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Reimagining South African Urban Planning Education: Aligning Digital Skills with Professional Demands

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1 ABSTRACT

The Fourth Industrial Revolution (4IR) demands a fundamental shift in educational institutions, aligning with Sustainable Development Goal 4's call for inclusive, equitable quality education and lifelong learning. This study examines how digital skills are integrated into South African urban planning education in response to evolving professional demands. Using qualitative content analysis and a four-step review, the study assesses the alignment between taught digital competencies and industry expectations shaped by 4IR. Findings reveal an increasing demand for proficiency in digital technologies and analytical tools for data-driven decision-making and innovative urban problem-solving. However, gaps remain in curriculum integration, access, and preparedness. A conceptual framework is proposed, encouraging capacity building, leadership development, module-curriculum alignment with industry, and ongoing upskilling/reskilling. This framework supports a more responsive planning education system that prepares students and professionals for roles shaped by digitisation, automation, and the complex realities of urban transformation in South Africa.

Keywords: Education, 4IR, GIS, AI, Bibliometric Analysis

2 INTRODUCTION AND BACKGROUND

Emerging urban planners must acquire relevant digital competencies to effectively navigate today's increasingly complex and uncertain urban challenges. As stated by Braun and Kropp (2023), ongoing transformations present opportunities for innovative solutions to the multifaceted crises facing planning and architecture. In this context, digital transformation has become a critical driver of effective and responsive planning (Kuppler & Fricke, 2024). Embracing this shift holds the potential to strengthen educational institutions by enabling them to meet evolving professional demands, while also preparing learners and practitioners to engage with complexity and seize emerging opportunities with confidence. Global frameworks such as the United Nations Sustainable Development Goal 4 (SDG 4) further emphasize the importance of skills development, particularly in technical and vocational domains therefore to enhance employability and promote entrepreneurship (UNESCO, 2017). These imperatives have contributed to the growing demand for integrating digital technologies into everyday planning practices. Understanding the trajectory of industrial revolutions provides an important context for digital transformation in urban planning education. The Third Industrial Revolution, spanning from the 1980s to the early 2000s, introduced information and communication technologies, leading to widespread computer use and the emergence of early internet systems (Vickers et al., 2019). During this era, planning research focused on advances in telecommunication (Batty, 1991; Graham & Marvin, 1999) and the development of planning support systems such as Geographic Information Systems (GIS) (Gill et al., 1999). The Fourth Industrial Revolution has since shifted attention toward smart city initiatives (Batty, 2013; Carter, 2017) and the evolution of planning support science (Geertman & Stillwell, 2020). Despite these advancements, efforts to digitalize planning practices remain constrained by various challenges. As Daniel and Pettit (2021) argue, there is often a persistent gap between the digital skills taught in universities and those required in real-world professional

contexts. This misalignment has significant implications not only for how students learn and apply knowledge but also for how educators conceptualize and deliver teaching in an increasingly digital environment. As the Fourth Industrial Revolution continues to reshape professional expectations, the integration of digital technologies into urban planning education is no longer optional, it is essential. This transformation should extend beyond the superficial use of software to the strategic and intentional incorporation of emerging technologies into the planning, design, and governance of urban environments. Such an approach fosters innovation, resilience, and adaptability in both education and practice. In response to these demands, educational systems must transition from traditional, instructor-centered approaches to more learner-centered and digitally enhanced pedagogies (Osmundsen et al., 2018). This paper examines the extent to which digital skills currently embedded in selected South African urban planning curricula align with the requirements of professional practice. The objective is to develop a framework for curriculum reform that addresses this digital divide, equipping future urban planners with the technological competencies needed to navigate and shape the rapidly evolving urban landscape.

3 DIGITAL TRANSFORMATION IN URBAN PLANNING EDUCATION

The Fourth Industrial Revolution (4IR) represents a transformative period marked by the fusion of technologies such as artificial intelligence (AI), the Internet of Things (IoT), robotics, and big data analytics. This revolution is reshaping knowledge production, dissemination, and use across all sectors, including higher education. Adelekan et al. (2023) highlight the urgency of adapting educational frameworks to produce graduates who are digitally fluent, innovative, and adaptable. In South Africa, this imperative is heightened by the dual challenges of addressing historical educational inequalities and preparing students for a competitive global workforce. The digital divide, while a persistent barrier, also presents opportunities for innovation through strategic investments in digital infrastructure and curriculum reform.

Moodley (2021) stresses that integrating 4IR tools into university education is more than a technological upgrade; it involves socio-pedagogical transformation. Higher education institutions must adopt digital pedagogies that foster ethical awareness, critical thinking, and relevance to local contexts – particularly vital in disciplines like urban planning. Traditional instructional methods are being challenged by the need for virtual learning, simulation-based instruction, and online collaborative platforms. These shifts align with Sustainable Development Goal 4 (SDG 4), which advocates for inclusive, equitable, and quality education. UNESCO (2021) further asserts that digital-age education should cultivate digital citizenship and adaptability alongside technical skills. Urban planning, as a discipline, increasingly depends on digital tools for spatial analysis, forecasting, and stakeholder engagement. Technologies such as Geographic Information Systems (GIS), remote sensing, 3D modeling, and digital twins are reshaping planning practices (Chigbu et al., 2021; Letsoko and Pretorius, 2025). Despite this, their integration into South African planning curricula remains inconsistent. Rukato et al. (2024) found that while theoretical instruction on digital tools exists, students often lack practical experience, leading to a skills mismatch in the labour market. This disconnect hinders the readiness of planning graduates to manage the data-driven demands of modern urban development.

Moreover, digital tools carry epistemological significance. Giles and Bhurosy (2023) argue that beyond technical proficiency, planning students must understand how these tools influence urban imaginaries, governance, and public participation. Critical digital literacy, understanding how digital technologies mediate power and knowledge, must be a core element of planning education (Letsoko and Pillay,2019). Lwasa et al. (2023) emphasize that digital thinking should be integrated across the curriculum rather than confined to isolated modules. Curriculum reform is therefore essential to align graduate outcomes with industry needs. UNESCO (2021) recommends strong partnerships between academia and industry to ensure educational responsiveness to evolving professional standards. In South Africa, SACPLAN and the CHE regulate curriculum development, with SACPLAN recently introducing digital proficiency requirements (Mabaso & Mahlangu, 2022). Nonetheless, implementation is uneven. Maphisa et al. (2024) advocate for a theory-of-change approach to curriculum design, one that defines expected outcomes, stakeholder roles, and enabling policy conditions. They recommend modular, flexible, and interdisciplinary curricula featuring topics like smart cities, digital ethics, and e-governance. Experiential learning – through internships, studios, and collaborative platforms – bridges theoretical learning with practical skills, enhancing both digital literacy and soft skills such as collaboration and problem-solving.

4 METHODOLOGY

The study employed a four-step review approach as applied in previous studies (Jiang et al., 2021) was used to examine digital skills alignment with urban planning (see Figure 1). The study aimed to investigate the state of digital transformation culture, emerging digitalisation strategies, challenges, and future trajectories for digital transformation with urban planning.

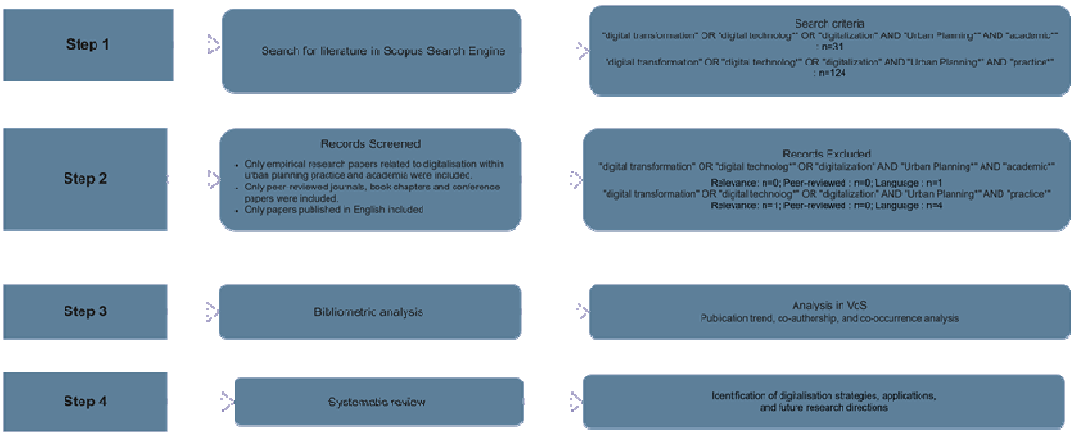

Figure 1: Review Approach.

Step 1 involved defining the review's scope, setting the stage for an in-depth exploration of digital transformation's role in urban planning. The study sourced academic articles from Scopus Search Engine, comprising peer-reviewed journal articles, conference papers, and book chapters. Two search strings were employed, namely:

"digital transformation" OR "digital technolog*" OR "digitalization" AND "Urban Planning*" AND "academic*"

"digital transformation" OR "digital technolog*" OR "digitalization" AND "Urban Planning*" AND "practice*"

Step 2 was the inclusion and exclusion of literature. The selection criteria were the title, keywords, or abstract, and peer-reviewed articles published in English, without restrictions regarding the study domain, due to the relevance in a wide range of disciplines. Only empirical research papers related to digitalisation within urban planning practice and academia were included. Following data acquisition, the subsequent steps encompassed data collection and quality assessment, ensuring the inclusion of reliable and pertinent resources. In Step 3, a quantitative analysis was undertaken. A Bibliometric analysis was undertaken using the Visualization of Similarities (VoS) Viewer package, namely publication trend, co-authorship, and co-occurrence analysis. In Step 4, a systematic review was conducted to identify digitalisation strategies, applications, and future research directions. The findings were then used to develop a framework for the digital transformation of urban planning.

5 ANALYSIS AND FINDINGS

In pursuit of global rankings and academic excellence, universities worldwide are increasingly prioritizing competitiveness and elevated academic standards. Similarly, the private sector is compelled to sharpen its competitive edge in response to global demands. As universities navigate this complex landscape, they encounter a range of institutional challenges foremost among them is the imperative to improve organizational efficiency. At the heart of this drive lies digital transformation, widely regarded as a cornerstone for institutional advancement. More than a mere technological upgrade, digital transformation serves as a strategic enabler, integrating Fourth Industrial Revolution (4IR) technologies into teaching, learning, and professional practice. This integration not only enhances operational performance but also redefines pedagogical and research paradigms, positioning institutions for long-term relevance in a rapidly evolving knowledge economy.

5.1 Publication trend

Figure 2 shows the developmental trend in digital transformation within urban planning academic and practise between the period 2010 to 2025. The timeline pre-2010 presents a period 4IR tools were either in

their infancy or not yet coherently defined under the 4IR framework. However, several precursor technologies and foundational digital tools such as Geographic Information Systems, Computer-Aided Design (CAD), and Remote Sensing were actively used in urban planning practice and academia. Pre-2010 academia and practice faced challenges in software integration and high implementation/usage costs, which resulted in a disconnect in technology uptake in planning policy and regulation.

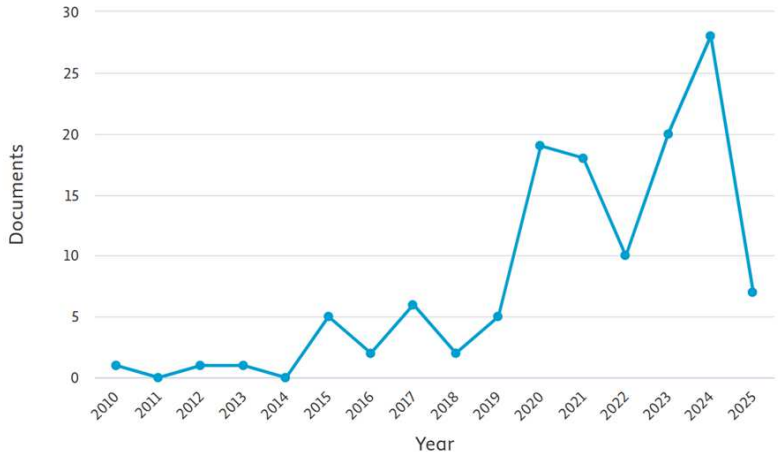

Figure 2: Publication Trend.

The period 2010 to 2015 represents the transition period from static digital tools to more dynamic, data-driven systems, marking the early integration of Fourth Industrial Revolution (4IR) technologies with urban planning. While publications were still low, this period was pivotal in bridging the gap between legacy systems and intelligent urban technologies. Between 2015 and 2020, urban planning entered a transformative phase characterised by the mainstreaming of 4IR tools. As evident with an increase in research, this era saw the accelerated institutionalisation of smart city initiatives, real-time data, and Internet of Things in both planning practice and academic research. At the same time, the period triggered critical debate on the role of planners in the implementation of emerging technologies with a focus on governance and equity. Post-2020, urban planning entered a more mature and contested phase of engagement with Fourth Industrial Revolution (4IR) tools. The global disruptions caused by COVID-19 served 2as a catalyst for the digital transformation of planning education and infrastructure planning. Publications in this period of increased documenting usage of 4IR technologies such as GIS and BIM integration, digital twins, and artificial intelligence within planning.

5.2 Network Analysis

The network visualisation represents co-occurring keywords in academic or thematic literature related to urban planning and digital transformation. Each node represents a keyword, and each link shows a relationship or co-occurrence between keywords in documents. In view of Figure 3 outlining thematic clusters of digitalisation with urban planning, it is evident that the most important part of the digitalisation in education is that students, teachers, and administrators have to take the necessary training for digital transformation.

Cluster 1: Core of Urban Planning

The blue cluster, anchoring the entire network, represents the traditional and evolving dimensions of urban planning, including technical tools, governance processes, and emerging urban forms. As planning systems are maturing and becoming increasingly indispensable in the planning process, they contribute to the paradigmatic (re-)emergence of technocratic planning as a science (Geertman and Stillwell, 2020). This instrumental rationality, currently re-emerging, involves digital and big data, smart technologies and software that frame the planned landscape as objectively known, accurately measured, analysed, modelled or visualised (see Ash et al. 2018, Cook and Karvonen, 2023, 12). However, Potts (2020) points out that the use of ICT and the emergence of Web 3.0 does not lead to a merely positivistic ontology of planning as a physical, scientific process due to its reliance on data, but is accompanied by a shift towards self-organisation.

Cluster 2: Governance Strategies

The purple cluster outlines varies governance strategies such as local participation, stakeholder engagement, improved communication links, and citizen engagement. This cluster engages with governance structures that underpin digital and sustainable planning. It focuses on how decisions are made and who controls technological urban futures. Teixeira et al (2021) also stated the importance of governance for facilitating the digitalisation vision at the management ministerial level and the institutional level. The support services to be provided during the digital transformation process will facilitate the adaptation of teachers and students.

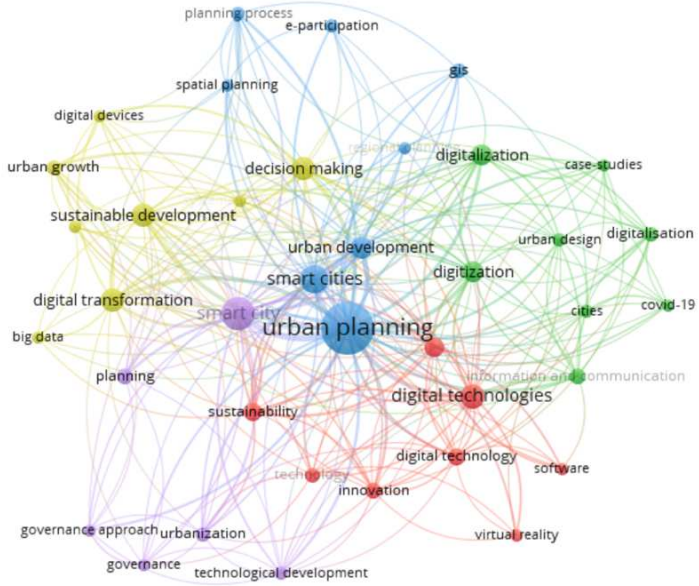

Figure 3: Network Analysis.

Academics have expressed the need for relevant educational policies for the design of innovative learning environments and for the transformation of schools. With education, digital transformation needs to be conceptualized and internalized. The emphasis is on ensuring the necessity of providing suitable infrastructure (Alenezi, 2021). Likewise, the development of the infrastructure and the development of the digital contents, learning environments should be informed by factors suitable for the partnership and learning characteristics of the shareholders are important, and the participation.

Cluster 3: Digital Transformation Culture

The yellow cluster represents the views of academicians and views on how digital transformation culture is to be formed in the direction of determined themes, and how to carry out learning in this culture should be combined with education in particular, and that the research and project work should be done from higher education institutions to industry. This cluster captures the macro-policy and ethical implications of urban digitalization emphasising sustainability and transformative goals. Furthermore, Oliveira et al. (2022) stated that in-service training should be done continuously, and they should act in the direction of strategic planning for digital transformation. This is supported by Bravo et al. (2020) articulation that there should be effective leaders who will make an evaluation on the issues, such as the monitoring and evaluation of training, the contribution of curriculum, and the level of institutional digital transformation. McCarthy et al. (2023) outlined that besides conscious consumption of emerging technologies, there should be strategies to address how efficiently technology merges with the professional culture.

Cluster 4: Technological enablers

The red cluster represents the technological enablers or infrastructure driving digital transformation in urban contexts. In addition, planning research focuses on smart cities and digital solutions, and oftentimes, on emblematic cases of digital planning in European Nordic countries such as Denmark (Fertner et al., 2019). Only a few scholars address the challenges of implementing ICT on the ground (Geertman and Stillwell, 2020) in the oftentimes ‘manual, paper-based, and tedious’ (Sabri and Witte, 2023, 1) planning practices. Others compare planning practices in different contexts, such as Potts and Webb’s (2023) survey on the use and challenges of ICT in the UK and Australia, or Christmann and Schinagl’s (2023) comparison of global planning offices in three locations. Kitchin and colleagues (2021) study how planning professionals in local

administrations use 3D spatial media in their day-to-day planning processes. Their results underline the challenges and the uneven adoption of 3D media in planning, with the private sector and architects more readily engaged than public sector planning. These scientific studies emphasise challenges to digital transformations, indicating a lagging adoption (Kitchin et al., 2021) and systemic barriers to integrate ICTs in public planning. These tensions lead to a considerable implementation gap between available technologies and data suggested by planning support science and digitalised everyday practices (Daniel and Pettit, 2021).

In addition, academics have expressed, along with the digital transformation, that their digital skills gains can be added in addition to the existing achievements (Geertman and Stillwell, 2020). In order to be able to evaluate the achievements identified, academicians have indicated that there may be product evaluation, peer assessment, portfolios, rubrics, and skill-based evaluation, usually from assessment methods. They also stated that curriculums should be rearranged in this direction and they stated that step-by-step, program-based, sub-learning-centered methods should be included according to the student's level (Geertman and Stillwell, 2020).

Cluster 5: Usage of emerging technologies

The green cluster focuses on case studies of the usage of emerging technologies to address urban challenges. Akhmedova and Vavilonskaya, (2019) have articulated the envisioned benefits from digital transformation as a solution to planning under uncertainty and complexity, while demanding new skills from and posing challenges to professionals. Several studies address the digital transformation of public and private planning practices in different contexts, not only based on forerunners of digital planning (Fertner et al., 2019), but also by drawing attention to mundane, in many local contexts often still manual, and non-digital planning practices (Sabri and Witte, 2023). Planning research focuses on key information and communication technologies (ICT), such as computer-aided design (CAD) (Kuppler and Alpermann, 2022) and other types of 3D spatial media (Kitchin et al., 2021) and how they have impacted plannings' content and form (Potts, 2020). Several studies emphasise challenges of digital transformations, indicating a lagging adoption (Kitchin et al., 2021), a 'digital skill gap in planning practice and education' (Yang, 2024, 39) as well as systemic barriers to integrate ICTs in planning practice. These tensions lead to a considerable gap between the potential transformation and everyday planning practices (Daniel and Pettit, 2021).

6 DISCUSSIONS

The Fourth Industrial Revolution (4IR) demands a global fundamental shift in educational institutions and calls for embedding relevant technology that are specifically designed for certain disciplines. Such adaptation aligns with the Sustainable Development Goal (SDG 4) call for inclusive and equitable quality education. It has been realized that there are various technical modules using technological software's that are taught within urban planning programmes. These tools are very critical to be sufficiently taught in the Urban Planning discipline providing support to rational decision-making on spatial analysis and planning. There are strongly grounded modules to technological innovations in Urban Planning which include (i) Geographic information systems and urban information systems where students are taught to analyze real-time data of urban spaces, mapping and monitor change to inform design decisions. (ii) Architectural and Planning design, and (iii) Advanced computer applications in AutoCAD affording digital design tools where students are taught basics operations of the softwares and advanced technological softwares that include 3D modelling to create digital representation of urban environments which assist in spatial analysis providing enhanced development proposal of existing spaces and new development proposals. However, there are various challenges faced by successfully having enhanced technological innovations in teaching and learning. With this mentioned, there is a lack of obtaining most updated softwares and provision of license software's to ensure that students are equipped with the necessary skills required in the industry. Accordingly, in certain instances there is a lack of data access that could be used to aid learning. Consequently, even with these technological modules that are taught, they are not dominant in the curricula. Such modules are taught on a semester basis, specifically, once a semester in a year. This does not provide sufficient time for learning and allows students to properly grasp the skills. Therefore, leading to students not having a concrete background of such planning perspectives creating a huge gap when they are presented to professional practice. Subsequently, there is a lack of continuous training for educators to stay up to date with new technological programs compromising the delivery of such technological modules.

Further, there is a lack of sufficient collaborations between industry and academia which compromises the alignment between the two. There are on-going projects where digital tools are deployed in the industry. With strong collaboration, this could afford an opportunity for accessibility to adequate data to be used for learning which at times is not easily accessible, and there could be alignment between most updated projects that are taking place and allow an opportunity to be taught in universities promoting lifelong learning opportunities applicable to evolving professional demands. For South African urban planning programmes, it is critical to align curricula and teaching models with the digital skills essential for graduate employability and effective engagement with real-world urban challenges. This could assist to prepare future urban planners with the technological competencies needed to navigate and shape the rapidly evolving

7 RECOMMENDATIONS AND FRAMEWORK

To adequately respond to the identified digital skills gap and misalignment between planning education and professional practice in South Africa, this section presents recommendations through a conceptual framework to guide curriculum transformation. These are structured around pillars essential for building a digitally competent, inclusive, and industry-relevant planning education system, as shown in Figure 3.

Curriculum innovation and digital integration are the first and most foundational recommendations. Digital tools such as GIS, AI, remote sensing, and 3D modelling must be embedded into the very core of planning pedagogy. Rather than offering these as electives or post-hoc certifications, planning programmes should incorporate them into foundational modules. Research by Batty (2018) shows the importance of digital spatial literacy for planners operating in increasingly data-driven urban environments. Co-teaching arrangements with computer science and engineering faculties can enhance the interdisciplinarity of urban problem-solving and expose students to diverse computational methods (Basnet and Basnet, 2018). This aligns with international trends in planning education, where digital urban labs and real-time data are used to simulate policy interventions (Kontokosta, 2018). Academic capacity building is the second pillar and addresses the systemic bottleneck of digital proficiency among planning educators. Without digitally skilled faculty, even the most well-designed curricula will falter. Institutions should therefore create structured upskilling programmes and continuous professional development (CPD) pathways, including industry secondments and attendance at digital planning conferences. SACPLAN (2015) has already called for accredited CPD courses, and universities should align their staff development initiatives with these standards.

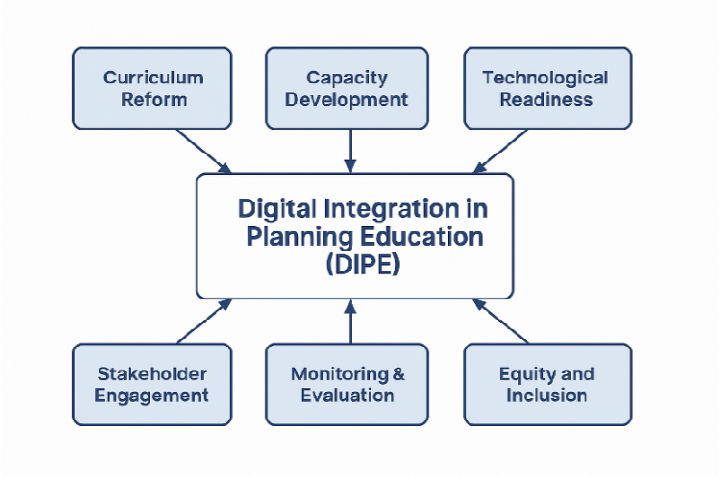

Figure 4: Digital Integration in Planning Education (DIPE).

Thirdly, strengthening university-industry partnerships is essential to anchor academic instruction in real-world practices. Collaborations between universities and municipalities, private firms, and professional councils can facilitate the co-creation of digital course content and ensure students are exposed to applied digital methods during their training (Esangbedo et al., 2023). Capstone projects addressing problems using digital solutions can serve as both a pedagogical tool and a service-learning opportunity (Shurin, Davidovitch, and Shoval, 2021). The fourth recommendation involves investing in technological infrastructure, especially in historically disadvantaged institutions. Digital equity cannot be achieved without equitable access to high-speed internet, licensed software, and computing hardware (Liu, Tschinkel, and

Miller, 2024). Institutions must invest in spatial planning labs and leverage cost-effective tools such as QGIS, R, Python, and Blender. Equity, inclusion, and digital justice constitute the fifth recommendation and underpin the ethical dimension of digital transformation. As digital divides often mirror broader socio-economic inequalities in South Africa, planning schools must adopt inclusive strategies. Device loan programmes, subsidised data, and foundational digital skills workshops can democratise access to digital learning (United Nations Development Programme,2024). Finally, the importance of monitoring, evaluation, and feedback mechanisms cannot be overstated. Regular curriculum reviews, graduate tracer studies, and stakeholder feedback loops can ensure planning education remains aligned with evolving market demands and technological trends (Kapala, 2024). The framework offers a roadmap for aligning South African planning education with the demands of the 21st century, and this framework can enhance not only the employability of graduates but also the social responsiveness of planning interventions in a digital era.

8 CONCLUSION

In conclusion, this study explored the intersection of digital transformation, planning education, and professional practice within South Africa's urban planning sector. It highlighted how global academic and professional competitiveness has reshaped expectations on universities, with digital transformation emerging as both a strategic necessity and a disruptor in pedagogy. Through an analysis of publication trends and keyword network visualisation, the study showed the evolution of Fourth Industrial Revolution (4IR) technologies, GIS, BIM, AI, and digital twins within planning theory, education, and practice. While interest in these technologies is growing, their implementation remains uneven. Five thematic clusters were identified, reflecting the growing complexity of digitalisation across planning systems. The analysis identified significant structural barriers, and the study proposed the Digital Integration in Planning Education (DIPE) framework to address these gaps. Therefore, aligning planning education with digital demands will better prepare future planners to shape equitable and sustainable urban futures.

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