Lahti Sports Center as a Living Urban Learning Laboratory: A Design-Based Approach to Engineer 5.0 Education

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Abstract: Higher education is under increasing pressure to provide learning environments that move beyond classroom-based teaching and connect advanced study to authentic, multi-stakeholder problems. This paper presents the Lahti Sports Center as a living urban learning laboratory for developing Engineer 5.0 education in a Finnish university of applied sciences context. The case is grounded in a long-standing collaboration around the area's event-related ICT infrastructure and in an emerging educational concept in which the sports center functions as a shared, real-world platform for multidisciplinary learning, experimentation, and regional innovation. The core argument is that the Lahti Sports Center offers an unusually rich educational environment because it brings together public infrastructure, event production, mobility, wellbeing services, digital platforms, and a diverse ecosystem of stakeholders, including the city, local organizations, companies, and users. Rather than positioning students as passive recipients of technical knowledge, the model frames them as practitioner-researchers who analyse and improve real operating environments. In this setting, students can work on service architecture analysis, data use, integration needs between actors, simulation-supported decision-making, and the design of digital services connected to events, resource use, and user flows. The paper adopts a design-based education research perspective and conceptualizes the sports center as a city-scale digital development laboratory. The pedagogical premise is that authentic infrastructure enables students to engage with complex systems, not isolated technologies. This makes it possible to combine human-centred design, sustainability, resilience, and data-informed decision-making in one coherent learning environment. The model also redefines the teacher's role from content transmitter to facilitator of inquiry, collaboration, and applied development. The contribution of the paper is twofold. First, it proposes a transferable framework for using urban sports and event infrastructure as a higher education learning platform. Second, it demonstrates how regional collaboration can strengthen both educational relevance and local innovation capacity. The Lahti case suggests that sports-center environments can serve not only as physical venues for events and wellbeing, but also as strategic sites for education research, digital experimentation, and future-oriented competence development.

Keywords: Living Lab; Engineering Education; Design-Based Research; Digital Twin; Urban Learning Environment; Regional Innovation

1. Introduction

The Universities of Applied Sciences Act (932/2014) defines the core mission of universities of applied sciences as operating at the interface of working life and its development. Under Section 4, UAS institutions are tasked with providing higher education for professional expert roles and supporting students' professional growth, while also conducting research, development and innovation (RDI) that strengthens education, advances working life and regional development, and contributes to renewing the region's business structure. In carrying out these duties, universities of applied sciences are additionally expected to promote lifelong learning (Finlex, 2014; Arene, 2017).

In Finnish universities of applied sciences, RDI work is commonly carried out with small and medium-sized enterprises (SMEs) in line with LAB's strategy (LAB, 2030). Such collaboration enables companies to test and develop new ideas outside their organizational boundaries and supports open innovation through shared resources, data, and expertise (Chesbrough, 2019; Brusila-Meltovaara et al., 2024). In this paper, the focus is not on research with SMEs, but on how an authentic operating environment can be used to create mutual value for learning and regional service development. We use the Lahti Sports Center as a real-world learning platform where students, staff, and partner companies co-design, pilot, and evaluate event- and wellbeing-related services, digital solutions, and operational improvements. This curriculum-integrated development work can strengthen students' professional capabilities while offering SMEs low-threshold opportunities to experiment, iterate, and scale service concepts in collaboration with the UAS (Bogdanova et al., 2021). This aligns with earlier work on strategic university–industry collaboration, which emphasizes the importance of building long-term partnership models that connect higher education with external development needs and practical innovation contexts (Lindström and Meltovaara, 2012). Related work has also shown that curriculum design can be strengthened through university–industry collaboration projects that connect higher education more directly with external development processes and applied problem-solving (Brusila-Meltovaara et al., 2022).

Higher education benefits from authentic, complex learning environments because many contemporary professional challenges are multidimensional, collaborative, and difficult to address through classroom abstraction alone (van den Heuvel et al., 2021). Research on authentic learning highlights how real-world tasks and disciplinary practice help students connect concepts to action, while complex learning settings expose learners to ill-structured problems, interdisciplinary collaboration, and multiple plausible solutions (Galindo, 2026). Such environments are especially valuable because they support applied skills, critical thinking, collaboration, and problem-solving capacities that are central to preparing students for future professional contexts (Koh et al., 2019; Rogers et al., 2023). In this study, these ideas are operationalized through the Lahti Sports Center, which functions as an authentic learning environment where students work with real stakeholders and infrastructure to co-develop and pilot services for regional companies and event operations.

The Lahti Sports Center is a site shaped through long-term collaboration. LAB and its predecessor LAMK have developed and maintained event-related ICT services in the area since 2004, supporting recurring international events such as Finlandia-Hiihto and the Salpausselkä Games and, over time, contributing to an event network that serves local clubs and organizers in everyday operations. This practical history is important for the present study because it provides an established infrastructure and stakeholder ecosystem that can be leveraged as an authentic learning environment and a low-threshold platform for co-developing services with regional companies. Lahti Sports Center can be viewed not only as a historically significant area for sport and events, but also as a changing and continuously reconfigured urban node where physical activity, event production, public space, services, investments, and broader urban development intersect. This is precisely what makes the area compelling from a research perspective: it offers a concrete example of how a place associated with sport can function in practice as a much wider city-scale infrastructural system.

2. Theoretical Background

Living labs function as campus-based or workplace-embedded spaces where students engage in realistic, complex problem-solving. Rogers et al. (2023) demonstrate that living labs promote authentic learning, transdisciplinary collaboration, and applied skill development. Five core competences can be identified and addressed across student labs: collaboration, communication, problem-solving, critical thinking, and creativity—developed through multidisciplinary, socially interactive environments (Admiraal et al., 2019). This competence perspective is also supported by recent peer-reviewed research showing that critical thinking is widely valued in engineering education, but that its development and assessment still require more systematic approaches within engineering curricula (Deo and Hölttä-Otto, 2024).

Universities must redesign engineering programs to integrate human-centric skills and advanced technologies for Industry 5.0, emphasizing interdisciplinary and holistic approaches; based on a non-systematic mapping and cross-case synthesis of ten universities. (Caratozzolo et al. 2024) In this study, Engineering 5.0 is understood as an approach to engineering education that intertwines and combines technological capability with human centred design, sustainability, systems thinking as well as interdisciplinary collaboration to address the challenges as depicted by Industry 5.0.

Engineering education is increasingly shifting toward systems thinking, sustainability, and human-centred design because contemporary engineering problems are complex, interdisciplinary, and closely connected to societal and environmental challenges. This requires educational approaches that move beyond narrow technical specialization and support broader competence development, including the ability to understand interdependencies, respond to stakeholder needs, and work across disciplinary boundaries (Ferreira et al., 2024; Fernando et al., 2025; Stefaniak et al., 2025). In addition, sustainability-oriented engineering education calls for design approaches that integrate ecological and social considerations into engineering problem-solving rather than treating them as secondary constraints. From this perspective, human-centred and systems-oriented engineering education provides a more relevant basis for preparing future engineers to operate in complex real-world contexts (Date and Chandrasekharan, 2025).

In addition, digital twin-based teaching and learning has been identified as a promising approach for preparing a skilled future workforce, as it enables students to engage with complex systems, real-time data, and simulation-supported decision-making in engineering education (Hazrat et al., 2023). Digital twins in engineering education can also support students' readiness for industrial digital transformation (Tabunshchyk et al., 2023). Review-based evidence further suggests that digital twins can enhance interactivity, systems understanding, and the practical relevance of engineering education across multiple disciplines (Shaikh, 2024).

3. From Sports Venue to Urban Infrastructure Ecosystem: The Case of Lahti Sports Centre

Lahti Sports Centre, located in the Päijät-Häme region of Finland, represents a multilayered urban setting where sport, event production, culture, and public infrastructure intersect. Rather than being viewed merely as a single sports venue, it can be understood as an urban infrastructure ecosystem in which physical sports facilities, services, event functions, cultural meanings, and everyday urban mobility are interconnected. Its location close to the city centre of Lahti, approximately a ten-minute walk from central services, integrates the Sports Centre into the daily functional structure of the city and makes it an accessible environment for both local residents and event visitors. The three internationally recognised large ski jumps form one of Lahti's most distinctive sporting landmarks and strengthen the area's role as part of the city's historical, visual, and symbolic identity. The Sports Centre is also situated within the Salpausselkä ridge landscape, which is part of the Salpausselkä UNESCO Global Geopark and adds geological, landscape-related, and environmental education dimensions to the area.

In terms of its physical structure, the area is layered and multifunctional. Lahti Stadium serves as a venue for football and athletics during the summer season and as a ski stadium in winter. Its spectator capacity is approximately 15,000, including seated accommodation for around 7,700 spectators. The main grandstand building also includes an indoor running track and meeting facilities for approximately one hundred people. In addition to the stadium and ski jumps, the area includes a biathlon venue, an outdoor swimming pool, the Ski Museum, restaurant services, and several indoor sports facilities, such as Luhta Arena, Salpausselkä Hall, the combat sports arena, and the sports facilities located in the ski jump grandstand. Together, these elements form an interconnected network of sports venues, services, support facilities, and cultural functions that enables year-round use by a wide range of user groups. From the perspective of education and research, Lahti Sports Centre offers an authentic learning environment in which pedagogical experimentation, multidisciplinary co-creation, and real infrastructure-related challenges can be connected with the objectives of higher education, urban development, and sustainable regional planning.

A further strength of Lahti Sports Centre lies in its capacity to combine elite sports infrastructure, everyday physical activity, recreational use, and large-scale event production within the same spatial and functional entity. The area is directly connected to the varied outdoor routes of the Salpausselkä ridge landscape, which are used during the summer for outdoor recreation, mountain biking, and orienteering, and during the winter as cross-country skiing tracks. These routes extend beyond the immediate sports centre area towards Messilä, thereby linking the site not only to local sports and leisure activities but also to a wider regional recreation and mobility network. This broader connectivity strengthens the interpretation of the Sports Centre as an infrastructure ecosystem, which value is not limited to individual built sports facilities, but emerges from the way in which routes, landscapes, services, event spaces, and everyday patterns of movement are spatially and functionally interconnected.

The event dimension of the area is further reinforced by the adjacent Lahti Sports and Fair Centre, which expands the Sports Centre from a sports-oriented environment into a broader platform for public events, commercial gatherings, exhibitions, conferences, concerts, television productions, and corporate events. With its extensive indoor event facilities, the fair centre enables the area to accommodate events of very different scales, from smaller meetings and customer events to large public gatherings. This adds an important layer to the ecosystem character of the area, as the same urban setting supports competitive sports, recreational activities, tourism, business events, cultural production, and large visitor flows. The significance of this event infrastructure is illustrated by the number and variety of events organised in the area, including public events, corporate events, international sports competitions, and mass-participation activities. Events such as the Salpausselkä Games, Finlandia Ski Marathon, Spartan events, gravel cycling events, the 2017 FIS Nordic World Ski Championships, and the IRONMAN 70.3 World Championship demonstrate how the Sports Centre functions simultaneously as an international showcase, a regional attraction, and a local platform for physical activity.

Accessibility and mobility are also central to the functioning of the area. The Sports Centre benefits from its proximity to the city centre, pedestrian and cycling connections, parking arrangements, and the need to manage changing traffic flows during major events. These features show that the area should not be understood merely as a collection of sports venues, but as a coordinated urban system in which transport, parking, pedestrian access, outdoor routes, services, and event logistics must operate together.

This infrastructural complexity is particularly relevant from the perspective of education and research, as it offers a real-world environment for examining questions related to urban planning, event management, service design, sustainability, accessibility, digital modelling, and the management of multi-user public spaces. The active future

development of the area, including plans for new aquatic facilities and the continued ambition to serve both high-level sports events and the everyday physical activity of local residents, further strengthens its relevance as a living laboratory for higher education, applied research, and co-creative urban development.

4. Using Lahti Sports Centre as a Living Learning Environment in Engineering Education

Lahti Sports Centre can be understood as a platform for human centric engineering education. A real urban setting in which Master's-level engineering students can engage with authentic infrastructure, services, users, and operational challenges. At the same time, education forms a complementary development platform through which the area can be systematically interpreted, assessed, and improved in collaboration with different stakeholders.

This perspective is also consistent with earlier work showing that authentic engineering learning benefits from integrating technical and business-oriented perspectives when students engage with real-life development problems (Leimu and Meltovaara, 2012).

It also resonates with earlier findings that student participation in engineering education can be strengthened through alternative practical work arrangements that position learners as active contributors rather than passive recipients of instruction (Meltovaara and Asp, 2012).

This multidisciplinary orientation is further supported by recent curriculum design research showing that online and cross-disciplinary degree structures can expand the ways in which students engage with complex, practice-linked development tasks across field boundaries (Brusila-Meltovaara, Heikinheimo and Sore, 2025).

Learning in this context is therefore not limited to the examination of individual technologies, built facilities, or separate service solutions. Instead, it focuses on understanding how the different functions of the area form an interdependent system. Within this setting, students can explore how sports facilities, event production, public infrastructure, digital services, mobility arrangements, user groups, and service processes interact in both everyday use and large-scale events.

This approach strengthens students' capacity to understand real urban operating environments systemically and to develop solutions that take into account user needs, changing conditions, sustainability, and operational reliability. In this way, Lahti Sports Centre supports the key objectives of modern engineering education by connecting technical expertise to human-centred design, systemic thinking, and expert work in multi-stakeholder contexts.

4.1 Project-Based Development Assignments

Project-based development assignments offer a practical way to embed engineering education directly into the authentic challenges of Lahti Sports Centre. Course modules can be structured around real development questions related to event operations, service paths, facility utilisation, visitor flows, safety, accessibility, and resource management. These themes require students to combine technical analysis with service thinking, stakeholder understanding, and practical problem-solving.

Rather than approaching learning tasks as isolated academic exercises, students work with issues that are connected to the actual use, management, and development of the area. This strengthens their ability to move from theoretical examination towards practically relevant solutions and prepares them to contribute to the improvement of demanding public service and infrastructure settings.

4.2 Examining Service Architecture and Integrations

The examination of service architecture and integrations enables students to view Lahti Sports Centre as an interconnected network of functions, actors, and digital interfaces rather than as a collection of separate facilities. Learning tasks can focus on how the city, event organisers, companies, users, service providers, and digital systems relate to one another and how these relationships affect the overall functioning of the area. Students may, for example, investigate how event information, facility management, visitor guidance, mobility services, safety arrangements, and digital communication channels interact before, during, and after events. This perspective helps them to identify dependencies, interface points, coordination needs, and possible gaps between different actors and service components. As a result, service architecture becomes a practical tool for understanding how a multi-actor urban setting can be organised, improved, and aligned with user needs and operational requirements.

4.3 Analysing Intelligent Infrastructure Data

The analysis of intelligent infrastructure data provides a further opportunity to connect engineering education with evidence-informed decision-making. At Lahti Sports Centre, students can work with utilisation data, event-related information, environmental data, and behavioural data to understand how the area functions under different conditions. Such data can support questions concerning operational efficiency, service development, user experience, resource coordination, and the assessment of environmental impacts. In this context, data analysis is not treated merely as a technical task of collecting, processing, or visualising information. Instead, students are encouraged to interpret data in relation to actual users, facilities, services, and decision-making needs. This develops analytical competence that extends from technical data handling to the production of actionable insights for the management and development of public infrastructure.

4.4 Digital Replicas and Simulation

Digital replicas (Digital Twins) and simulation provide a concrete way to move from descriptive analysis towards scenario-based evaluation. Students can model Lahti Sports Centre as a digital representation of an integrated urban system in which physical facilities, user flows, event schedules, services, and operational resources are linked together. By connecting the model with selected urban and event-related datasets, students can evaluate how different decisions may influence the functioning of the area. These decisions may concern, for example, resource allocation, energy use, crowd movement, service capacity, or event logistics. Simulation-based assignments allow students to compare alternative solutions before they are implemented in the real environment. Recent peer-reviewed research on digital twin technologies further supports the educational relevance of interoperable, data-linked modelling approaches for analysing and improving complex operational systems (Mattila et al., 2025). Related work in engineering education has also shown that digital twinning and remote engineering can support immersive and practice-oriented learning in technically complex environments, particularly when students engage with system behaviour through interactive digital representations (Hussein et al., 2023). Research has also suggested that digital twins in engineering education can support students' readiness for industrial digital transformation (Tabunshchyk et al., 2023). Review-based evidence also suggests that digital twins can strengthen systems understanding and increase the practical relevance of engineering education across multiple disciplines (Shaikh, 2024). In Master's-level engineering education, this strengthens the ability to use modelling, systems thinking, and predictive analysis as tools for planning, decision support, and the development of more robust operating models.

4.5 Co-Creation and Ecosystem Management with the City and Regional Stakeholders

Co-creation extends the educational use of Lahti Sports Centre from analysis and modelling towards shared development with the city and regional stakeholders. The area brings together the city, event organisers, companies, service providers, users, and educational institutions, creating a setting in which development assignments can be connected to real needs and practical decision-making situations. From the perspective of ecosystem management, students can map how actors, services, resources, data flows, and operational responsibilities are coordinated within the wider urban and regional context. This shifts the focus from individual development tasks to the relationships, dependencies, and value-creation mechanisms between stakeholders.

Through co-creative processes, students learn to interpret diverse perspectives, identify systemic development needs, and formulate solutions that are technically feasible, socially relevant, and useful for regional development. In this pedagogical setting, the teacher acts primarily as a facilitator, while students take the role of developing experts who produce new insights for the city and its partners. Thus, co-creation and ecosystem management connect education, applied research, and regional development, while strengthening the role of engineering education as an active contributor to the renewal of multi-actor public environments. This emphasis on shared value creation is also consistent with recent work showing that co-creative collaboration with SMEs can strengthen future-oriented development capacity and produce mutual value for both higher education and partner organizations (Brusila-Meltovaara and Karppinen, 2025).

5. Discussion

This paper shows that Lahti Sports Centre can be understood not only as a sport and event venue, but also as a city-scale living learning environment that supports the aims of Engineer 5.0 education. The case expands existing discussion on living labs and authentic learning by demonstrating how a real urban infrastructure ecosystem can be used as a pedagogical platform for multidisciplinary learning, applied development, and

regional collaboration. Its educational value is not based on a single facility, technology, or event, but on the interaction between infrastructures, services, users, data, operational practices, and stakeholder relationships.

The case makes the theoretical principles of authentic and living lab-based learning concrete. Prior research has emphasised the value of authentic, multidisciplinary, and practice-oriented learning environments in preparing students for complex professional contexts (Admiraal et al., 2019; van den Heuvel et al., 2021; Rogers et al., 2023). In the Lahti Sports Centre context, these principles are translated into learning tasks related to event operations, service paths, facility utilisation, visitor flows, accessibility, mobility, safety, and resource management. Students are therefore not positioned as passive recipients of technical knowledge, but as practitioner-researchers who examine and improve a real operating environment.

The presented case also demonstrates how Engineer 5.0 education can be operationalised in higher education. Instead of treating human-centred design, sustainability, systems thinking, digitalisation, and interdisciplinary collaboration as separate curriculum themes, the Sports Centre brings them together within one shared learning environment. Project-based development assignments connect students with authentic stakeholder needs. Service architecture analysis helps them understand dependencies between actors, services, and digital interfaces. Intelligent infrastructure data analysis develops evidence-informed reasoning, while digital replicas and simulation support scenario-based evaluation of alternative decisions. In this way, the case illustrates how Engineer 5.0 competences can be developed through integrated, practice-based learning rather than through isolated technical exercises.

Digital twins and simulation are particularly important in linking theory and practice. Research on digital twin-based teaching and learning highlights their potential to support systems understanding, real-time data use, simulation-supported decision-making, and readiness for industrial digital transformation (Hazrat et al., 2023; Tabunshchyk et al., 2023; Shaikh, 2024). In the Lahti Sports Centre case, this potential can be applied to questions such as crowd movement, service capacity, event logistics, energy use, mobility flows, and facility utilisation. The educational value of digital modelling is therefore not limited to technical representation. It enables students to explore how decisions in one part of the system may affect users, services, resources, safety, sustainability, and operational reliability elsewhere in the ecosystem.

The Lahti case further highlights the importance of ecosystem management in modern engineering education. Lahti Sports Centre is not developed or operated by one actor alone; its functioning depends on coordination between the city, educational institutions, event organisers, companies, service providers, users, and regional development actors. For students, this creates opportunities to analyse actor roles, information flows, service interfaces, operational responsibilities, and shared value creation. For regional stakeholders, the same learning activities can produce insights that support service development, event operations, infrastructure use, and collaboration practices. The living learning environment therefore creates reciprocal value: it strengthens students' professional competences while also contributing to the development capacity of the surrounding ecosystem.

The transferability of the model does not depend on the specific characteristics of Lahti Sports Centre alone. Other cities and higher education institutions may have different types of urban environments where public services, mobility, events, digital systems, users, and stakeholder networks intersect. The transferable contribution of this paper is the pedagogical and organisational model: identify a complex real-world environment, connect it to curriculum objectives, involve relevant stakeholders, formulate authentic development assignments, use data and simulation where appropriate, and create mechanisms for co-creation and feedback. However, such environments require careful educational design. Access to a real site is not sufficient by itself; learning tasks must be structured so that students can connect theoretical concepts to practical analysis, stakeholder interaction, data interpretation, and solution development.

6. Conclusion

Overall, the Lahti Sports Centre case demonstrates how a city-scale sports and event environment can be used to align theory and practice in Engineer 5.0 education. The theoretical concepts of authentic learning, living labs, systems thinking, digital twins, human-centred design, sustainability, and co-creation are not treated as separate academic ideas, but are connected to practical learning activities and real development needs. This alignment is the main contribution of the paper. It shows that engineering education can be renewed by moving learning into authentic urban systems where students, teachers, public actors, companies, and users jointly examine how technology, services, infrastructure, and human activity interact. In doing so, the model strengthens both future-

oriented engineering competences and the capacity of the region to develop more intelligent, inclusive, and sustainable urban environments.

Ethics Declaration

This work did not require ethical clearance.

AI Declaration

Mircosoft copilot was used at the ideation stage and to check compliance of list of references with paper template. Microsoft copilot was used to check for spelling and grammatical errors.

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