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How can Digital Robots Help Creating a Smart Campus?

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Abstract: **The development of technology has created the need to increase the quality of life of individuals all over the world. This need for development has initiated the transformation of the 'smart campus' in university campuses called small cities. A transformation that started with digitalization has led universities to use digital technologies in their business processes and education periods within the scope of smart campuses. Robotic Process Automation (RPA), one of the digital transformation technologies, automates repetitive and labor-intensive business processes in these digitalization processes. The application of RPA in four different processes at Izmir Bakırçay University was examined to show how RPA can help creating a smart campus. The university saved up to 92.59% of cost and 98.25% of time from these four processes. It has been observed that the studies carried out within the scope of smart campuses will continue to increase because some routine processes still need to be automated.**

Keywords: Robotic Process Automation, Smart Campus, Digital Transformation, Process Automation, Digital Robots.

I. Introduction

All countries and organizations want to increase the quality of life and establish sustainable ecosystems with the rapidly developing technology in their working habits. These aspirations are reflected in learning methods and quality of life. With the rapid development of technology, the concept of rapid urbanization requires the basic vital services of people to provide in a quality and sustainable manner. Because this supply becomes more difficult, it should be "smarter" to find solutions to these challenges (Dogan et al., 2021). All these situations have revealed the concept of a smart city. With the developing technology and processes, a great increase in demand for individual learning has started. Smart cities make this rapid growth sustainable. This rapid growth also creates the need for a new reform in the field of education. This reform provides the transition of the education system to another and higher dimension, revealing the concept of a 'Smart Campus'. University campuses represent an invaluable opportunity to potentiate this approach, as they concentrate on a large community of students, professors, and employees, forming a "population" that is willing to adopt and promote innovations as well as get involved as developers and testers (Fortes et al., 2019).

Within the context of smart campuses, the population they host—comprising students, faculty, staff, and various stakeholders—represents a significant resource and opportunity for implementing transformative reforms. The convergence of this diverse population provides a fertile ground for innovation and catalyzes the evolution of smart campuses. The amalgamation of willing participants within this community offers a unique chance to establish and nurture a smart learning environment that caters to the needs of modern education. As smart campuses evolve, they not only focus on enhancing academic experiences but also strive to cultivate an intelligent workforce equipped with the skills and adaptability needed in a rapidly changing world.

Moreover, the synergy between smart cities and smart campuses is increasingly apparent, as education plays a pivotal role in the fabric of smart urban environments. Smart cities prioritize education as a crucial component, recognizing its impact on societal development and overall city performance. Educational institutions within smart cities contribute significantly to the city's vibrancy, innovation, and overall appeal, creating a symbiotic relationship where advancements in one realm positively influence the other. As a result, integrating education into the framework of smart cities not only elevates the city's status but also enhances its attractiveness as a hub for growth, innovation, and sustainable development. The interconnection between smart cities and smart campuses thus forms an inseparable whole, complementing and enriching the other in pursuing progress and excellence.

The viability of the smart campus idea naturally depends on implementing digital transformation. In many campuses, efficient use of human resources and increasing the quality of education and service come to life with digitalization. For this reason, digital transformation is imperative when creating a smart campus or city.

Digital transformation is "a company's way of using digital technologies to develop a new digital business model that helps create more value for the company and make it affordable" (Verhoef et al., 2021). For this reason, digital transformation can be divided into two main categories as software development and digitalization processes. With the rapid development of digital technologies, the digitalization process in businesses has begun to cover business processes, models, and organizational structures. The digitalization process of incorporating digital technologies into all business processes and life includes software development in the light of digital transformation in the technological products needed in this process.

Some business processes have repetitive tedious tasks and are labor intensive Robotic Process Automation (RPA) automates high-volume work processes in business processes with higher efficiency and lower error rate. This makes us realize that it is a digital technology that saves time and costs. Process automation provides time and cost savings with Smart Campus studies. Accuracy is increased in identified and automated business processes, resulting in increased efficiency and consistency with digitalization. With RPA technology, educators or university staff can not only have a tool that simplifies their work but also save a significant amount of time and resources (Plattfaut et al., 2022). All these savings become reportable and these reports contain numerical values.

RPA systems are a technology that has emerged of direct the time and energy employees to value-added and knowledge-based works by undertaking large-volume, repetitive and rule-based tasks such as information entry, data copying, data parsing, opening applications, scanning documents, filling out forms (Özdem and Bora, 2022). They are software robots that automate these repetitive business processes by imitating users, depending on certain rules. These digital software robots perform repetitive and rule-based activities. Within the scope of Smart Campus, studies can be seen in many universities around the world. Many processes such as course registration, meeting scheduling, exam score calculation, and distance education models (Kyzy et al., 2017; Patrício et al., 2023; Gomes and Seruca, 2023) along with the pandemic have been digitized. In a study conducted at a university, the software robot examined the e-learning process in four different stages and presented the learning outcomes of the students with great accuracy to the lecturers (Munawar, 2021). In another study conducted at the University of Washington, a Smart Grid System was established within the scope of the smart campus to make power systems more reliable and increased energy savings. In another study, a digital robot that automates scholarship payment processes has been developed within the scope of İzmir Bakırçay University's Smart campus project.

The paper is structured as follows: Section II introduces digital transformation and process automation under smart campus. Section III exemplifies process automation applications for smart campuses. Section IV gives four RPA implementations at Izmir Bakircay University and their benefits concerning the time, workforce and cost efficiencies. Finally, Section 5 concludes the study.

II. Digital Transformation of Processes Under Smart Campus

A. Digital Transformation

Analog systems could no longer respond to developments in various fields. Companies should adapt to remain competitive and relevant as the world becomes increasingly digital. Transforming analog operations to digital describes how a firm uses digital technologies to develop a new digital business model that helps to create more value and make it relevant (Verhoef et al., 2021). This digital transformation requires companies to reconsider their operations, embracing technology and data to streamline processes.

Digital technologies play a significant role in driving digital transformation in various industries. Some of the key digital technologies that are leading the way include cloud computing, artificial intelligence (AI), big data, the internet of things (IoT), blockchain, 5G networks, virtual and augmented reality (VR/AR), and robotics. Cloud computing allows companies to store, process, and manage large amounts of data and applications over the internet, which helps to reduce the cost and complexity of managing IT infrastructure (Qiu and Xiao, 2020; Xie, 2022; Huang and Li, 2021). AI, on the other hand, automates tasks and processes, enables more informed decision-making, and improves customer experiences (Razak et al., 2023; Mosteanu, 2022). Big data enables organizations to collect and analyze large amounts of data to gain insights and make more informed decisions (Villegas-Ch et al., 2019; Revathi et al., 2020). The internet of things (IoT) connects devices, machines, and other physical objects to the internet, enabling real- time data collection, analysis, and control. Blockchain, a secure and decentralized ledger, records transactions and enables safe and transparent information sharing (Shah et al., 2021; Oktuğ et al., 2020; Sutjarittham et al., 2019; Vieira et al., 2019). Blockchain technology can be used to easily verify the detailed information in each student's micro-credentials. The application of blockchain in the education sector provides a new horizon for a number of non-functional requirements including but not limited to security, immutability, independence from the institution, and immutability of official records and certificates (Alsobhi et al., 2023; Guerreiro et al., 2022). 5G networks provide high-speed internet connectivity and real-time data transfer, improving communication and collaboration (Amadi and Nwauloaku, 2022). Virtual and augmented reality (VR/AR) enhances customer experiences, training, and remote collaboration (Koparan et al., 2023; Buchner and Kerres, 2022; Hafsa and Majid, 2020; Ozcan et al., 2017). Finally, robotics automates manual and repetitive tasks, increasing efficiency and reducing costs (Amadi and Nwauloaku, 2022).

With technological advancements, the concept of "digital" has become widespread and affects many aspects of daily life, especially in business. The integration of digital technologies has led to the evolution of business models and is now referred to as digital transformation. This transformation encompasses all aspects of a business, including its processes, models, and structure. The digitalization process in companies results from the fourth industrial revolution.

B. Process Automation

Digital transformation can be divided into two main categories: software development and process automation. Both software development and process automation play a crucial role in driving digital transformation and help organizations to stay competitive in a rapidly changing digital landscape. Software development involves the creation and implementation of new digital tools and systems that enable organizations to operate more efficiently and effectively. This can include the development of new mobile applications, websites, and cloud-based software systems. On the other hand, process automation focuses on automating repetitive tasks and workflows using technologies such as robotic process automation (RPA), artificial intelligence (AI), and the Internet of Things (IoT). The goal of process automation is to streamline business operations and improve efficiency, accuracy, and productivity (Akyol et al., 2023).

RPA is an important component of the process automation aspect of digital transformation. It allows organizations to automate repetitive tasks and workflows using software robots. These robots follow pre-defined rules to complete tasks and work alongside human employees to enhance the overall efficiency and accuracy of business processes. The benefits of RPA include reduced errors, increased speed, lower costs, and improved compliance with regulations (Akkol et al., 2023).

RPA has been proven to bring numerous benefits to organizations implementing digital transformation. One of the key advantages is time and cost savings. It automates repetitive tasks, reducing the time required to complete them and freeing employees to focus on more high-value work. Additionally, RPA can lower costs by reducing the need for manual labor and improving efficiency because digital robots can work 24/7 without breaks and a time barrier to their work. This leads to increased efficiency and enhanced productivity for the organization. Another critical benefit of RPA is the high accuracy rate, which can approach 100%. RPA robots follow pre-defined rules and do not make mistakes, unlike human employees, who are prone to error. It leads to fewer errors in business processes and helps to improve the overall quality of the work being performed. However, it is essential to note that while RPA can reduce the workforce, it is not intended to replace human employees. Instead, RPA works alongside human employees to enhance their work and make their jobs easier. In this way, RPA can increase efficiency with digitalization. Additionally, RPA is a reliable tool that organizations can count on to improve their operations and drive digital transformation.

C. Digital Transformation Under Smart Campus

A smart campus is a higher education institution that leverages digital technologies to improve student experiences and outcomes. Smart campuses use technology to enhance student experiences by providing online learning opportunities, digital resources, and interactive spaces. Digital transformation is crucial in developing smart campuses, enabling universities to transform traditional operations into more efficient, effective, and sustainable systems (Berktas et al., 2023).

A critical aspect of smart campus development is technology integration into university operations. It can involve implementing digital systems for student registration, course management, and campus security. By automating these processes, universities can streamline operations and improve efficiency, releasing resources to focus on more strategic initiatives. Additionally, smart campuses use technology to create more engaging and personalized learning experiences for students. This can include the use of virtual and augmented reality tools, online learning platforms, and data analytics to provide real-time feedback and insights (Akkol et al., 2023). The development of smart campuses also has important implications for sustainability. By leveraging technology, universities can reduce their carbon footprint and become more energy-efficient. It can involve the use of smart building systems to optimize energy usage, the implementation of renewable energy sources, and the creation of sustainable transportation systems. Additionally, smart campuses can use technology to promote sustainability education and engage students in sustainability initiatives.

Integrating RPA into smart campus operations can have a significant impact on the efficiency and effectiveness of higher education institutions. RPA can automate many repetitive and time-consuming tasks common in higher education, such as student registration, course management, and campus security. By automating these processes, universities can free up resources to focus on more strategic initiatives, such as enhancing student experiences and outcomes. In addition to improving operational efficiency, RPA can also play an essential role in developing smart campuses by providing valuable data and insights. For example, RPA can gather data from various sources, such as student records and campus systems, and analyze it to provide real-time feedback and insights. This information can be used to inform decision-making and drive continuous improvement in smart campus operations. Furthermore, RPA can be integrated with other technologies, such as artificial intelligence and machine learning, to create even more advanced and sophisticated systems for smart campuses (Olucoglu et al., 2023a).

III. Process Automation Applications for Smart Campus

Smart campuses represent a fundamental shift in the educational landscape, embracing digitalization to revolutionize how students learn, interact, and navigate their academic journey. Unlike traditional institutions, these new-generation campuses are at the forefront of leveraging cutting-edge technology to enhance the educational experience (Altun and Zencikiran, 2021). They transcend physical boundaries, integrating many digital tools and innovations and reshaping the educational ecosystem. With the advent of technology, colleges and universities seek rapid and efficient solutions, leading to the emergence of smart campuses that harness the power of digital technologies to elevate student experiences and outcomes. This evolution has fundamentally transformed higher education processes, creating a sector defined by a myriad of technological functions driven by digitalization. The impact of this transformation is significant, as highlighted by a Gartner survey that revealed 59 percent of higher education CIOs anticipate substantial changes in business

models due to digital transformation (Moore, 2022). As a result, smart campuses have embraced Robotic Process Automation (RPA) as a pivotal branch of process automation, utilizing automation tools to streamline administrative tasks, optimize resource management, and enhance overall operational efficiency. RPA empowers these campuses to automate repetitive tasks, allowing faculty and staff to focus more on strategic initiatives and innovation and providing an enriched learning environment for students. This integration of RPA within the fabric of smart campuses underscores their commitment to leveraging technology to drive progress and efficiency in higher education.

The multifaceted definition of smart campuses encompasses various perspectives, and one crucial aspect is the integration of automation into university processes. Universities have embraced RPA as a cornerstone of their digital transformation strategy. RPA has been deployed across a spectrum of critical areas within the university ecosystem, showcasing its versatility and impact. From streamlining course registrations to optimizing the enrollment process and managing candidate shortlisting, RPA has significantly improved operational efficiency and accuracy. Attendance management, eligibility criteria control, meeting scheduling, and even email communications have all benefited from implementing RPA at the University of Texas (University of Texas System, 2022). Beyond these academic functions, administrative domains such as Finance and Accounting, HR Services, and IT Services have also harnessed the power of RPA, reaping the rewards of automation in reducing manual workload, minimizing errors, and enhancing overall productivity. This comprehensive integration of RPA across diverse university operations underscores its transformative potential in revolutionizing administrative and academic processes within the smart campus framework (Olucoglu et al., 2023b). The University of Texas's successful implementation serves as a testament to the broad applicability and effectiveness of RPA in advancing the efficiency and functionality of higher education institutions.

Instructors must keep track of students' activities, success rates, attendance rates, and homework assignments. This monitoring process becomes problematic when the number of students increases. These everyday actions can be automated as the number of subjects and students increases. For example, Munawar et al. RPA robots to track student attendance, collect and track tasks, process and track exams, and send the whole process as an e-mail (Munawar, 2021). It was observed that time and effort were saved in these four stages. In the education sector, technology investments to scale, experiment, innovate, and improve student and staff experiences are always on tight budgets. With RPA, higher education institutions save time and cost and become more efficient. For example, an employee has a voluminous job when registering students in the university's automation. It is a repetitive task for every student at the university. RPA robots perform student entries into the automation system at a university instead of the employee and provide a success rate of close to 95% compared to the employee (Nandwani et al., 2021).

Yu Chen et al. (2023) worked on designing a Chatbot (Student assistant) to support student achievement in the classroom with Artificial Intelligence (AI). In higher education, low teacher-student ratios can make it difficult for students to receive immediate and interactive help. This research addressed this gap in IS literature by investigating the opportunities, challenges, effectiveness, and ethical concerns of using chatbots as pedagogical tools in business education. They conducted a chatbot-guided interview with 215 undergraduate students to understand student attitudes toward the potential benefits and challenges of using chatbots as intelligent student assistants. They captured findings on student learning needs, which we used to design and develop a novel, experimental chatbot assistant to teach basic AI concepts to 195 students (Chen et al., 2023).

IV. Case Studies in Izmir Bakircay University

In line with the needs of different faculties and administrative units within the body of İzmir Bakırçay University, robotic process automation, which enables the completion of successive repetitive and complex processes, has been utilized to save time, workforce, and costs. Digital robots carry out four processes at Izmir Bakircay University. The conducted RPA implementations have shown significant savings in workforce and costs. The robot ONDOscop carried out regarding the preparation of scholarship payment documents, resulted in a 97.5% time saving and a 98.83% cost saving. Because it is an attended robot, one person must work with it. Therefore, it didn't affect the workforce. The BYOD-1 robot, which automated the course opening process in the Graduate School of Education, achieved 57%-time savings, 50% workforce savings, and 95% cost savings. With the BYOD-2 robot, which enables the preparation of Graduate School management board decisions and their loading onto UBYS (University Information Management System), 75%-time savings, 50% workforce savings, and 78% cost savings were achieved. The robot EKON, performed within the scope of the internship obligation certificate's automatic filling, provided 96.67%-time savings, 75% workforce, and 98.51%.

The studies have demonstrated that RPA can provide significant improvements in university processes. The annual average cost saving is 92.59%, and the average time reduction is 98.25%. It also decreased the staff requirement by 43.75%. The cost savings were calculated by considering the hourly cost of the employee performing process tasks and process cycle time.

A. ONDOscop TUBITAK Scholarship Payment Process

Currently, one employee is responsible for preparing scholarship payment documents. At the end of each month, project coordinators fill out the application form and submit it with a wet signature. In some cases, project coordinators may need to remember to fill in a required field or enter incorrect information, which can prolong the process. The responsible employee prepares three forms from four sources using the application forms. The coordinator currently serves 18 academics. While similar fields are found in each document, personalized information such as identity number, name and surname, student number, project ID, and project name must also be written. It takes more than two working days to

prepare 54 documents for all scholarship recipients. Each time this process is repeated, the employee's three-day gross cost is 3950 Turkish liras. Additionally, it is possible to encounter some errors that increase the process cost (Akyol et al., 2023). Table 1 presents the analytics results of ONDOScop.

Table 1: ONDOscop analytics results

Metrics	Current	Improved	Improvement ratio
Frequency	Once per month		NA
Repetition	18		NA
Cycle time (min)	60	1.5	97.50%
Duration (min)	1080	27	
Number of employees	1	1	NA
Cost (TL)	3506.26	30	99.92%

B. Robot BYOD-1: LEE Course Addition and Branch Opening Process

The robot aims to automate the process of entering the courses and course schedules held at the beginning of each semester in the Graduate Education Institute of Izmir Bakircay University into the system. At the institute, the process of opening and defining graduate course schedules from the departments on UBYS takes six days and requires two people to work together. This repetitive and time-consuming task is considered RPA-compliant because all department course schedules are expected to be in the same format. The aim is to use minimum human resources and complete the process more quickly with RPA. Table 2 demonstrates the analytics results of BYOD-1.

Table 2: BYOD-1 analytics results

Metrics	Current	Improved	Improvement ratio
Frequency	Twice a year		NA
Repetition	50		NA
Cycle time (min)	35	15	57%
Duration (min)	2880	1872	
Number of employees	2	one	50%
Cost (TL)	49	2.45	95%

C. Robot BYOD-2: Reporting the Institute's Decisions and Implementation in the System Process

The robot aims to automate the process of preparing and entering the decisions made at the weekly council meetings at the Graduate Education Institute of Izmir Bakircay University into the system. At the institute, some of the council decisions involve the preparation of records for each department regarding the assignment of academic advisors to registered students at the beginning of each semester, as well as any changes made to academic advising based on student requests during the semester, suspension of registration, and removal of registration, etc. Each of these records takes about 3 minutes to prepare. Assuming that approximately 20 decisions are made at each council meeting, it takes two people working together 140 minutes to prepare and enter the decisions into UBYS for a single council meeting. Table 3 shows the analytics results of BYOD-2.

Table 3: BYOD-2 analytics results

Metrics	Current	Improved	Improvement ratio
Frequency	Once a week		NA
Repetition	20		NA
Cycle time (min)	15	60	75%
Duration (min)	35	140	
Number of employees	one	2	50%
Cost (TL)	42	196	78%

D. Robot EKON: Personalized Document Preparation and Mailing Process

Students need a mandatory internship certificate to give to their companies during their internship periods. In the engineering faculty alone, about 240 students need internship certificates prepared every term, which leads to ineffective use of time and human resources. The process of preparing the internship certificate, transferring it to digital media, and automatically completing and sending it to the relevant student, which is a repetitive and laborious process, has been automated with the developed robot. Thus, it is possible to save time and costs, especially in repetitive operations at the operational level. The motivation of this study is to use the university's limited human resources more efficiently and to ensure that repetitive tasks are completed more quickly and autonomously. With this study, 75% labor and 96.67%-time savings have been achieved. Table 4 indicates the analytics results of EKON.

Table 4: EKON analytics results

Metrics	Current	Improved	Improvement ratio
Frequency	Once per semester		NA
Repetition	240		NA
Cycle time (min)	2	0.06	96.67%
Duration (min)	480	16	
Number of employees	4	1	75%
Cost (TL)	80600	1200	98.51%

V. Conclusions

It has been observed that universities, which include processes such as work, education, etc., for the populations they create, have become centers of attraction. These centers of attraction have been described as crucial steps in the success of all humanity. For this reason, the point reached with digital transformation has been that universities should eliminate traditional campuses and create smart campuses within the scope of digital transformation. Again, it has been seen that digital technologies have been implemented in many universities within the scope of smart campuses and have benefited many business processes.

The technological process emerging in the developing and changing world has brought many different perspectives and applications. Cloud Computing, Artificial Intelligence (AI), Big Data, the Internet of Things (IoT), Blockchain, 5G networks, Virtual and Augmented Reality (VR/AR), and Robotics processes have improved many processes on campuses and all over the world. In many universities, the applications of digital technologies under smart campuses have been examined. The studies showed that a smart campus was needed for better work conditions, education efficiency, and

administrative effectiveness.

Some tasks or processes in university processes have become repetitive and labor-intensive processes. The effect of robotic process automation (RPA) is considerably high in these tasks and processes. RPA reduces workload, time, and cost savings in many processes when applied to many university functions, including course registration, attendance management, eligibility criteria control, meeting planning, and e-mailing.

This study examines the implementation of digital transformation in the processes of universities, which are expressed as small cities. The values added to the campuses by the studies on the processes of fast technologies that can be applied on campuses with digital transformation have been investigated. It investigated how robotic process automation was involved in four different processes within the scope of smart campus applications at Izmir Bakırçay University and what results were achieved.

Within the scope of smart campus applications at Izmir Bakircay University, four processes were automated with RPA robots for the needs of different faculties and administrative units. The first of the processes, the robot ONDOscop, was created to prepare Scholarship Payment documents. The robot completed this work in 27 minutes in total and saved 97.5% of time and 98.83% of cost. The second robot, BYOD-1, was created for the repetition of course addition and branch opening process at the beginning of each semester at the Institute of Postgraduate Education. It saved 57% time, 50% labor, and 95% cost. The third robot, BYOD-2 ensured that the decisions of the Institute's board of directors were prepared and uploaded to the UBYS (University Information Management System). It provided 75%-time savings, 50%-labor savings, and 78% cost savings. Finally, the robot EKON was used to fill out compulsory internship documents and saved 96.67% of time, 75% of labor, and 98.51% of cost. In total, Izmir Bakırçay University saved up to 92.59% of cost and 98.25% of time from these four processes.

RPA technology provides high time and cost savings, working with a 100% of accuracy rate in repetitive processes, minimum human error, reduced workload, and increased efficiency and reliability with digitalization.

Despite the many benefits of RPA and digital transformation and plenty of studies on RPA, there are some limitations of RPA technology. RPA robots are not flexible to changes. The robot works for constantly repeating processes that have to be done and do not change. Changing a step in the process causes the robot to stop working, such as changing the file location.

It has been seen that technologies and studies that promote smart learning need to reach more stakeholders. Examples show that although many successful applications are worldwide, studies are more focused on technological developments. Digital transformations affect economic, social, and environmental processes. As a result, campuses will continue to benefit from the technologies that come with digital transformation in many areas. Robotic Process Automation, Cloud Computing, and Artificial Intelligence will continue to develop and contribute to many parts of our lives with technology. These studies should be more comprehensive, and studies on all applicable processes should be carried out in many areas.

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