, the number of study visits with partners, etc.

In terms of quality, RI's impact can be felt in updating curricula with innovative technologies, improving course materials, increasing the quality of research conducted by faculty members and preparing students capable of the job market.

Research infrastructure (RI) is important to guide and promote research in technology and science for the years to come. There are a few questions raised for an institution that decides for the path they should follow to adopt RI.

- How can they attract investments to create the necessary RI in accordance with the needs of the time?
- How will RI's impact on social, economic, and scientific life be evaluated?

The conclusions of the European Council on Research Infrastructure address the need to provide resources and services for scientific researchers. The Swedish Presidency of the Council of the EU has set RI as the main priority in the Research and Innovation Agenda as an incentive tool for cooperation [62].

The clear vision of a modern research infrastructure requires the cooperation of creative and ambitious researchers with policymakers, relying on digital technologies and the appropriate skills of the researchers themselves. Everyday challenges require the creation of intelligent environments, the use of virtual laboratories, and the adoption of AI within university environments.

The environment of scientific research and implementation of modern technologies needs services with high data security. Improving the infrastructure of scientific research and increasing the skills of researchers will ensure the cyber security of data and their processing.

Designing the university of the future involves implementing modern technologies and innovative solutions to improve the student experience, facilitate learning, and improve its functioning.

5. CONCLUSIONS

The development of sustainable Research Infrastructure in the field of Information Technology is very important and essential to respond to current global challenges in education science and the economy. As supported by the evidence reviewed in our synthesis, expansive and effective RI does much more than enrich academia and creativity; it also builds a mutually beneficial connection between universities, industry coalitions, and transnational organizations. When properly managed through investments and partnerships, universities can become centers for excellence regarding the development of technology and catalysts for the improvement of societies. UAMD's experience demonstrates the potential of this strategy and the need for a more focused RI development.

Thanks to the implementation of several projects financed by the EU, UAMD has increased its research activities, improved and updated its curricula, and has become a recognized leader in the sphere of IT education. Overall, these innovations have led to curriculum enhancement, improved and increased student engagement, and enhanced university-industry relations ultimately benefiting all stakeholders.

Thus, it becomes pertinent for these universities to remain abreast with the emerging trends and technological revolutions. Introducing and designing the intelligent environment, incorporation of virtual laboratories, and the use of artificial intelligence are crucial components for the strategic evolution of education.

Also advancing the mechanisms of cybersecurity is essential for the safety of sensitive research data and for the effective functioning of academic institutions. In conclusion, the development of sustainable research infrastructure is a collective venture with the active involvement of universities research and development industries and the government.

By establishing a culture of constant enhancement and change, it would be possible for universities in Albania, Western Balkan, and other regions to be adequately prepared for the requirements of a digital age and make a great contribution to the further development of education and technology

6. FUTURE RESEARCH DIRECTIONS

The current study lays a strong foundation for understanding the impact of Research Infrastructure (RI) on higher education in the field of Information Technology (IT), particularly in Albanian and Western Balkan universities. However, there are several areas that warrant further exploration. Future research could focus on the following directions:

1. **Longitudinal Impact of RI on Educational and Research Outcomes**: While this study provides a snapshot of the immediate effects of improved RI, a longitudinal study could offer insights into the long-term impact on educational quality, student performance, and research productivity. Future research could track the performance of students, faculty, and university research outputs over multiple years to better understand how sustained investments in RI continue to shape academic success and industry collaborations.
2. **Cross-Regional Comparative Studies**: Expanding this research to include a comparison between Albanian and Western Balkan universities and other regions, such as Western Europe or Southeast Asia, could provide a broader perspective on how different levels of RI investment affect educational outcomes. Such comparative studies could also explore how cultural, economic, and policy differences influence the development and sustainability of RI in various contexts.
3. **Exploration of Emerging Technologies in RI**: As technology evolves, there is a need for future research to explore how emerging technologies, such as artificial intelligence, blockchain, and quantum computing, can be integrated into Research Infrastructure. This would help universities stay ahead of technological advancements and further enhance their research capabilities, particularly in IT education.
4. **Assessment of RI's Socio-Economic Impact**: Future studies could explore the broader socio-economic impact of RI beyond the academic setting. Specifically, research could assess how improved research infrastructure contributes to regional economic growth, job creation, and the development of local industries. This

would provide policymakers with valuable insights into the return on investment in research infrastructure.

5. **Evaluation of Virtual and Remote Research Platforms**: With the rise of virtual learning and remote work, future research should evaluate the effectiveness of virtual research infrastructures, such as cloud-based laboratories and virtual reality environments. Exploring how these technologies enhance or hinder research and education in IT could provide new models for universities seeking to expand their RI in a cost-effective manner.
6. **Sustainability Models for RI Development**: Given the importance of sustainability in RI, future research could investigate models for maintaining and scaling RI while ensuring financial, technological, and environmental sustainability. This research could focus on identifying best practices in funding, resource management, and stakeholder engagement to ensure long-term viability.
7. **Cybersecurity Frameworks for Academic Research Infrastructures**: With the growing emphasis on data security, future research should delve into the development of robust cybersecurity frameworks specifically tailored for academic institutions. This could include studying the vulnerabilities of digital RI and proposing solutions to safeguard sensitive academic and research data.

REFERENCES

[1] Fecher, B.; Kahn, R.; Sokolovska, N.; Völker, T.; Nebe, P. Making a Research Infrastructure: Conditions and Strategies to Transform a Service into an Infrastructure. Science and Public Policy 2021, 48, 499–507.
[2] Ngo, L.; Apon, A.; Xuan, P.; Ferguson, K.; Marshall, C.; McCann, J.; Zheng, Y. An Infrastructure to Support Data Integration and Curation for Higher Educational Research.; 2012.
[3] Forfás, I. Research Infrastructure in Ireland : Building for Tomorrow, 2007.; December 21 2006.
[4] Hua, J. Dissussion on the Sustainable Devlopment of Research Insitutes of Higher Education in Colleges and Universities.; 2002.
[5] Larsen, S.C. Enhancing University Research through Innovations in Graduate Education. In Proceedings of the Merrill Series on The Research Mission of Public Universities; September 1 2016; pp. 67–74.
[6] Verhoeven, D. As Luck Would Have ItSerendipity and Solace in Digital Research Infrastructure. Feminist Media Histories 2016, 2, 7–28, doi:10.1525/fmh.2016.2.1.7.
[7] Lilja, E. Threat of Policy Alienation: Exploring the Implementation of Open Science Policy in Research Practice. Science and Public Policy 2020, 47, 803–817, doi:10.1093/scipol/scaa044.
[8] Heck, T. 8.2 Open Science and the Future of Metrics. In 8.2 Open Science and the Future of Metrics; De Gruyter Saur, 2020; pp. 507–516 ISBN 978-3-11-064661-0.
[9] Bilder G, Lin J, Neylon C (2020) The Principles of Open Scholarly Infrastructure (v1.1, 2023) Available online: https://openscholarlyinfrastructure.org/ (accessed on 25 April 2024).
[10] Øvrelid, E. Exploring the Alignment between Digital Strategies and Educational Practices in Higher Education Infrastructures. Education Sciences 2022, 12, 711, doi:10.3390/educsci12100711.
[11] Shestakova, I.; Morgunov, V. Structuring the Post-COVID-19 Process of Digital Transformation of Engineering Education in the Russian Federation. Education Sciences 2023, 13, 135, doi:10.3390/educsci13020135.
[12] Amado, C.; Dorotea, N.; Pedro, A.; Piedade, J. MOOCs Design: A Conceptual Framework for Continuous Teacher Training in Portugal. Education Sciences 2022, 12, 308, doi:10.3390/educsci12050308.
[13] Toti, L.; Kunicina, N. Sustainable Development of the Professional Education during the Period of COVID-19. In Proceedings of the 2023 IEEE 64th International Scientific Conference on Power and Electrical Engineering of Riga Technical University (RTUCON); October 2023; pp. 1–6.
[14] Singer, T.S.; Hughey, A.W. The Role of the Alumni Association in Student Life. New Directions for Student Services 2002, 2002, 51–68, doi:10.1002/ss.70.
[15] Rista, A.; Toti, L.; Xhaferra, E. Design and Implementation of an Alumni Management System. In Proceedings of the 2023 4th International Conference on Communications, Information, Electronic and Energy Systems (CIEES); November 2023; pp. 1–4.

[16] Jutawongcharoen, K.; Varavithya, V.; Lekdee, K.; Chaichit, A.; Sribuddee, T. The Implementation of the UniNet's Research DMZ. In Proceedings of the 2016 International Computer Science and Engineering Conference (ICSEC); IEEE: Chiang Mai, Thailand, December 2016; pp. 1–5.
[17] Ponce de Leon, M.; Mao, S.; Steuer, F.; Schumacher, J.; Magedanz, T.; Beyah, R.A.; Midkiff, S. Advances In Wireless Test Beds and Research Infrastructures. Mobile Netw Appl 2010, 15, 311–314, doi:10.1007/s11036-010-0230-1.
[18] Krieger, J. Computer Network for Research Gains Support. Chem. Eng. News Archive 1988, 66, 5–6, doi:10.1021/cen-v066n035.p005a.
[19] Lee, W.; Cho, B.; Ahn, S. Design of National Research Network for Strengthening of Supporting an Advanced Research Activities.; Park, J.J., Stojmenovic, I., Jeong, H.Y., Yi, G., Eds.; Springer Berlin Heidelberg: Berlin, Heidelberg, 2015; Vol. 330, pp. 1189–1193.
[20] Rico-Bautista, D.; Guerrero, C.D.; Collazos, C.A.; Maestre-Góngora, G.; Hurtado-Alegría, J.A.; Medina-Cárdenas, Y.; Swaminathan, J. Smart University: A Vision of Technology Adoption. Rev. colomb. comput. 2021, 22, 44–55, doi:10.29375/25392115.4153.
[21] Varzaneh, A.S.; Merikhi, B.; Varzaneh, M.S.; Isfahani, M.H.A.V.; Kalahroodi, H.H.; Sharabiany, M.F. A Comprehensive Architecture Platform for Smarter Universities. In Proceedings of the 2023 28th International Computer Conference, Computer Society of Iran (CSICC); IEEE: Tehran, Iran, Islamic Republic of, January 25 2023; pp. 01–07.
[22] Monica Oloo, O.; Muteheli. Florence, A. The Role of Knowledge Management and Infrastructure in Developing Smart Universities in Saudi Arabia. Int J Humanit Soc Sci Educ 2023, 10, 68–81, doi:10.20431/2349-0381.1007009.
[23] Amron, A.; Putra, F.I.F.S.; Budiantoro, R.A.; Wardhani, M.F. Smart University Implementation in Higher Education to Improve the Graduates' Competitiveness. JK 2022, 6, 173–188, doi:10.21831/jk.v6i2.45706.
[24] Ismail, R.; Safieddine, F.; Kulakli, A. E-University Lecture Delivery Model: From Classroom to Virtual. In Proceedings of the 2017 International Conference on Engineering & MIS (ICEMIS); May 2017; pp. 1–7.
[25] Adeyeye, B.; Ojih, S.E.; Bello, D.; Adesina, E.; Yartey, D.; Ben-Enukora, C.; Adeyeye, Q. Online Learning Platforms and Covenant University Students' Academic Performance in Practical Related Courses during COVID-19 Pandemic. Sustainability 2022, 14, 878, doi:10.3390/su14020878.
[26] Gunawan, G.; Suranti, N.M.Y.; Fathoroni, F. Variations of Models and Learning Platforms for Prospective Teachers During the COVID-19 Pandemic Period. Indonesian Journal of Teacher Education 2020, 1, 61–70.
[27] Elfirdoussi, S.; Lachgar, M.; Kabaili, H.; Rochdi, A.; Goujdami, D.; El Firdoussi, L. Assessing Distance Learning in Higher Education during the COVID-19 Pandemic. Education Research International 2020, 2020, 8890633, doi:10.1155/2020/8890633.
[28] Almusharraf, N. & Khahro, S Students Satisfaction with Online Learning Experiences during the COVID-19 Pandemic. International Journal of Emerging Technologies in Learning (iJET) 2020, 15, 246–267.
[29] SDG Indicators Available online: https://unstats.un.org/sdgs/report/2023/ (accessed on 23 May 2024).
[30] Vandamme, F. Towards an InTELligent Learning Environment System for Higher Education. Higher Education in Europe 1989, 14, 28–39, doi:10.1080/0379772890140204.
[31] Liu, G.; Liu, Z.; Lu, F.; Ye, Q.; Liu, Z. Design and Application of University Intelligent Learning Environment Centered on Improving User Experience. In Proceedings of the Design, User Experience, and Usability. Application Domains; Marcus, A., Wang, W., Eds.; Springer International Publishing: Cham, 2019; pp. 457–471.
[32] Everett, R. The 'Building Colleges for the Future' Program. Delivering a Green and Intelligent Building Agenda. New Review of Information Networking 2008, 14, 3–20, doi:10.1080/13614570902953549.
[33] Bureš, V.; Tučník, P.; Mikulecký, P.; Mls, K.; Blecha, P. Application of Ambient Intelligence in Educational Institutions: Visions and Architectures. International Journal of Ambient Computing and Intelligence (IJACI) 2016, 7, 94–120, doi:10.4018/IJACI.2016010105.
[34] Harrell, K. Green Student Centers' Influence on the Campus Environment. Educational Foundations & Leadership Theses & Dissertations 2012, doi:10.25777/6fmc-t384.
[35] Teasley, S.D.; Lonn, S. Using Learning Management Systems to Support Students' Collaborative Learning in Higher Education. In Proceedings of the Proceedings of the 8th

iternational conference on Computer supported collaborative learning - CSCL'07; Association for Computational Linguistics: New Brunswick, New Jersey, USA, 2007; pp. 718–720.
[36] Leeder, C.; Lonn, S.; Hollar, S. Use of Library Tools in a Learning Management System. In Proceedings of the Proceedings of the 2012 iConference; ACM: Toronto Ontario Canada, February 7 2012; pp. 595–597.
[37] Suhaim, A.B. Faculty Perceptions of the Educational Value of Learning Management Systems.; August 1 2017.
[38] Leeder, C.; Lonn, S. Faculty Usage of Library Tools in a Learning Management System. CRL 2014, 75, 641–663, doi:10.5860/crl.75.5.641.
[39] Schön, D. Customizable Teaching on Mobile Devices in Higher Education.; 2016.
[40] Vicente Dos Anjos, F.E.; Rocha, L.A.O.; Oliveira Da Silva, D.; Pacheco, R. Impacts of the Application of Virtual and Augmented Reality on Teaching-Learning Processes in Engineering Courses: A Systematic Literature Review About Learning and Satisfaction on Students. International Journal of Virtual and Personal Learning Environments 2021, 12, 1–19, doi:10.4018/IJVPLE.291541.
[41] Abulrub, A.-H.G.; Attridge, A.N.; Williams, M.A. Virtual Reality in Engineering Education: The Future of Creative Learning. In Proceedings of the 2011 IEEE Global Engineering Education Conference (EDUCON); April 2011; pp. 751–757.
[42] Alshammari, S.H. The Role of Virtual Reality in Enhancing Students' Learning. International Journal of Educational Technology and Learning 2019, 7, 1–6, doi:10.20448/2003.71.1.6.
[43] Huang, T.-C.; Limniou, M.; Wu, W.-C.V. Editorial: Virtual Learning Environments in Educational Institutions. Front. Virtual Real. 2023, 4, doi:10.3389/frvir.2023.1138660.
[44] Toti, L.; Kunicina, N. The Impact of Virtual Reality Technologies on the Modernization of the Curricula of Western Balkan Universities in the Field of Renewable Sources. In Proceedings of the 2023 10th International Conference on Electrical, Electronic and Computing Engineering (IcETRAN); June 2023; pp. 1–6.
[45] Garito, M.A. Artificial Intelligence in Education: Evolution of the Teaching—Learning Relationship. Brit J Educational Tech 1991, 22, 41–47, doi:10.1111/j.1467-8535.1991.tb00050.x.
[46] Xu, Y. Research on the Application of Artificial Intelligence Tools in Higher Vocational Education. ACE 2023, 22, 265–272, doi:10.54254/2755-2721/22/20231227.
[47] Vinogradova, A.I.; Gorodishcheva, A.N.; Gorodishchev, A.V.; Paskhalskaya, Y.V.; Yaskov, E.S. Predictive Online Analytics Tools in the Educational Environment. J. Phys.: Conf. Ser. 2020, 1691, 012186, doi:10.1088/1742-6596/1691/1/012186.
[48] Lievens, Jeroen ARTIFICIAL INTELLIGENCE (AI) IN HIGHER EDUCATION: TOOL OR TRICKERY? 2023, doi:10.36315/2023v2end141.
[49] Bilad, M.R.; Yaqin, L.N.; Zubaidah, S. Recent Progress in the Use of Artificial Intelligence Tools in Education. Jurnal. Penelitian. Pengkajian. Ilmu. Pendidikan. e-Saintika 2023, 7, 279–315, doi:10.36312/esaintika.v7i3.1377.
[50] Sullivan, M.; Kelly, A.; McLaughlan, P. ChatGPT in Higher Education: Considerations for Academic Integrity and Student Learning. Journal of Applied Learning and Teaching 2023, 6, 31–40, doi:10.37074/jalt.2023.6.1.17.
[51] Xhaferra, E.; Cina, E.; Toti, L. Classification of Standard FASHION MNIST Dataset Using Deep Learning Based CNN Algorithms. In Proceedings of the 2022 International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT); IEEE: Ankara, Turkey, October 20 2022; pp. 494–498.
[52] Mankolli, E.; Bushati, S. Candidate Engagement Success Prediction Using Machine Learning and Natural Language Processing Techniques. In Proceedings of the 2023 24th International Conference on Control Systems and Computer Science (CSCS); May 2023; pp. 431–435.
[53] Rista Amarildo, Kadriu Albana, A. A Model for Albanian Speech Recognition Using End-to-End Deep Learning Techniques | Interdisciplinary Journal of Research and Development. 2023, doi:https://doi.org/10.56345/ijrdv9n301.
[54] Yaseen, K.A.Y. Importance of Cybersecurity in The Higher Education Sector 2022. Asian Journal of Computer Science and Technology 2022, 11, 20–24, doi:10.51983/ajcst-2022.11.2.3448.
[55] Singar, A.V.; Akhilesh, K.B. Role of Cyber-Security in Higher Education. In Smart Technologies : Scope and Applications; Akhilesh, K.B., Möller, D.P.F., Eds.; Springer: Singapore, 2020; pp. 249–264 ISBN 9789811371394.

[56] Liluashvili, G.B. Cyber Risk Mitigation in Higher Education. Law and world 2021, 7, 15–27, doi:10.36475/7.2.2.
[57] Trofymenko, O.; Loginova, N.; Serhii, M.; Dubovoil, Y. CYBERTHREATS IN HIGHER EDUCATION. Cybersecurity 2022, 4, 76–84, doi:10.28925/2663-4023.2022.16.7684.
[58] Bongiovanni, I. The Least Secure Places in the Universe? A Systematic Literature Review on Information Security Management in Higher Education. Computers & Security 2019, 86, 350–357, doi:10.1016/j.cose.2019.07.003.
[59] Ulven, J.B.; Wangen, G. A Systematic Review of Cybersecurity Risks in Higher Education. Future Internet 2021, 13, 39, doi:10.3390/fi13020039.
[60] Wangen, G. Quantifying and Analyzing Information Security Risk from Incident Data.; Albanese, M., Horne, R., Probst, C.W., Eds.; Springer International Publishing: Cham, 2019; Vol. 11720, pp. 129–154.
[61] Zeneli, M. Pathway of Applications of Cyber Security Standards and Rules in Albania. In Proceedings of the 2022 29th International Conference on Systems, Signals and Image Processing (IWSSIP); IEEE: Sofia, Bulgaria, June 1 2022; pp. 1–4.
[62] Research and Innovation Funding Available online: https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/research-and-innovation-funding (accessed on 20 June 2024).
[63] Towards a safe Cyberspace in Higher Education: Assessment of the cybersecurity practices