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SHORT PAPER

Virtualization and Online Engineering of the Administrative Services in Universities

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ABSTRACT

Virtualization and online engineering of services are emerging as key themes that will profoundly influence society and industry in the near and distant future. This paper focuses on the transformation of administrative services in universities into virtual services through online engineering. This transition presents challenges not only to universities in Bulgaria but also worldwide. Given the significant impact of technology on the daily operations of universities, it is evident that the digital divide is an issue worthy of investigation. Disparities in the adoption of online administrative services can and will lead to inconsistencies in the economic development of universities. This article aims to explore some of the challenges associated with virtualization and online engineering of administrative services in universities and offers insights into how to address them.

KEYWORDS

virtualization, online engineering, digital transformation, administrative services, higher education

1 INTRODUCTION

One of the key themes that will continue to transform society and industry in the not-too-distant future is virtualization and the online engineering of services. This transformation brings about several changes, impacting both the internal processes of an organisation and its interactions with customers and third parties. These changes are so profound that this process has been identified as the most potent force driving 21st-century industrial development and corporate advancement, effectively sparking the Fourth Industrial Revolution [1].

The potential benefits are numerous: virtualized online processes can handle massive volumes of data, enabling the swift collection of necessary information, efficient processing, and quicker decision-making. Additionally, the shift from paper-based methods to software-based solutions allows for automated data collection, improving data quality. This, in turn, facilitates real-time analytics, risk reduction,

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revenue enhancement, cost reduction, and more. On a global scale, virtualized services contribute to a decrease in unemployment, an enhancement in the quality of life, increased public access to services, and an overall improvement in the transparency of government actions [2].

As a result of efforts to realise the benefits and the imperative demands brought about by the pandemic from 2019 to 2022, virtualization and the online engineering of services have made a tangible impact on universities. In many instances, these changes could even be characterised as "revolutionary" [3]. They encompass activities such as conducting online exams, offering access to digital learning materials across all academic disciplines, delivering online lectures, and providing administrative services to students without requiring their physical presence, among others.

The transition to these revolutionary changes and the adoption of new technologies pose challenges not only to universities in Bulgaria but also on a global scale [4–6]. Given the significant influence of technology on university development, it is logical to acknowledge that the existence of a digital divide is a matter deserving of investigation. Disparities in the adoption of modern technology can and will result in inconsistencies in the economic advancement of universities.

2 VIRTUALIZATION AND ONLINE ENGINEERING OF THE DIGITAL TRANSFORMATION OF SERVICES

The study of the specifics of a given process requires a precise definition. In scientific literature and on the Internet, various terms related to the researched field can be found, but the most common ones, "virtualization" and "online engineering of services," are closely connected to "digitalization" and "digital transformation."

According to [7], some authors, digitalization is a process characterised by continuous change, driven by the growing utilisation of digital technologies. Others associate it with the comprehensive integration of digital technologies across all aspects of human society [8]. [9] defines it as "the ability to transform existing products or services into digital versions, thereby offering advantages over physical products." In each of these definitions, it becomes evident that the digitalization process is a complex amalgamation of activities, roles, and software, emphasising the outcome of converting data from analogue to digital format (digitization) rather than merely identifying it.

The term "digital transformation" has gained significant popularity on the Internet, with Google Trends indicating that it is searched for more than twice as often as "digitalization" (see Figure 1).

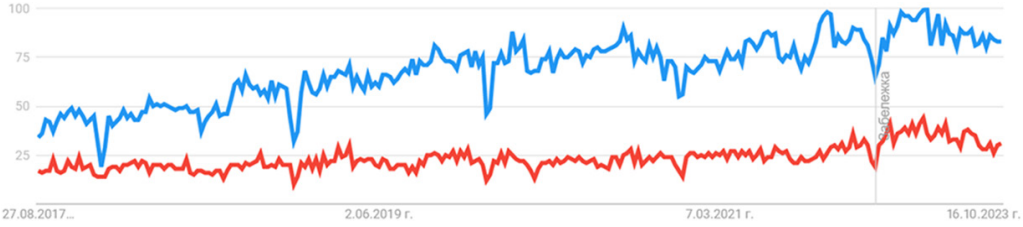

Fig. 1. Digitalization vs. Digital transformation

Source: Google Trends.

Different definitions of the term can be found in the non-scientific literature, with the general point being that it is aimed at a combination of factors—customer and digital technologies. According to an article in Forbes, "digital transformation can

only be about a strategy or a business as a whole and puts the customer first" [10]. A similar interpretation can be found on the IBM web page: "Digital transformation takes a digital approach that puts customers first in all aspects of business, from building business models to improving the user experience for customers to changing processes and operations" (https://www.ibm.com/topics/digital-transformation).

Comparing these two concepts reveals that, despite their similarities, one has garnered more attention and can thus lead to confusion. Defining a term primarily centred on customer focus raises questions about software products that serve other software products without end-users—should they not also undergo digital transformation? In this article, as is the convention in much of the scientific literature, the terms "digitalization" and "digital transformation" will be used interchangeably.

Given the provided definitions, digitalization can be defined as the process of implementing changes in work methods, roles, and overall business operations using digital technologies within a company or the organisation's work environment. This encompasses changes across various levels [2].

- Processes: adopting new digital tools and streamlining processes by reducing manual steps;
- Organizational level: offering new services and removing outdated practices and offering existing services in new ways;
- Business area level: changing roles and value chains in ecosystems; and
- Society level: changing societal structures (e.g., type of work, means of influencing decision-making).

The significance of digitalization has led to substantial scientific interest. Numerous studies have sought to define the levels of digitalization and the factors that influence them. Various researchers have explored multiple aspects, including access to digital technologies such as laptops, tablets, and mobile phones [11], digital competence [12–16], the development of new teaching and learning methods [17–18], institutional changes [19], and ICT infrastructure [20–21], among others. Each of these factors addresses specific challenges at local or global levels. However, a comprehensive approach is needed to provide answers to questions such as: What variables should be used to measure digitalization? How can these variables be quantified? How can the current level be compared with the desired level or with that of other universities? At what point in these variables will the added value of digitalization be realised?

The quest for answers to these questions has given rise to numerous studies in the realm of developing digital maturity models. While some of these models have general applicability, most are designed to address specific challenges in various industries. For the purposes of the current study, we will utilise two general-purpose models to lay the groundwork for a digital maturity model in universities. [22] outlines four levels of digital maturity: researcher level (with limited digitalization attempts), novice level (where only some departments are pursuing digitalization without interdepartmental communication), medium level (where most departments have interconnected software solutions), and expert level (where all departments have interconnected software solutions and the organisation has embraced a digitalization strategy). These levels of digital maturity are correlated with four dimensions: digitalization strategy, technology, data management, organisation, and social factors (employee training).

In another publication [23–24], selected indicators encompass the presence of a strategy, the readiness of the technological infrastructure, the capacity of the

management apparatus and staff for adaptability, the availability of requisite technical resources, and effective data management.

The commonality of these measures is evident and deliberate; they encompass all essential components for the successful implementation of processes involving software. Software relies on hardware for execution and data for collection and processing. The effective use of software in universities hinges on both the preparedness of administrative staff, teachers, and students to work with it and the willingness of management to allocate financial resources for software and hardware while adapting working methods. These elements take on measurable and manageable forms when described within a unified strategy.

Data plays a pivotal role in the functioning of any organisation and can exist in analogue or digital form. Through digital recording and subsequent processing, data can be harnessed for software solutions. As the volume of data, their sources, and formats expand, the necessity arises for multiple actions, both technological and organisational, to ensure the data's usability and accuracy. However, as a starting point, it's imperative to identify the need for data collection within the university, pinpoint its sources, and devise suitable digitization methods.

Technology stands as the primary driver of digital transformation. While some technological solutions are well-known, free, and widely adopted (e.g., Moodle, email, etc.), others are paid and unique (e.g., digital signatures), and still, others can be tailor-made to meet the university's specific needs (e.g., a student portal for accessing grades and student status). The most significant challenge for maximising the value of this metric lies not only in the availability of technology but also in the integration of software systems employed throughout the process.

At the lowest level, organisations lack any connection between the software solutions they employ. Moving up a level, some systems are connected, but this leads to numerous complications when utilising others. In more digitally advanced organisations, most systems are interconnected, but integration issues may still persist. At the highest level, you find organisations where all systems are seamlessly interconnected, facilitating the exchange of data without the need for additional intervention.

The management's ability to implement changes in work practices, restructure business processes, and utilise digital solutions in the management process is among the most critical factors for achieving a high level of digitalization. However, due to the distinct characteristics of governmental organisations, which encompass internal management regulations and legal requirements, each of these activities may pose significantly greater challenges compared to the private sector.

Having a strategy is directly related to and dependent on the management's readiness to implement digital transformation. A digital transformation strategy for the organisation must be included and integrated into the development strategy for the organisation. It should provide a list of the precise steps that must be taken in order to reach a high degree of digital maturity while also avoiding interfering with the goals established in the organisation's current strategy. Instead, it should complement it, enrich it, and thus lead to an improvement in the organisation's performance indicators. Maturity levels can be determined after answering the question of whether such a strategy exists.

- Level 1: It does not exist, and its development is not planned.
- Level 2: Development planned but not started.
- Level 3: Development is ongoing but not complete.
- Level 4: The strategy is developed and published.

For employees taking part in the digital transformation process, a high degree of digital maturity means a high level of digital competence. Successful implementation of the strategy presupposes staff readiness and awareness of upcoming changes. Commitment, people's motivation, and participation in strategic changes inside an organisation are critical to success in the digitization process. A common problem is the lack of training among the staff, which leads to reluctance to start a digitalization process and/or the inability to use already implemented software solutions.

When considering digitalization in universities, it's important to acknowledge that this transformation takes place within an academic environment, involving staff responsible for preparing specialists in information technology. In such a setting, factors related to management readiness, the availability of technology, and the formulation of strategies and policies for data management are relatively attainable. On the other hand, the specific characteristics of the system users—namely, teachers, students, and administration staff—must also be considered. Typically, students are accustomed to using modern software solutions and tend to be more inclined towards embracing innovation rather than resisting it. However, it's possible that the changes required during the digital transformation may lead to some resistance to working with new technologies among teaching and administration staff. To facilitate the transition from one mode of operation to another and to demonstrate the advantages of digitalization, it is highly recommended to provide user training.

For this reason, a question by which the levels of the "human resource" metre can be determined is whether employee training is carried out:

- Level 1: Training is not offered.
- Level 2: On-site training is available.
- Level 3: Online or face-to-face training is available.
- Level 4: Trainings are integrated into the work process and made a mandatory condition for participation in it.

3 CHALLENGES AND SOLUTIONS

Although the importance of digitalization is well recognised, many businesses, including universities, fail to see its potential influence and benefits on their processes. There are numerous impediments to digital transformation. [9] defines digital transformation projects as the use of software technologies to assist business model modifications that touch the entire organisation, including operational processes, resources, and internal and external users. Successful implementation frequently necessitates a significant shift in habits [25–26] and ways of functioning based on collaboration and extensive interactions.

To illustrate the meaning of the above-mentioned metrics, an example will be presented of implementing a system for online payments of semester student fees at the University of Economics in Varna.

3.1 Description of the process prior to digitalization

Students are informed of their university fees via the university's website. These data are entered into the system by employees in the "Study Department." Students can choose to make payments either in person at a branch of the servicing bank or via bank transfer. The data from both sources is processed by the

"Accounting Department," where it necessitates manual verification of the transferred amounts, which often involves confirming the identity of the sender, especially when the bank payment is made on behalf of the student by a relative and contains incorrect data. Subsequently, students provide a copy of the payment order, along with their student ID card, to the "Students Department." Here, they receive a stamp on their ID card and are enrolled for the relevant semester.

3.2 Description of the process after system implementation

The process of digitalization brings about several changes, affecting both the university's workflow and students (see Figure 2).

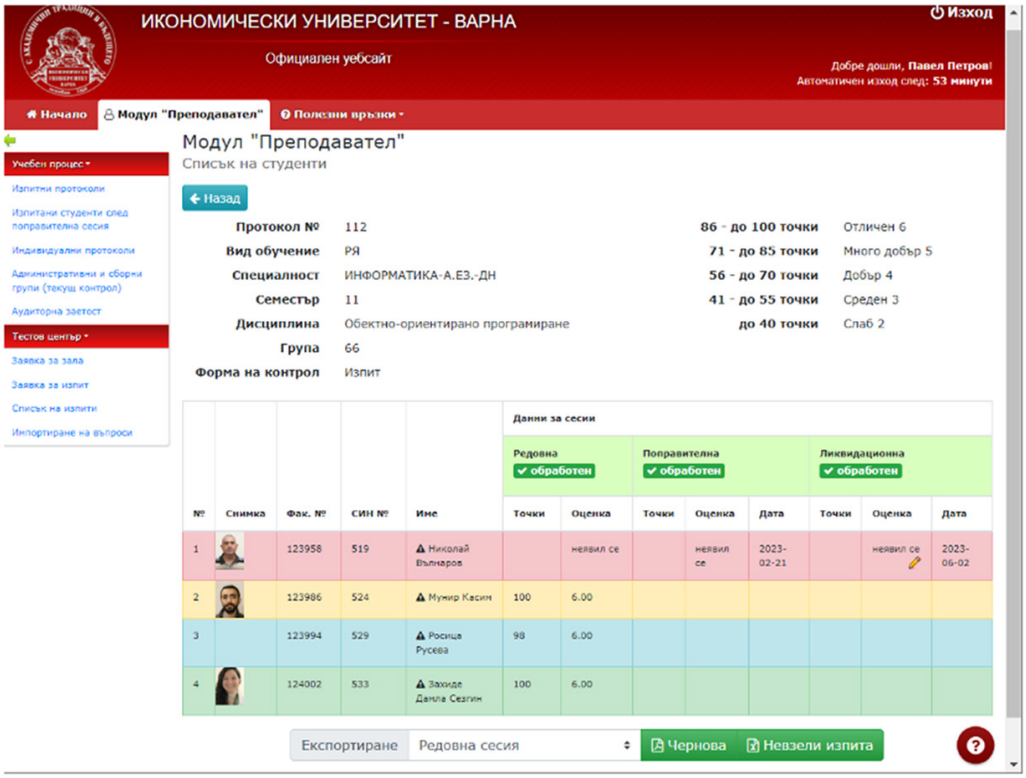

Fig. 2. Screenshot of the WebStudent online system used in UE-Varna; different background colours of the rows facilitate the employee to quickly focus on the important cases

Initially, the "Study Department" must input information about majors and optional course subjects (OCS) fees into the system. Each student accesses the WebStudent system to check their fee, calculated based on their enrolled course, major, and OCS. Students can make payments through the system, ensuring the accurate transfer of the correct amount, and are automatically linked to the payment. If a student pays at a bank branch, payments received via bank transfers are analysed through a specialised algorithm. If the payment details are correctly filled in, they are recorded in the system. Payments received through bank transfers and those made via the WebStudent system are available to the "Accounting Department." An interface is in place to handle cases where bank payment details are incomplete or have other issues. The "Students Department" receives real-time information about student payments made through the system, as well as those additionally processed

by the "Accounting Department," following their review. The collected data could be further analysed with a geographic information system and visualised with equal-area geohash coding [27].

3.3 Reasons for successful project implementation

When examining the differences between the two processes from the perspective of digitalization metrics, it becomes evident that all the necessary prerequisites are in place. The data is readily available, and the technology for accessing it is well-established: inputting fees via a user-friendly interface on one end and making online payments through the bank's programme interfaces on the other. The commitment of management to embrace, enforce, and support the new process is also reflected in the university's strategy, which encompasses a broad spectrum of digitalization initiatives. The reduced timeframes for gathering information on financial receipts and the opportunity for their analysis serve as additional motivations. Human resources readiness is also greatly influenced by the shared desire to simplify or eliminate the manual verification tasks of the administration. Moreover, students are keen on making payments swiftly and conveniently, avoiding the need to queue for hours.

4 CONCLUSION

This research demonstrates that the digital transformation of administrative activities in universities aligns with the same metrics found in models designed to determine maturity levels for general purposes. Given the routine nature of the functions performed and the presence of software solutions and hardware resources, it is evident that these factors alone do not account for some universities lagging in digitization. Instead, it is the actions of university management in driving essential changes in processes and the willingness of employees to adopt new technologies and work methods that have a more significant impact.

We observed that digitization initiatives at the university are hindered by concerns, which include remote engineering and cyber-physical systems. Some of the most frequently asked questions are related to:

- Security of information and software systems: Many employees believe that paper documents provide a higher level of security because they have physical contact with them. This is often a false assumption because e-documents allow the enforcement of a number of security systems, tracking of changes made, and the rapid creation of backup copies at geographically remote locations.
- The likelihood that the new process will make the worker redundant: The most common reason for participants sabotaging digitization processes is the perception that they will be replaced by software. In fact, the university's history shows that not a single employee has been laid off after implementing the software solutions in the last 15 years. Instead, the specifics of the tasks being performed are changing. For example, instead of accepting paper applications from students, they now check electronic submissions for inconsistencies, which involves the use of algorithms to streamline the process.
- Lack of knowledge about whether it's possible to digitalize a process and how long it would take: Often, this lack of digital competence leads to the denial of any ideas of digital transformation at an early stage. To address this, the university

should invest in simulation techniques and virtual and remote instrumentation to help employees understand and adapt to the digitalization process more effectively. Additionally, they can make use of management products to better coordinate and manage the transition to a more digitally driven environment, assuaging concerns about job security and the feasibility of the transformation.

In this evolving landscape, it's essential to emphasise that digitalization is not about replacing employees but enhancing their roles through the integration of robots and simulation techniques into their work processes, making the university more efficient and competitive in the modern world of academia.

In order to achieve a higher level of digitization in universities in the country, it is necessary to invest more efforts into enhancing digital literacy.

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