SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2025
ORGANIZATION AND MANAGEMENT SERIES NO. 227

SPORT MANAGEMENT IN THE CONTEXT OF THE SMART CITY CONCEPT

Agnieszka ULFIK

Jerzy Kukuczka Academy of Physical Education in Katowice; a.ulfik@awf.katowice.pl,
ORCID: 0000-0001-8561-7621

Purpose: The purpose of this paper is to explore the integration of sport management within the smart city framework, focusing on how modern technologies—such as the Internet of Things (IoT), mobile applications, and data analytics—transform sports infrastructure, public engagement in physical activity, and urban planning strategies for sustainable development.
Design/methodology/approach: This is a theoretical and conceptual study grounded in a comprehensive literature review. The article synthesizes interdisciplinary research in sport management, urban studies, and information and communication technologies (ICT), supported by case studies from Tokyo, Amsterdam, and Singapore. The approach highlights the convergence between digital innovation and sport governance in the context of smart urban ecosystems.
Findings: The study finds that the implementation of smart technologies in sport management enhances infrastructure efficiency, increases community participation in physical activity, and supports sustainable urban development. It also reveals that data analytics, when integrated with sports systems, provide valuable insights for policy-making and operational optimization. However, challenges remain regarding data privacy, funding, and social acceptance.
Practical implications: The paper provides guidance for urban planners, sport facility managers, and policymakers on how to implement smart technologies in sport settings to improve operational efficiency and community health. It also informs investment strategies and public-private partnership models for infrastructure innovation.
Social implications: By promoting physical activity and digital inclusion, smart sport solutions contribute to improved public health outcomes, environmental sustainability, and greater social cohesion. These technologies can also shape more equitable access to urban sport facilities, aligning with broader social responsibility and quality-of-life goals.
Originality/value: This article offers an original synthesis of sport management within the emerging field of smart city development. It bridges gaps between technology, public administration, and community health, providing a structured framework for understanding the multifaceted role of sport in intelligent urban systems. The paper is relevant to scholars, urban planners, sport professionals, and civic leaders.
Keywords: smart city, sport management, sustainable development, digital infrastructure, urban innovation.
Category of the paper: literature review.

1. Introduction

Sport management in the context of the smart city concept is gaining increasing importance due to growing urbanization and the demand for efficient use of urban resources. The smart city model emphasizes the utilization of information and communication technologies (ICT), which not only enhance public sector operations and the economy but also contribute to improving residents' quality of life. Within this framework, sport emerges as a vital component of daily activity, shaping public health and supporting community development. Integrating smart technologies into sport management enables sustainable administration of sports infrastructure, precise monitoring of community needs, and the creation of innovative solutions for promoting physical activity.

The aim of this paper is to analyze sport management in the context of smart city development, with particular emphasis on modern technologies that support sports infrastructure, data analytics, and the integration of sport with other areas of the smart city. Key aspects of sport management will be addressed, including the role of digital systems, data analysis, and mobile tools in promoting physical activity. The paper will also discuss the challenges and limitations associated with implementing smart technologies in the sports domain.

2. The smart city concept and its components

The idea of a smart city is one of the key issues of contemporary urban planning and urban management. A smart city is defined as an urbanized space where information and communication technologies (ICT) are used to optimize city processes, enhance residents' quality of life, and support sustainable development (Komninos, 2015). Smart cities encompass various sectors, including transportation, economy, administration, education, and sports and recreation (Harrison, Donnelly, 2011). The implementation of smart city initiatives responds to the dynamic growth of urban populations and the resulting necessity to manage urban resources efficiently. Real-time data analytics and smart technologies play a key role in automating and optimizing city operations (Albino et al., 2015).

Information and communication technologies (ICT) serve as the backbone of the smart city concept. The Internet of Things (IoT) enables infrastructure monitoring, artificial intelligence (AI) supports data management, and 5G networks ensure rapid data transmission (Gubbi et al., 2013). In the context of sport, these technologies facilitate dynamic management of sports facilities, resource optimization, and personalized user experiences.

Smart cities are commonly structured into six key areas (Chen et al., 2021; European Commission, 2024; Gotlibowska, 2018; Kinelski, 2022; Nam, Pardo, 2011; Ulfik, 2024):

- Smart governance: the use of digital tools for transparent municipal governance.
- Smart environment: integration of eco-friendly solutions into urban infrastructure.
- Smart mobility: development of sustainable transport and optimization of urban traffic.
- Smart people: education and development of citizens' digital competencies.
- Smart economy: implementation of innovative business models and digitalization of services.
- Smart living: improving living conditions through modern technological solutions.

3. Sport Management

Sport management includes the strategic planning, organizing, leading, and controlling of sport-related activities to ensure their effective functioning (Hoye et al., 2018). This process includes managing sports facilities, events, and the promotion of physical activity among residents. Contemporary sport management also incorporates innovative technologies that improve event organization and increase accessibility to sports infrastructure (Ratten, 2019).

In the literature on the subject, several key aspects of sports management are distinguished. In most studies, smart city solutions in sports focus on three issues (Poynter, Viehoff, 2016; Ratten, 2019):

- modernizing sports infrastructure through the implementation of smart energy management systems and resource monitoring,
- utilizing ICT in organizing sports events, such as participant registration systems, smart ticketing, and digital crowd management,
- personalizing user experiences through Big Data analytics, enabling customized sport offerings based on individual needs.

Modern sport management is increasingly aligned with sustainable development strategies, which consider the ecological impact of sports events and their interaction with the urban environment (Gratton, Henry, 2002; Masdeu Yelamos et al., 2019; Triantafyllidis, Mallen, 2022).

4. Integration of sport management in the smart city

Smart sports infrastructure forms the foundation for effective sport management in the smart city context. An illustrative example includes smart stadiums that utilize IoT technologies for crowd monitoring, energy management, and safety assurance (Mahdi et al., 2021). IoT systems installed in sports facilities deliver benefits for athletes, fans, event organizers, and emergency services. These benefits include (Fernández-Villarino, 2021; Hu et al., 2016; João et al., 2019; Mohammed Sadeeq et al., 2021; Whaiduzzaman et al., 2022):

- continuous monitoring of environmental conditions (e.g., temperature, humidity, air pressure, wind speed),
- automated lighting and climate control to optimize energy usage,
- real-time detection of infrastructure overloads,
- analysis of crowd flows to enhance emergency evacuation protocols.

There can be many more applications for intelligent sports infrastructure. Other applications encompass intelligent water management systems for field irrigation, automated snowmaking technologies for winter sports venues, and predictive maintenance platforms designed to optimize operational efficiency and reduce long-term infrastructure costs.

Mobile applications and digital platforms play a pivotal role in promoting physical activity and managing sports infrastructure (Chioma Anthonia Okolo et al., 2024; Romeo et al., 2019). These tools enable:

- recording users' physical activity and delivering individually tailored training recommendations,
- real-time booking of sports facilities, enhancing access and efficiency,
- monitoring progress and enabling local community comparisons to foster motivation and engagement,
- utilizing loyalty programs that reward consistent use of public sports infrastructure.

From an urban management perspective, such applications may be integrated with healthcare systems, educational programs, or healthy lifestyle promotion campaigns.

Big Data is essential to decision-making processes in both facility management and athlete training. Data from IoT sensors, mobile apps, and CRM systems allow analysis of physical activity trends across age groups, forecasting infrastructure demand, optimizing training plans based on performance and injury risk, and customizing fan experiences (e.g., personalized match-day offers). Data analytics also support the development of urban dashboards, which provide policymakers with insights into infrastructure utilization, event effectiveness, and investment needs (Karaboga et al., 2023; Watanabe et al., 2021).

5. Global Examples of Smart Sport System Implementations

A wide range of major international sports venues have implemented various elements of smart management practices, primarily aimed at optimizing event logistics, enhancing safety measures, and advancing environmentally sustainable operations. These facilities often resemble self-contained micro-cities during events, hosting tens of thousands of people. Notable examples include venues in Tokyo, Amsterdam, and Singapore.

Tokio Smart Stadion – **The Tokyo Dome** is widely regarded as a pioneering model of smart stadium infrastructure (Coakley, Souza, 2013; Maguire, Nakayama, 2004; Manzenreiter, 2020). The facility integrates advanced safety systems featuring real-time video surveillance and analytics, energy management systems that adjust power and climate control based on demand, and mobile applications for fans providing real-time information on facility navigation, restroom availability, and food services. These solutions improve visitor comfort while minimizing environmental impact.

Amsterdam's CitySports Platform is an exemplary initiative in promoting physical activity by connecting municipal sports facilities into an integrated network (Hoekman et al., 2016; Van Mechelen et al., 2000). It enables streamlined booking and scheduling, integrates data from public transportation and energy systems, and fosters community collaboration through shared training sessions and events. The initiative has significantly increased physical activity among residents and improved infrastructure utilization.

Singapore, known for its innovative healthcare and urban space management, has implemented Smart Health & Fitness systems that integrate health apps with urban planning (Foong et al., 2024; Tan, 2022). These solutions track vital signs such as heart rate, steps, and calorie expenditure, relay the data to municipal databases, and analyze it for chronic disease prevention. Notifications and recommendations are personalized, encouraging healthy lifestyles and linking physical activity with broader health policies.

6. Challenges and limitations

The deployment of smart technologies entails processing vast volumes of personal data, raising concerns about data privacy and security (Cui et al., 2018; Eckhoff, Wagner, 2018). Within the context of sport management, this raises concerns regarding the protection of app users' privacy, protecting sensitive data such as health information, and preventing the misuse of data for profiling or commercial exploitation. Thus, legal frameworks, data protection standards, and user education are critical.

Moreover, advanced technologies such as IoT, AI, and Big Data require substantial financial investments (Karvonen et al., 2019; Vinod Kumar, Dahiya, 2017). For cities with limited resources, this represents a major barrier. External funding, including from EU programs, cost-benefit analysis, and public-private partnerships (PPPs) are essential mechanisms to support smart technology adoption in sports infrastructure.

Smart technologies may also encounter public skepticism regarding their necessity, security, and costs (Dirsehan, Van Zoonen, 2022; Manogaran, Teoh, 2023; Rijshouwer et al., 2022). In sport, it is vital to involve citizens in decision-making through consultations, provide educational campaigns highlighting the benefits of innovation, and maintain transparency in data collection and use. Social trust and acceptance are prerequisites for the full realization of smart city potential in sport.

7. Benefits of integrating sports management and smart cities

Implementing modern technologies can significantly increase residents' physical activity levels (Andrews, Silk, 2012). Mobile apps, social platforms, and other tools motivate participation in sports events both as athletes and spectators, leading to improved health, enhanced social integration, and promotion of healthy habits.

Process automation and data analytics (e.g., in booking, financial settlement, and infrastructure monitoring) allow for more efficient resource utilization. Smart systems reduce operating costs, ensure faster responses to system failures or overloads, and improve service quality.

Technology-driven sporting events can stimulate local economic growth, attract sponsors and tourists, and generate new jobs related to infrastructure operation and event organization (Müller et al., 2016; Thabi, 2024). This supports regional development and enhances urban competitiveness.

In summary, sports management in the smart city concept is closely linked to the use of modern technologies that allow for effective coordination of sports infrastructure, activation of residents and development of the local economy. Examples of implementations from global metropolises show the diversity of innovative solutions - from smart stadiums, through digital platforms integrating data from city systems, to mobile applications engaging users in physical activity and health prevention.

Implementing these solutions has the potential for significant benefits, such as improving the quality of life, strengthening social capital, and creating cities that are conducive to health and recreation. However, one cannot ignore the challenges related to personal data protection, investment costs, or the need to ensure social acceptance. The ultimate success of smart implementations in the field of sports depends on a properly designed city policy, coherent financing, and openness to further technological innovations.

8. Summary

Integration of sports management in the context of smart cities brings numerous benefits, such as improving the efficiency of infrastructure management, increasing the involvement of residents in physical activity, increasing the attractiveness of cities as places friendly to a healthy lifestyle, and the economic development of local communities. At the same time, implementing technology requires solving challenges related to data protection, investment costs and social acceptance.

To sum up, effective sports management in smart cities is not limited to the implementation of modern technologies, but is a holistic process covering planning, promotion and development of various sports initiatives supported by ICT solutions. Integration of these elements promotes building a community involved in an active lifestyle, generates new economic opportunities and strengthens the global position of cities.

In the future, we will certainly observe further development of sports in smart cities, including better integration with health care systems, education and public transport. Developing a coherent policy and consciously involving residents in the process of change will allow for lasting and sustainable benefits for the entire community. Thanks to this, cities will become places where sports play a key role in shaping a healthy, friendly and innovative living environment.

References

1. Albino, V., Berardi, U., Dangelico, R.M. (2015). Smart Cities: Definitions, Dimensions, Performance, and Initiatives. *Journal of Urban Technology*, *22*(1), 3-21. https://doi.org/10.1080/10630732.2014.942092.
2. Andrews, D.L., Silk, M.L. (Eds.) (2012). *Sport and Neoliberalism: Politics, Consumption, and Culture*. Temple University Press. http://www.jstor.org/stable/j.ctt14bt86n.
3. Chen, Y., Hong, Z., Liao, Y., Zhu, M., Han, T., Shen, Q. (2021). Automatic Detection of Display Defects for Smart Meters based on Deep Learning. *Journal of Computing and Information Technology*, *28*(4), 241-254. https://doi.org/10.20532/cit.2020.1005158.
4. Chioma Anthonia Okolo, Oloruntoba Babawarun, Jeremiah Olawumi Arowoogun, Adekunle Oyeyemi Adeniyi, Rawlings Chidi (2024). The role of mobile health applications in improving patient engagement and health outcomes: A critical review. *International Journal of Science and Research Archive*, *11*(1), 2566-2574. https://doi.org/10.30574/ijsra.2024.11.1.0334.
5. Coakley, J., Souza, D. (2013). Sport mega-events: Can legacies and development be equitable and sustainable? *Motriz. Revista de Educacao Fisica*, *19*, 580-589.

6. Cui, L., Xie, G., Qu, Y., Gao, L., Yang, Y. (2018). Security and Privacy in Smart Cities: Challenges and Opportunities. *IEEE Access*, *6*, 46134-46145. https://doi.org/10.1109/ACCESS.2018.2853985.
7. Dirsehan, T., Van Zoonen, L. (2022). Smart city technologies from the perspective of technology acceptance. *IET Smart Cities*, *4*(3), 197-210. https://doi.org/10.1049/smc2.12040.
8. Eckhoff, D., Wagner, I. (2018). Privacy in the Smart City—Applications, Technologies, Challenges, and Solutions. *IEEE Communications Surveys & Tutorials*, *20*(1), 489-516. https://doi.org/10.1109/COMST.2017.2748998.
9. European Commission. *Smart cities*. Retrieved from: https://commission.europa.eu/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en, 08.04.2024.
10. Fernández-Villarino, R. (2021). Sustainability in the football industry: An approach to the gap between theoretical formulation and practical application, through the results of the social fair play project. *Heliyon*, *7*(6), e07318. https://doi.org/10.1016/j.heliyon.2021.e07318.
11. Foong, Y.P., Pidani, R., Sithira Vadivel, V., Dongyue, Y. (2024). Singapore Smart Nation: Journey into a New Digital Landscape for Higher Education. In: A.O. J. Kwok, P.-L. Teh (eds.), *Emerging Technologies in Business* (pp. 281-304). Springer Nature Singapore. https://doi.org/10.1007/978-981-97-2211-2_13.
12. Gotlibowska, K. (2018). Propozycja modelu miasta inteligentnego (Smart City) opartego na zastosowaniu technologii informacyjno-komunikacyjnych w jego rozwoju. *Rozwój Regionalny i Polityka Regionalna*, *42*, 67-80.
13. Gratton, C., Henry, I. (eds.) (2002). *Sport in the City: The Role of Sport in Economic and Social Regeneration*. Routledge. https://doi.org/10.4324/9780203471401
14. Gubbi, J., Buyya, R., Marusic, S., Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. *Future Generation Computer Systems*, *29*(7), 1645-1660. https://doi.org/10.1016/j.future.2013.01.010.
15. Harrison, C., Donnelly, I.A. (2011). A theory of smart cities. *Proceedings of the 55th Annual Meeting of the ISSS*, *55*(1).
16. Hoekman, R., Breedveld, K., Kraaykamp, G. (2016). A landscape of sport facilities in the Netherlands. *International Journal of Sport Policy and Politics*, *8*(2), 305-320. https://doi.org/10.1080/19406940.2015.1099556.
17. Hoye, R., Smith, A.C.T., Nicholson, M., Stewart, B. (2018). *Sport Management: Principles and Applications* (5th Edition). London: Routledge. https://doi.org/10.4324/9781351202190.
18. Hu, K.-H., Chen, F.-H., Tzeng, G.-H. (2016). Evaluating the Improvement of Sustainability of Sports Industry Policy Based on MADM. *Sustainability*, *8*(7), 606. https://doi.org/10.3390/su8070606.

19. João, B.D.N., Souza, C.L.D., Serralvo, F.A. (2019). A systematic review of smart cities and the internet of things as a research topic. *Cadernos EBAPE.BR*, *17*(4), 1115-1130. https://doi.org/10.1590/1679-395174442x.
20. Karaboga, T., Zehir, C., Tatoglu, E., Karaboga, H.A., Bouguerra, A. (2023). Big data analytics management capability and firm performance: The mediating role of data-driven culture. *Review of Managerial Science*, *17*(8), 2655-2684. https://doi.org/10.1007/s11846-022-00596-8.
21. Karvonen, A., Cugurullo, F., Caprotti, F. (eds.) (2019). *Inside smart cities: Place, politics and urban innovation*. Routledge.
22. Kinelski, G. (2022). Smart City 4.0 As a Set of Social Synergies. *Polish Journal of Management Studies*, *26*(1), 92-106. https://doi.org/10.17512/pjms.2022.26.1.06.
23. Komninos, N. (2015). *The age of intelligent cities: Smart environments and innovation-for-all strategies* (First edition). Routledge. https://doi.org/10.4324/9781315769349.
24. Maguire, J., Nakayama, M. (eds.) (2004). *Japan, Sport and Society*. Routledge. https://doi.org/10.4324/9780203504413.
25. Mahdi, M.J., Aljuboori, A.F., Hussein Ali, M. (2021). Smart Stadium using Cloud Computing and Internet of Things (IoT): Existing and New Models. *International Journal of Computer Applications Technology and Research*, *10*(05), 111-118. https://doi.org/10.7753/IJCATR1005.1002.
26. Manogaran, P., Teoh, A.P. (2023). Determinants of Smart City Technology Acceptance: Role of Smart Governance as Moderator. *Journal of Governance and Integrity*, *6*(1), 515-528. https://doi.org/10.15282/jgi.6.1.2023.9358.
27. Manzenreiter, W. (2020). Tokyo 2020. In: B. Holthus, I. Gagné, W. Manzenreiter, F. Waldenberger, *Japan Through the Lens of the Tokyo Olympics* (pp. 137-140). Routledge. https://doi.org/10.4324/9781003033905-34.
28. Masdeu Yelamos, G., Carty, C., Clardy, A. (2019). Sport: A driver of sustainable development, promoter of human rights, and vehicle for health and well-being for all. *Sport, Business and Management: An International Journal*, *9*(4), 315-327. https://doi.org/10.1108/SBM-10-2018-0090.
29. Mohammed Sadeeq, M., Abdulkareem, N.M., Zeebaree, S.R.M., Mikaeel Ahmed, D., Saifullah Sami, A., Zebari, R.R. (2021). IoT and Cloud Computing Issues, Challenges and Opportunities: A Review. *Qubahan Academic Journal*, *1*(2), 1-7. https://doi.org/10.48161/qaj.v1n2a36.
30. Müller, A., Bíró, M., Kinga, R.-O., Ráthonyi, G., Széles- Kovács, G., Eszter, B., Macra-Oşorhean, M., Andras, A. (2016). Economic impacts of sports events. *Studia UBB Educatio Artis Gymn.*, *LXI*, 85-95.
31. Nam, T., Pardo, T.A. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. *Proceedings of the 12th Annual International Digital Government Research Conference: Digital Government Innovation in Challenging Times*, 282-291. https://doi.org/10.1145/2037556.2037602.

32. Poynter, G., Viehoff, V. (eds.) (2016). *Mega-event cities: Urban legacies of global sports events*. Routledge. https://doi.org/10.4324/9781315594798.
33. Ratten, V. (2019). *Sports Technology and Innovation: Assessing Cultural and Social Factors*. Springer International Publishing. https://doi.org/10.1007/978-3-319-75046-0.
34. Rijshouwer, E.A., Leclercq, E.M., Van Zoonen, L. (2022). Public views of the smart city: Towards the construction of a social problem. *Big Data & Society*, *9*(1), https://doi.org/10.1177/20539517211072190.
35. Romeo, A., Edney, S., Plotnikoff, R., Curtis, R., Ryan, J., Sanders, I., Crozier, A., Maher, C. (2019). Can Smartphone Apps Increase Physical Activity? Systematic Review and Meta-Analysis. *Journal of Medical Internet Research*, *21*(3), e12053. https://doi.org/10.2196/12053.
36. Tan, G. K. S. (2022). Citizens go digital: A discursive examination of digital payments in Singapore's Smart Nation project. *Urban Studies*, *59*(12), 2582-2598. https://doi.org/10.1177/00420980211039407.
37. Thabi, K. (2024). Economic Impact of Major Sporting Events on Local Economies. *International Journal of Arts, Recreation and Sports*, *3*(3), 1-13. https://doi.org/ 10.47941/ijars.1940.
38. Triantafyllidis, S., Mallen, C. (2022). *Sport and Sustainable Development: An Introduction*. Routledge. https://doi.org/10.4324/9781003128953.
39. Ulfik, A. (2024). Chapter 2. Innovative and smart cities of the future. In: J. Kabus, L. Piersiala, M. Dziadkiewicz, *The Use of Information and Communication Technologies (ICT) in the Management of the Innovative and Smart City* (pp. 19-40). Boca Raton: CRC Press, ttps://doi.org/10.1201/9781003465157.
40. Van Mechelen, W., Twisk, J.W.R., Post, G.B., Snel, J., Kemper, H.C.G. (2000). Physical activity of young people: The Amsterdam Longitudinal Growth and Health Study: *Medicine & Science in Sports & Exercise*, 1610-1616. https://doi.org/10.1097/00005768-200009000-00014.
41. Vinod Kumar, T.M., Dahiya, B. (2017). Smart Economy in Smart Cities. In: T.M. Vinod Kumar (eds.), *Smart Economy in Smart Cities* (pp. 3-76). Springer Singapore. https://doi.org/10.1007/978-981-10-1610-3_1.
42. Watanabe, N.M., Shapiro, S., Drayer, J. (2021). Big Data and Analytics in Sport Management. *Journal of Sport Management*, *35*(3), 197-202. https://doi.org/ 10.1123/jsm.2021-0067.
43. Whaiduzzaman, M., Barros, A., Chanda, M., Barman, S., Sultana, T., Rahman, Md. S., Roy, S., Fidge, C. (2022). A Review of Emerging Technologies for IoT-Based Smart Cities. *Sensors*, *22*(23), 9271. https://doi.org/10.3390/s22239271.