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10. THE TWIN TRANSITION STRATEGY FRAMEWORK: HOW UNIVERSITIES CAN EFFECTIVELY LEVERAGE THEIR CAPABILITIES IN RESEARCH, TEACHING, AND COLLABORATIONS

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Abstract: The twin transition (digital and ecological transformations) is crucial for addressing sustainable growth within Higher Education (HE). This conceptual paper proposes a Twin Transition Strategy Framework for Higher Education institutions, focusing on how universities can leverage their research, teaching, and collaboration capabilities to address sustainable growth through digital and ecological transformations. The framework identifies four key entities: Research Culture, University Curricula, University-Industry Partnerships, and University-Government Partnerships. It highlights significant opportunities for universities, including pioneering interdisciplinary research and adapting curricula, while also acknowledging challenges like potential conflicts between digital and environmental goals. The paper advocates for a holistic, integrated approach, emphasizing innovative teaching, strong partnerships, and ambitious sustainability targets for university operations, ultimately offering recommendations for contributing to a sustainable and digital future.

Keywords: Twin Transition Strategy Framework, Digital Transformation, Sustainability, Benefits and Challenges in Twin Transition, Sustainable and Digital Future.

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Therefore, this research aims to answer the following questions:

- What strategies can universities adopt to revise curricula for twin transition readiness?
- How can academia-industry collaboration accelerate twin transition innovation?
- What models enable effective university-government engagement for policy influence?

1.2 Understanding the Twin Transition and The European Union's Perspective

In recent years, organisations are increasingly encouraged to align digital and sustainability strategies (Zannini, 2024). Methodologies such as PA Consulting's twin transition framework promote "Greening by IT" and "Greening of IT" (PA Consulting, 2025). Tools like the digital sustainability assessment framework for the public sector (EY, 2021) and sustAIn.brussels (de Kerchove, 2024) offer structured approaches to evaluate digital practices' sustainability impacts. However, a holistic model tailored for HEIs remains necessary (Eteris, 2024). According to Müller, Lang, and Stöber (2024), the European Union (EU) integrates twin transition into policies like the European Green Deal, aiming for climate neutrality by 2050 through digital and ecological convergence (Müller, Lang, and Stöber, 2024; Peña, 2024). It supports this via projects such as Destination Earth and the Digital Product Passport (Viola, 2023). Yet, critics warn that bundling both transitions may prioritize digital gains at the cost of environmental integrity (Kovacic *et al.*, 2024). They highlight the potential incompatibility of the "logic of limits" in sustainability and the "logic of limitless growth" in digitalization. Despite debates, the EU focuses on workforce reskilling, emphasizing green and digital capabilities to support

recovery and long-term climate goals (Charatsari, 2024). This paper builds on this context to offer a strategic framework for universities.

2. Literature Review

2.1 The Role of Universities as Drivers of the Twin Transition

Research and Innovation: Universities are key hubs for innovation, education, and interdisciplinary collaboration (Kozirog, Lucaci, and Berghmans, 2022). Their digital research contributions—such as using AI for energy efficiency—are crucial for green transformation (Dæhlen, 2023). Furthermore, universities can develop and apply low-carbon digital tools to reduce the ICT sector's footprint. Promoting team-science and interdisciplinary collaboration is vital for addressing twin transition complexities (Dæhlen, 2023).

Education and Skills Development: HEIs need to prepare students for evolving green-digital economies. Curricula should include both hard and soft skills such as adaptability, problem-solving, and communication (Fleacă, Fleacă, and Militaru, 2024). Modern pedagogies, including experiential and challenge-based learning, are essential to equip students with systems thinking and the ability to navigate interconnected challenges (Dæhlen, 2023; Charatsari, 2024). Upskilling existing workforces is also a key university function.

Institutional Operations and Leadership: The UW Sustainability Action Plan (2020-2025) exemplifies how universities can lead by example through sustainable practices in their operations (University of Washington, 2025). Digitalization enhances operational efficiency, enabling data-driven decisions on energy and resource use (Hopping, 2024). A comprehensive

sustainability plan with clear goals, objectives, and metrics is essential. Strong commitment and active promotion of a sustainability culture by university leadership are vital.

Community Engagement and Partnerships: Kozirog, Lucaci, and Berghmans (2022) recommend that universities should actively engage with regional, national, and international communities to identify problems and find green solutions based on cutting-edge, interdisciplinary research. Collaboration with industry, government bodies, and civil society organizations is essential for maximizing impact and driving the twin transition agenda. Universities can act as "honest brokers," bridging stakeholders and fostering entrepreneurship and innovation related to the twin transition (Kozirog, Lucaci, and Berghmans, 2022). These collaborations can generate green digital solutions and boost urban innovation (Mohammed, Ukai, and Hall, 2022).

2.2 Main Research Areas at the Intersection of Digital and Ecological Sustainability

The interdisciplinary areas (e.g., smart agriculture and sustainable energy powered by AI) apply digital technologies to enhance food production and environmental sustainability. Precision agriculture uses tools including Global Positioning System (GPS), Geographic Information Systems (GIS), and variable rate equipment to optimize resource use (pesticides, nutrients, water) (Taylor, 2018; Azadi *et al.*, 2021; Singh *et al.*, 2022). Data analytics and AI generate data-driven strategies for farmers to make informed decisions (Zhu *et al.*, 2018; Khanh, Ngoc and Pramanik, 2023). Research focuses on developing and applying sensors, wireless sensor networks, agricultural IoT, and agricultural robotics for efficiency and sustainability (Patil and Kale, 2016; Sinha and Dhanalakshmi, 2022). Several universities have dedicated centres

for smart agriculture technology (e.g., Centre for Smart Agriculture Technology (CeSAT), University of Texas at Tyler).

On the other hand, the integration of AI with sustainable energy systems offers promising avenues for research and development. AI and machine learning algorithms can optimize renewable energy sources (wind, solar) by predicting patterns and managing energy distribution (SOS Project, 2025). For example, projects at Monash University, in partnership with ENGIE and other stakeholders, show how academic R&D can enhance power grid resilience (Ershaghi and Paul, 2023; Raman *et al.*, 2024; Tamilarasi *et al.*, 2025). However, more energy-efficient AI models are needed.

Digital technologies provide innovative solutions for waste management and promoting a circular economy. Research focuses on smart waste management systems using IoT, AI, and sensors to optimize collection, identification, characterization, and sorting (Czekała, Drozdowski, and Łabiak, 2023). AI-powered robots are being developed for efficient waste sorting in recycling centres (Cheng *et al.*, 2024). Digital platforms and mobile applications improve recycling rates, provide consumer information, and foster a circular approach to resource management (Cheng *et al.*, 2024).

Beyond the above, the intersection of digital and ecological sustainability offers numerous other research areas. These include digital tools contribute to smart cities, sustainable transport, and biodiversity monitoring (Müller, Lang, and Stöber, 2024; Dæhlen, 2023). Big data enhances climate risk modelling and material circularity (Hariyani *et al.*, 2024; JRC EU Science Hub, 2022). Research into sustainable consumption is also growing.

2.3 Adapting University Curricula to Equip Students for the Twin Transition

Integrating Sustainability and Digital Literacy: Preparing students for the twin transition requires fundamental integration of sustainability and digital competencies (Weiss *et al.*, 2021; Charatsari, 2024). Students need to understand sustainability principles (environmental, social, economic) alongside essential digital technology skills. Frameworks such as GreenComp (sustainability competencies) and DigComp (digital competencies) can guide universities in defining learning outcomes (Charatsari, 2024). Curricula should specifically develop skills for the emerging green digital workforce. Ultimately, universities aim to provide future-proof education equipping graduates to contribute synergistically to both green and digital transformations (Fleacă, Fleacă, and Militaru, 2024).

Interdisciplinary Programs and Courses: The complex and interconnected nature of the twin transition necessitates interdisciplinary programs and courses bridging traditionally separate fields (Science Europe, 2022). Universities need to explore new degree programs combining sustainability and digital technologies (e.g., interdisciplinary digital practices, environmental sustainability with a digital focus, digital agriculture, sustainable energy) (e.g., Minerva University's IDP courses). Additionally, integrating sustainability concepts and digital tools across existing disciplinary courses ensures all students develop foundational understanding. Creating taught courses and research degrees focused on current interdisciplinary sustainability issues can provide diverse perspectives and foster collaborative problem-solving.

Innovative Teaching Methodologies: Traditional teaching may not suffice for the twin transition's multifaceted challenges

(Smith, 2019). Universities need to embrace transactional and participatory approaches in sustainability education, moving beyond knowledge communication to active student engagement (Smith, 2019). Problem-based learning, experiential learning, and challenge-based learning are effective methodologies (Fleacă, Fleacă, and Militaru, 2024). Incorporating gamification, simulations, and virtual reality can enhance motivation and understanding (Shenkoya and Kim, 2023). Curricula should also foster critical thinking and systems thinking skills, enabling students to analyze complex issues from multiple perspectives (Charatsari, 2024). Training educators is crucial for successful implementation (Smith, 2019).

2.4 Collaboration and Partnerships to Advance the Twin Transition Agenda

2.4.1 University-Industry Partnerships

Collaboration between universities and industry is increasingly recognized as vital for advancing research and development in sustainability (Forward Pathway, 2024). These partnerships offer numerous benefits – applying classroom knowledge to real-world problems, enhanced student learning through internships and co-ops, and driving innovation through industry expertise access (Awasthy *et al.*, 2020). Universities and industries can collaborate on joint research projects, facilitating knowledge and technology transfer from academia to practical applications in the twin transition (Norwegian University of Science and Technology, 2023). Industry professionals can also contribute to curriculum development, aligning university y programs with evolving job market needs (Valentin, 2000). Establishing mutual

goals and fostering trust are key for strong and lasting collaborations (Workforce Development, 2024).

2.4.2 University-Government Collaborations

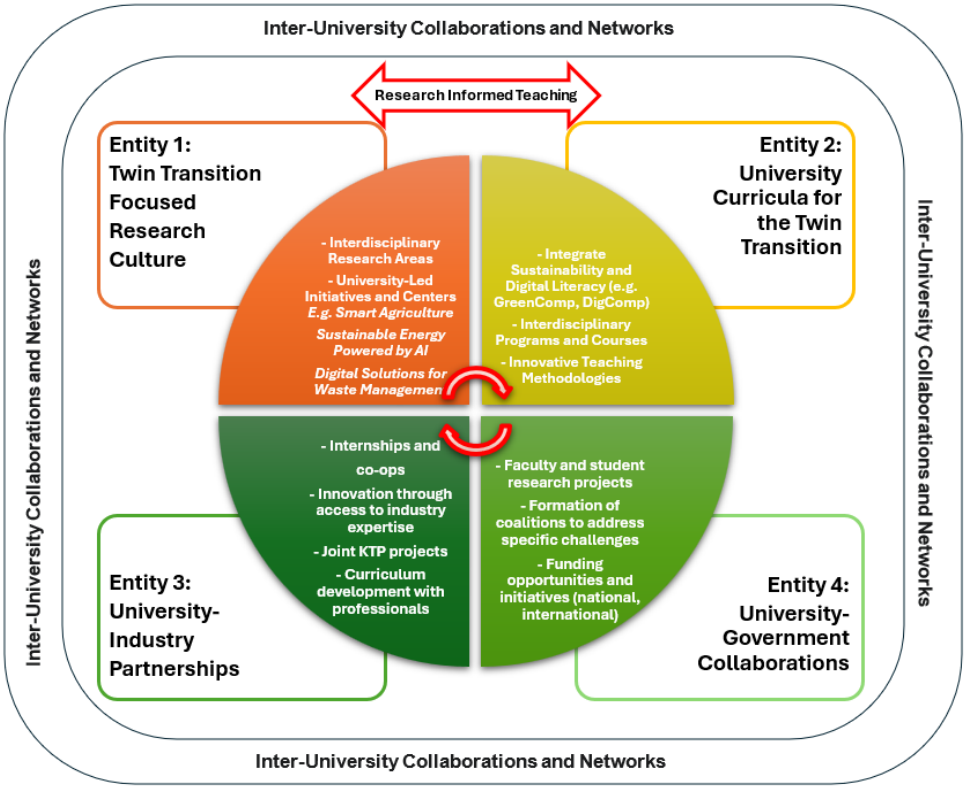
Another important form of collaboration, which is between universities and government agencies, is pivotal for advancing the understanding of public policy issues related to sustainability and the twin transition (Wen *et al.*, 2020). These collaborations can include faculty and student research projects and the formation of coalitions to address specific challenges (Wen *et al.*, 2020). By doing so, governments can provide funding opportunities for university research on the twin transition, nationally and internationally. Universities, in turn, provide evidence-based policy recommendations to inform government decision-making on climate change mitigation and sustainable digital practices (The World Economic Forum, 2023). Establishing mutual interest and clear expectations are essential for successful university-government collaborations.

2.5 Fostering Inter-University Collaborations and Networks

In recent years, there are strong research evidence that inter-university collaboration is crucial for accelerating the twin transition in higher education (Carayannis and Morawska, 2023; Secundo *et al.*, 2024; Ordoñez De Pablos, 2024). By sharing best practices, resources, and knowledge, universities can collectively enhance their contributions to sustainability and digital innovation. Networks like AASHE and HESI facilitate knowledge-sharing and coordinated efforts (Higher Education Sustainability Initiative, n.d.). Projects like SUNSET demonstrate the benefits of city-university collaboration (Mohammed, Ukai, and Hall, 2022).

As discussed in the introduction, the aim of this conceptual paper is to explore how universities can enhance their capabilities in three arenas of research, teaching and wider collaborations to contribute to the twin transition in the HE sector. The strategy framework of research questions (Figure 2.1) was developed by taking the key opportunities and challenges for universities in the twin transition. It outlines specific questions to guide institutional strategies across research, education, and partnership domains.

Figure 2.1: The Twin Transition Strategy Framework leveraging universities' capabilities in research, teaching, and collaborations



Source: Author's own, 2025

3. Conclusion

The twin transition embodies a transformative shift where digital innovation supports ecological sustainability. This paper outlines a strategic framework for HEIs to lead this transformation by enhancing their capacities in research, teaching, and collaboration. To facilitate this, the paper recommends universities to establish interdisciplinary centres, develop new integrated degree programs and courses, embed sustainability and digital literacy across all curricula, prioritize research in key interdisciplinary areas, set ambitious sustainability goals for campus operations, actively seek strategic partnerships with industry and government, encourage participation in relevant events, develop a tailored university-specific framework, and last but not least, secure funding for twin transition initiatives.

Declarations

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