
INNOVATIVE TOOLS FOR ENSURING THE SUSTAINABILITY OF HIGHER EDUCATION IN THE CONTEXT OF DIGITAL TRANSFORMATION

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Abstract

The paper examines innovative digital tools that can ensure the sustainability of higher education institutions under digital transformation. The cyclical dynamics of global EdTech venture investment in 2010–2024 and the scale of massive open online courses and micro-credentials are analysed as indicators of the maturity of the digital education market. Six groups of innovative tools AI tutors and learning analytics, micro-credentials and MOOCs, cloud ERP and process automation, digital twins of campuses, blockchain-based credentials and hybrid learning are systematised according to their contribution to economic, social and environmental sustainability, and a phased approach to their selection and implementation is proposed.

Keywords: Digital transformation, higher education, sustainability, innovative tools, EdTech, MOOCs, micro-credentials, digital twin, blockchain credentials, cloud ERP.

INTRODUCTION

Digital transformation is changing not only how universities teach but also how they generate revenue, manage costs and maintain their relevance. Institutions that rely solely on traditional face-to-face programmes are increasingly exposed to demographic fluctuations, rising costs and competition from global online providers. In these conditions, the sustainability of a university depends on its ability to adopt innovative digital tools that expand access, reduce unit costs and increase resilience.

At the same time, the digital education market itself is volatile. After a pandemic-driven boom, global EdTech venture investment fell to its lowest

level in a decade, which forces universities to choose tools carefully, based on proven value rather than market hype [5]. A systematic understanding of which tools contribute to which dimension of sustainability is therefore required.

The aim of the study is to systematise innovative digital tools for ensuring the sustainability of higher education and to substantiate an approach to their selection and implementation.

MAIN PART

The dynamics of global EdTech venture investment reflect the cyclical nature of the digital education market (Figure 1). Investment grew from \$0.5 billion in 2010 to \$7 billion in 2019 [1], peaked at a record \$20.8 billion in 2021, fell to \$10.6 billion in 2022 [2] and declined to about \$2.4 billion in 2024, the lowest level in a decade [3]. For universities, this means two things: venture-funded solutions may be unstable, but the post-boom market offers mature tools at lower prices and favours solutions with demonstrated outcomes.

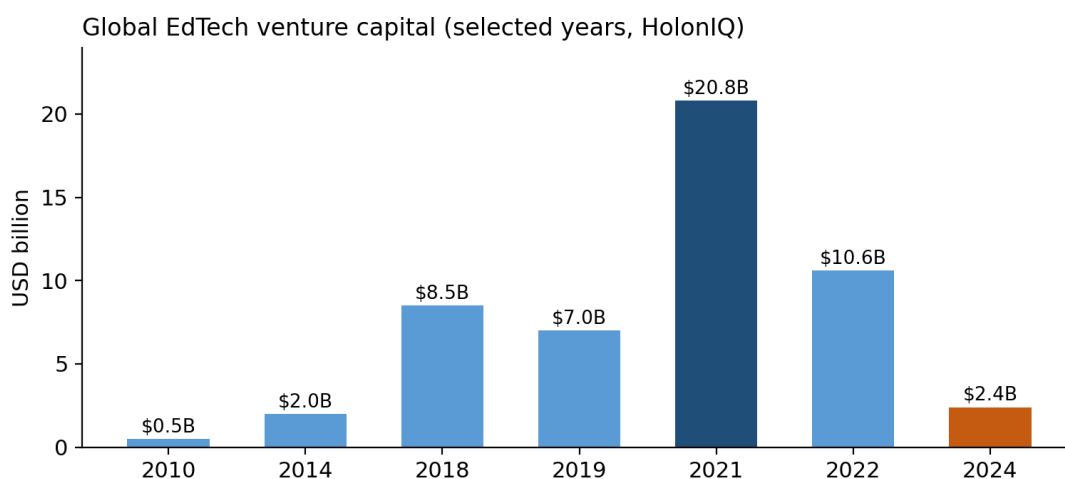


Figure 1. Global EdTech venture capital investment, selected years, USD billion

Source: compiled by the author based on HolonIQ data [1–3].

The open online learning segment shows the scale that digital tools can reach (Figure 2). By the end of 2021, massive open online courses (MOOCs) had reached 220 million learners worldwide (excluding China), with 40 million new learners in 2021 alone; around 950 universities offered about 19,400



MOOCs, and 500 new micro-credentials were launched during the year [4]. Coursera alone had 97 million learners and 910 micro-credentials, edX 42 million learners and 480 micro-credentials [4]. For universities, participation in such platforms provides an additional revenue stream, international visibility and a channel for lifelong learning.

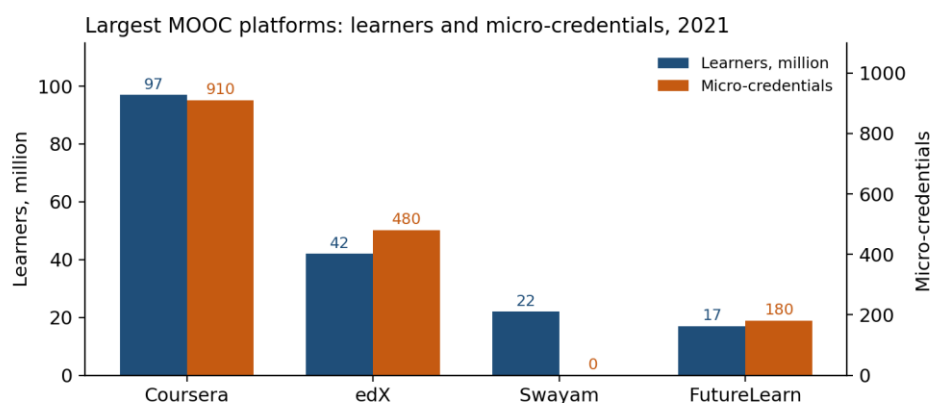


Figure 2. Learners and micro-credentials on the largest MOOC platforms, 2021

Source: compiled by the author based on Class Central data [4].

Based on international practice, six groups of innovative tools that contribute to university sustainability are distinguished (Figure 3). Together they form a toolkit around which a sustainable digital university can be built.

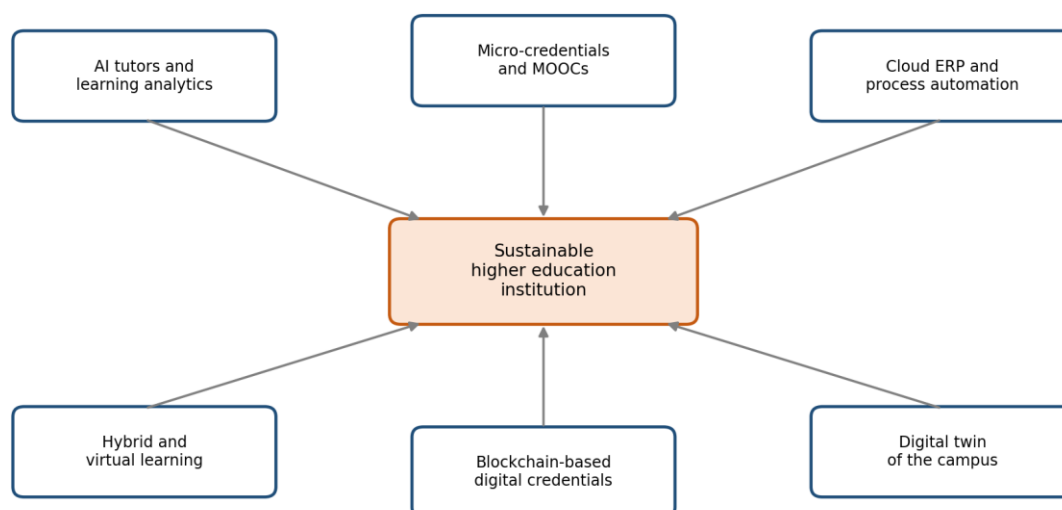


Figure 3. Innovative digital tools for ensuring the sustainability of a higher education institution

Source: developed by the author.

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Each tool affects different dimensions of sustainability and requires different levels of investment and organisational maturity (Table 1).

Table 1 Innovative tools and their contribution to the sustainability of higher education

Tool	Main function	Economic	Social	Environmental
AI tutors and learning analytics	Personalised support, early identification of at-risk students	High: retention of tuition revenue	High: academic success	Low
Micro-credentials and MOOCs	Short, stackable courses for a global audience	High: new revenue streams	High: lifelong learning	Medium: less travel
Cloud ERP and process automation	Integrated finance, HR and student administration	High: lower administrative cost	Medium	Medium: fewer servers and paper
Digital twin of the campus	Virtual model for managing space and energy	Medium: optimised space use	Low	High: lower energy consumption
Blockchain-based digital credentials	Tamper-proof, instantly verifiable diplomas	Medium: lower verification cost	High: graduate mobility	Low
Hybrid and virtual learning	Combination of face-to-face and online formats	Medium: scalable capacity	High: access for remote regions	Medium: less commuting

Source: developed by the author.

Given the different costs and levels of maturity required, it is advisable to introduce the tools in phases (Table 2), starting with those that deliver quick economic returns and create the data foundation for more advanced solutions.

Table 2 Phased approach to implementing innovative tools in a university

Phase	Tools	Prerequisite	Expected outcome
1. Foundation	Cloud ERP, process automation, hybrid learning	Digital infrastructure, data standards	Lower administrative cost, unified data
2. Expansion	Micro-credentials and participation in MOOC platforms	Quality assurance for online courses	New revenue streams, international reach
3. Intelligence	AI tutors and learning analytics	Integrated student data, data protection rules	Higher retention and academic success
4. Advanced innovation	Digital twin of the campus, blockchain credentials	Mature data and IT governance	Energy efficiency, graduate mobility

Source: developed by the author.

CONCLUSION AND RECOMMENDATIONS

Digital transformation provides universities with a broad set of innovative tools that can strengthen their economic, social and environmental sustainability. The cyclical nature of the EdTech market, however, requires a careful, evidence-based choice of solutions and phased implementation. On this basis, the following recommendations are made:

1. Sustainability-based selection. Assess every digital tool against all three dimensions of sustainability before investment, using a common evaluation matrix.
2. Start with the foundation. Prioritise cloud ERP and process automation, which reduce costs and create the integrated data needed for AI-based tools.
3. Develop micro-credentials. Create a national framework for recognising micro-credentials and encourage universities to offer short courses on international platforms.
4. Reduce dependence on venture-funded vendors. Prefer open standards and contracts that guarantee data portability, given the volatility of the EdTech market.
5. Green digital campus. Use digital-twin and energy-monitoring solutions to reduce the environmental footprint and operating costs of university campuses.



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