

*Aleksander Orłowski<sup>1</sup>, Narek Parsamyan<sup>2</sup>*

## The role of sport in the Smart City concept

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### Abstract

Sport brings to cities innovative solutions that influence urban life, yet considerations about sport still rarely contribute to the development of the very popular smart city concept. This raises the question: what is the perception of sport in the city from the perspective of the smart city concept? One of the challenges of future urban policy is to provide initiatives that ensure the wellbeing and promote the model of a healthy city, especially during the era of the COVID-19 pandemic. Therefore, sport creates an opportunity to combat these challenges. The study provides an in-depth literature review on sport factors influencing smart city domains through a systematic review process. Exploring this topic creates a paradigm for future studies regarding the discourse on smart cities and the impact of sport on the evolution of cities of tomorrow. In particular, it indicates potential areas of interest from the point of view of local authorities and policymakers, who are able to incorporate governance through sport agendas.

**Keywords:** smart city, urban governance, sport city, urban development

**JEL Classification Codes:** I18, L38, L83, Q01

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<sup>1</sup> Faculty of Management and Economics, Gdańsk University of Technology, Gdańsk, Poland, e-mail: aorlowski@zie.pg.gda.pl, <https://orcid.org/0000-0003-4699-1703>

<sup>2</sup> Faculty of Management and Economics, Gdańsk University of Technology, Gdańsk, Poland, e-mail: narek.parsamyan@pg.edu.pl, <https://orcid.org/0000-0002-7610-1524>

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## Rola sportu w rozwoju koncepcji inteligentnego miasta

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### Abstrakt

Sport wprowadza do miast innowacyjne rozwiązania, które wpływają na życie miejskie, jednak rozważania dotyczące sportu wciąż rzadko przyczyniają się do rozwoju cieszącej się dużą popularnością koncepcji inteligentnego miasta (*smart city*). W związku z tym pojawia się pytanie: jak postrzegany jest sport w mieście z perspektywy koncepcji inteligentnego miasta? Jednym z wyzwań przyszłej polityki miejskiej jest zapewnienie inicjatyw zapewniających dobrostan i promujących model zdrowego miasta, zwłaszcza w czasach trwającej pandemii COVID-19. Przedsięwzięcia sportowe stwarzają możliwość walki z tymi wyzwaniami. W artykule dokonano pogłębionego przeglądu literatury na temat czynników sportowych wpływających na różne obszary (domeny) koncepcji inteligentnego miasta. Zbadanie powyższego tematu tworzy paradygmat dla przyszłych badań dotyczących dyskursu na temat inteligentnych miast i wpływu sportu na ewolucję miast przyszłości. Artykuł w szczególności wskazuje na potencjalne obszary zainteresowania z punktu widzenia władz miejskich, którzy mogą uwzględnić sport jako istotny element budujący strategię miasta inteligentnego.

**Słowa kluczowe:** inteligentne miasto, zarządzanie miejskie, sportowe miasto, rozwój obszarów miejskich

**Kody klasyfikacji JEL:** I18, L38, L83, Q01

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## Introduction

Currently, city inhabitants face various types of problems related to urban life, in particular, issues concerning: social disparities, unemployment, low availability of public services, air pollution, transport, and communication difficulties. Furthermore, the dynamic development of cities increases their density. According to United Nations research, by 2050, 68% of the world's population will be living in urban areas, causing significant congestion of the urban space (UN DESA, 2018). The continued rapid growth of the population living in cities may lead to irreversible social and environmental changes. Therefore, the urban space should be thoughtfully managed, providing balanced and sustainable development. For this purpose, the concept of a smart city has been developed towards the use of technological solutions which make a city more intelligent in order to improve the quality level of urban life and positively influence the sustainable development of cities (Neirotti et al., 2014). Due to the diversity of smart city definitions provided in the scientific literature, it is difficult to select a single common definition (Mora, Bolici and Deakin, 2017).



Considerations about the smart city are nowadays focused on the various aspects of the use of information and communications technologies (ICTs), and their development. However, the view has been expressed that ICTs alone are not enough to create a comprehensive concept of a smart city (Neirotti et al., 2014). To create new solutions and innovations, human capital and public participation (Feng, 2019) are needed, especially in the design and implementation processes (Oliveira and Campolargo, 2015). Reflections on the role of people in smart cities referred to a new paradigm, called the human smart city (Deserti, Cobanali and Rizzo, 2015), which largely concerns the need for the participation of a city's inhabitants in the co-design (Orłowski, 2021), planning and creation of smart city services, and assumes that the usage of technology and social interaction is maintained in a balanced way (Lara et al., 2016).

Despite the trend toward digitalisation in the smart city concept (Jucevičius, Patašienė and Patašius, 2014), modern urban strategies are not only filled with agendas that contain the development of ICT infrastructure and further urban applications, but also provide opportunities to live a happy and harmonious life. Cities provide space for recreation, relaxation, and sport-related activities through various types of indoor and outdoor facilities. Sports stadiums, training bases, sports facilities, and headquarters of sports clubs are primarily located in cities. Sports clubs and major sporting events are named after cities (Dickson and Zhang, 2020) and those connections may bring tangible benefits for cities in terms of recognition and attractiveness, becoming a tourist destination, for instance, as in the city of Barcelona in Spain, home of the world-famous football club Futbol Club Barcelona. The links and impact of sport on urban development seem obvious; however, only a small amount of research currently addresses the considerations of sport in the city (Kozma, Tepetics and Radics, 2014; Dickson and Zhang, 2020). Sport has an impact on cities, but does it contribute and if so how to the concept of a smart city? Therefore, we intend to consider how specifically sport influences modern cities and how it corresponds to the concept of a smart city. This paper aims to examine the relationship between sport and the smart city concept by identifying sport factors in the literature related to smart cities. The research will emphasise the influence of sport on urban areas and its contribution to the smart city concept, explaining how it initiates the introduction of new smart solutions and innovation in cities. The examples and reflections presented in the paper regarding the impact of sport on the smart city concept are an attempt to fill the gap in the context of the current state of the art in the field of sport in smart city strategies.



## Methodology

To identify the current state of the art in the context of sport factors in the smart city concept, an appropriate systematic literature review was conducted. The review was carried out based on the methodology presented by Wolfswinkel et al. (2013). A systematic literature review was conducted with a comprehensive search, consisting of six steps (see Table 1).

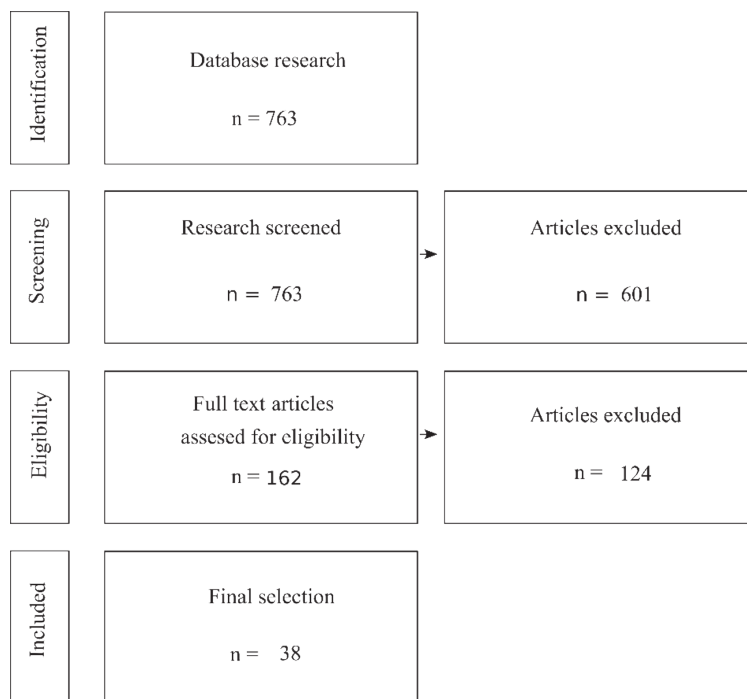
**Table 1. Process of the systematic literature review in steps**

Step	Task	Procedure	Description
1	Define the criteria	Set up the criteria of inclusion of the review	<ul style="list-style-type: none"> <li>• only peer-viewed articles</li> <li>• till July 2022</li> </ul>
2	Identify the field of research	Clarification and selection of the specific research field	<ul style="list-style-type: none"> <li>• not limited</li> </ul>
3	Select databases	Determination of databases	<ul style="list-style-type: none"> <li>• Elsevier (Science Direct)</li> <li>• Springer (Springer Link)</li> <li>• Taylor and Francis (Taylor and Francis Online)</li> <li>• Wiley (WileyOnlineLibrary)</li> </ul>
4	Formulate terms and search	Formulation of variously possible search terms	<ul style="list-style-type: none"> <li>• search terms; phrases in full text: (“<i>sport and smart city</i>”) OR (“<i>sport and city</i>”)</li> <li>• keyword: (“<i>smart city</i>”)</li> </ul>
5	Refine the sample	Narrow search based on additional verification	<ul style="list-style-type: none"> <li>• read abstracts and introductions</li> </ul>
6	Analyse and select	Final selection of papers relevant to the scope and objective of the study	<ul style="list-style-type: none"> <li>• finding relevant sport factors in the full body of the articles</li> </ul>

Source: own elaboration based on Wolfswinkel et al. (2013).

The search resulted in a total of 763 articles found in the databases: Springer “Springer Link” – 379, Elsevier “Science Direct” – 299, Taylor and Francis – “Taylor and Francis online” 60, and Wiley “WileyOnlineLibrary” – 25. Then the search was narrowed to 162 articles, from which the final selection was made, finding 38 relevant papers to the objective of the literature search. The process of article exclusion, along with the various stages, is shown in Figure 1.



**Figure 1. Article exclusion process**

Source: own elaboration.

## Results

A detailed analysis of the selected articles in the full body of text was carried out to examine how sport in the broad sense affects different areas of the city and how sport is mentioned by scholars in the context of the smart city. Depending on the area in which the sport factors were found in the relevant literature, they were then matched with the specific domains and subdomains of the smart city (see Table 2). The analysis was provided based on the smart city domains classification (Neirotti et al., 2014), consisting of: living domain, transport and mobility domain, natural resources and energy domain, buildings domain, government domain, economy and people domain.

Table 2 presents the novel classification of sport into smart city domains, and examines the factors of sport that contribute to the development of the smart city concept. The outcome of the literature review presents the role and perception of sport in the smart city domains. Statistically, the highest number of articles in which sports were discussed applied to the living domain (67%), the buildings domain (13%), the

transport and mobility domain (11%), and the natural resources and energy domain (9%). Surprisingly, the sport factor in smart cities is not described enough in the literature to classify them into the remaining domains: government, economy and people. The next subsequent section more broadly describes the sport factors that have been found in the literature and are allocated to the respective domains and subdomains of the smart city.

**Table 2. Sport factors in Smart City domains**

References	Smart City domains									
	Living					Natural resources and energy			Transport and mobility	Buildings
	Healthcare	Welfare and social inclusion	Public safety	Entertainment	Public space management	Public lighting	Smart grid	Water management	Info mobility	Facility management
1	Aguilar et al. (2021)				X					
2	Bai et al. (2022)	X								
3	Canales-Ide et al. (2019)							X		
4	Elnour et al. (2022)						X			
5	Dubinsky (2022)				X					
6	Fernandez-Anez et al. (2020)				X					
7	Gaffney & Robertson (2018)				X					
8	J. Song et al. (2014)									X
9	Jararweh et al. (2020)			X						
10	Kamiński et al. (2020)								X	
11	Kassens-Noor (2018)	X		X	X				X	
12	Koens et al. (2019)		X							
13	Kousiouris et al. (2018)			X						
14	Kumar et al. (2020)				X					
15	Li et al. (2021)	X			X					
16	Liu et al. (2020)									X
17	Mishra et al. (2021)	X								
18	Mohamed et al. (2020)			X						
19	Molinillo et al. (2019)				X					
20	Molyneaux et al. (2021)								X	
21	O'Brocháin et al. (2019)									X
22	Pérez-delHoyo et al. (2021)				X					



References	Smart City domains									
	Living					Natural resources and energy			Transport and mobility	Buildings
	Healthcare	Welfare and social inclusion	Public safety	Entertainment	Public space management	Public lighting	Smart grid	Water management	Info mobility	Facility management
23	Petrakis et al. (2020)			X						
24	Pujol et al. (2020)			X						
25	Rocznik et al. (2017)				X					
26	Rodrigues et al. (2020)		X							
27	Shan & Mai (2020)	X								
28	Steenbruggen et al. (2015)			X						
29	T. Song et al. (2021)									X
30	Stellios et al. (2022)					X				
31	Tjønndal & Nilssen (2019)	X	X							
32	Wang (2020)								X	
33	White (2016)								X	
34	Wiig (2015)			X						
35	Xiahou et al. (2020)				X					
36	Zandbergen (2020)					X				
37	Zhang et al., (2021)	X								
38	Zhou et al. (2020)				X					X

Source: own elaboration based on Neirotti et al. (2014).

## Sport factors in Smart City domains

### Living domain

Public space management subdomain. Increasing the attractiveness of public spaces and introducing innovative technological services to organise mega-sports events was the agenda of the Rio de Janeiro Olympic Summer Games (Gaffney and Robertson, 2018) and Nanjing Youth Olympic Games in 2014 (Xiahou et al., 2020). Mega-sports events are a challenge for a city's governance, but at the same time, offer great possibilities for cities for rapid urban development. The Tokyo 2020 Olympic competition is one of the examples of how sports can influence the smartness of the



city and prompt innovative urban solutions to the flow of people, the monitoring of environmental systems, security, and health management (Kassens-Noor & Fukushige, 2018). Nevertheless, cities should develop sports infrastructure even without organising mega-sports events, and local governments should invest in the modernisation and adaptation of existing sports facilities, including new smart functionalities for greater accessibility and convenience (Fernandez-Anez et al., 2020). Innovation and technology used in sports can improve the attractiveness of the city and influence public space management (Dubinsky, 2022). Furthermore, the prevalence of the participation of city inhabitants in the planning and design of public infrastructure that is addressed for physical activities is growing (Aguilar et al., 2021). Moreover, the inclusion of physical activity data collection and the creation of a channel of communication between the citizens and the local authority are helpful in order to improve the decision-making process with regard to the participatory manner (Pérez-delHoyo et al., 2021) and the engagement of intermediary actors (Zhou et al., 2021). In the public space management subdomain, sport is presented mainly as a source of major sporting events, for which the construction or modernisation of urban sports facilities is expected. The topic of the management of urban sports facilities is becoming an increasingly popular one among smart city researchers.

Public safety subdomain. Live sports events attract tens of thousands of spectators and visitors, causing increasing urban densities. Modern technologies support crowd management (Kassens-Noor & Fukushige, 2018; Petrakis et al., 2020; Pujol, Mora and Pertegal, 2020) and provide data about users (Jararweh et al., 2020; Kousiouris et al., 2018), which can benefit in predicting the flow of people and preventing hazards (Steenbruggen, Tranos and Nijkamp, 2015). IBM's special smart city platform was designed for the complex integration and management of the city components, one of them being security and crisis management (Wiig, 2015). Furthermore, unmanned aerial vehicles can monitor the crowd at large-scale sports events (Mohamed et al., 2020) and provide public safety. Major sporting events in the literature are depicted as a trigger for implementing technological solutions that improve public safety, especially in the context of crowd management.

Healthcare subdomain. Sports provide the possibility of physical activity for the city's inhabitants, both outdoors and indoors, and are an opportunity for leisure time (Tjønndal and Nilssen, 2019). The introduction of intelligent ICT solutions for monitoring and controlling professional athletes during sports mega-events improves health services (Kassens-Noor & Fukushige, 2018) and, at the same time, influences the development of fitness management technology that collects real-time data from such activities (Shan and Mai, 2020; Li et al., 2021). Practising sports positively influences physical health, but also, thanks to the possibility of performing activities



in the open air and among greenery, it influences mental health, thus, it is plausible that sport reduces the risk of chronic diseases (Mishra et al., 2021). Another example is to use sport as a means to achieve a healthier lifestyle (Zhang et al., 2021), through investment in sports facilities and initiating the introduction of the healthy cities approach (Bai et al., 2022). Moreover, technological advancement allows for the proposal of an exercise assistant for runners, through an app that scans and maps the terrain and, based on that, recommends the best running route (Li et al., 2021). The role of sport is presented as an essential part of urban life, affecting health and wellbeing. More focus on sport in cities can lead to creating new facilities and sports programs, hence making more healthy and active cities.

Sport in the area of the subdomains of welfare and social inclusion, and entertainment is not particularly referenced much in the literature with regard to smart cities. However, the role of sport in these subdomains is presented as an influential factor in urban life, improving the integration of the urban community (Rodrigues et al., 2020), providing citizen participation (Koens et al., 2019), as well as ensuring information on sporting events for residents and tourists (Kumar et al., 2020; Molinillo et al., 2019; Rocznik et al., 2017). The impact of sport in these subdomains is presented as a side topic rather than as a significant area of interest for scholars.

## Transport and mobility domain

In this domain, sport corresponds to an info mobility subdomain, where ICT solutions support the public transportation system at the time of the sports events, including city traffic information (W. Wang, 2020), and the recommendation of routes (White, 2016), and also improves city transport network management (Kamiński et al., 2020). Mega-sports events accelerate the development of transportation technologies due to the need to provide an extremely efficient communication infrastructure that is capable of transporting tens of thousands of fans and tourists daily (Kassens-Noor & Fukushima, 2018). More efficient mobility and superior crowd management during sporting events can be achieved by providing useful information in real-time, for example, directions to bus stops or train stations to be projected on street curbs and pavements (Molyneaux et al., 2021). In the domain of transport and mobility, sport is presented in the literature mainly as a factor influencing the development of ICT and affecting the management of urban transportation systems. Researchers indicate that mega-sports events generate crowds of people, whose movement should be adequately controlled and managed to reduce traffic jams and prevent city chaos.



## Buildings domain

The subdomain of facility management is an area where sport plays an important role. Primarily, because sports facilities must meet the same construction, environmental and technological conditions as other facilities developed in cities. Smart solutions for the construction of intelligent and manageable buildings are commonly a relevant issue in cities and they correspond to the planning, design and implementation stages. This is in line with sport industry infrastructure, where buildings and facilities are designed and constructed in line with modern technologies and ICT solutions, such as the Internet of Things (T. Song et al., 2021; Stellios et al., 2022), smart grids (J. Song et al., 2014; Elnour et al., 2022), and artificial intelligence. For instance, automatic cleaning robots support the process of managing sports facilities (e.g., football stadiums), and robots use intelligent technologies for a precise and efficient automatic cleaning process (Liu et al., 2020). Similarly, the innovations and smart solutions used in sports stadiums contribute to enriching the spectator experience and providing them with contemporary services (O’Brolcháin et al., 2019). The literature review indicated that sport can be a driver for the development of intelligent buildings and solutions that facilitate building management.

## Natural resources and energy domain

It may not seem obvious that sport effects natural environments, yet sport has been identified in the literature as a factor influencing the domains of public lighting, smart grid, and water management. It is possible to adapt the city lighting management system to the needs of sports games and sports events, for instance, the “virtual sports field”, which allows different types of games to be displayed on the street or pavements (Zandbergen, 2020). Moreover, lighting is an important component of modern sports stadiums, indicated as one of the critical elements of infrastructure. The work by Stellios et al. (2022) emphasised that special attention should be paid when designing and implementing lighting in sports stadiums, as they are vulnerable to cyber-attacks. Moreover, sports can also influence a city’s water management optimisation process. Sports fields and facilities cover a large space of green area in cities; therefore, modern and advanced technologies are used for precise and optimal irrigation systems, saving up to 60% of water (Canales-Ide, Zubelzu, Rodríguez-Sinobas, 2019). In view of the fact that there are hundreds of sports facilities in cities, they are likely to have an explicit impact on the natural environment. Sports facilities consume a significant amount of energy, which affects the urban energy supply, and are a generator of pollution and CO<sub>2</sub> emissions. The implementation and



integration of intelligent energy monitoring and management systems installed at sports facilities (e.g., smart grid) can contribute to a more sustainable and effective approach to environmental protection (Elnour et al., 2022). Given these aspects, sport has been identified in the literature as a factor contributing to the subdomains of public lighting, smart grid, and water management through enhancing the development of environmental protection solutions and urban innovations, thus aiming to establish an agenda of sustainable and resilient cities.

## Sport from the perspective of the Smart City

The following discussion focuses on the analysis and evaluation of the significance of the role of sport in tomorrow's multidimensional cities. However, despite the explicit link between sport and city development in the reviewed literature, the aspect of smart cities is rather rarely addressed as a core research topic, being most often discussed as a background topic. The literature review results indicate that sport: 1) and smart city connections are often hidden in the literature, and need to be sought out – scholars do not explicitly emphasise the direct role of sport in the context of the smart city, the most popular view being to present sport from the perspective of urban development; 2) is widely discussed in the domain of living, and least in government, and economy and people, besides the noticeable significant interest among scholars in the subdomains of public safety, and public space management, where sporting mega-events were an influencing factor; and 3) is a trigger for urban technology development, whereas technology is a tool, not a destination – ICT solutions are increasingly used in the sport business industry, yet technology is a means to achieve the strategic objective: to improve the quality of city life. Given the above, the interest of a city's governance is to recognise the opportunities that arise from the realisation of sport-related projects, which can be an impulse for urban change, social integrity, and technological development. The connection between sport and smart city domains may be a guide for establishing the city's strategic documents. City authorities shall start to consider sport as one of the factors of the smart city. The measurement of the impact of sport on urban evolution should receive attention from city authorities in the context of the urban planning process and complex city management. Sport-related projects and initiatives are an inseparable part of cities, and they cannot be governed in isolation from the sidelines. Therefore, sport should be considered jointly, and in accordance with other city projects and agendas, including smart city strategies.

Furthermore, public policymakers should be attentive to the growing role of sport in strategic plans and agendas. Sport is an important factor contributing to a healthy life and making cities more inclusive, which is indicated in the Sustainable Development Goals (UNOSDP, 2014). Sport promotes a healthy lifestyle, and encourages people to undertake physical activity, which reduces the risk of multiple diseases and has a positive impact on child development (McEachan et al., 2018). Urban areas within cities should be planned and designed that will provide a more healthy city approach (WHO, 2020) through accessibility to sports facilities, including open air facilities, which can be especially relevant in the era of the COVID-19 pandemic. Hence, more sports in the city will improve the general health of the people, create new ways of spending active time and create possibilities to challenge societal issues in vulnerable neighbourhoods (Government of Netherlands, 2022). Considering the holistic impact of sport on the smartness of the cities, attention should also be paid to the comprehensive use of existing sports facilities and also for those that are planned. The COVID-19 pandemic has turned our lives around and forced governments to look for different types of solutions to save lives and to prevent the spread of the virus. Sports facilities around the world have been significantly involved in the pandemic challenge and have become, in a way, healthcare facilities. For instance, in the autumn of 2020, the National Stadium in Warsaw, Poland, was transformed into a temporary hospital, and within a few months, it was fully equipped and prepared to provide medical treatment to patients suffering from COVID-19 (CSK, 2020). City authorities should look at sport from different angles, using a more holistic approach, trying to leverage sport in a smart way for multi-domain city development.

## Conclusion

This paper identifies and investigates the role of sport in the smart city concept, as a relevant factor for ensuring city development. In the light of the study, the links between sport and cities are clearly noticeable and this relationship can act as a stimulation for initiating new reflections on comprehensive urban management and technological development that enhance innovation. Sports projects, due to their multidimensionality and wide impact on cities, should be one of the building blocks of the smart city initiative. The result of the literature review reveals the influence of sport on cities and its relevant role in the evolution of the smart city. For this reason, there should be a place for sport in the current and forthcoming smart city discourse and sport should be considered as a subsequent separate subdomain of the smart city.

Cities are required to monitor and evaluate the influence of a variety of sports projects in the context of city operations. Therefore, the governance of city sports projects should consider the incorporation of a holistic approach to management, including the presence of sport in city agendas and development strategies. Further investigation in this direction will support the city's governance, particularly in the decision-making process related to the preparation of urban policies and strategies for smart and sustainable urban development, the aims of which are to improve livability and the quality of city life through sport. Thereby, the paper indicates potential areas of interest from the perspective of sport governance and urban management, and offers an opportunity to further explore a possible gap in the context of the role of sport in smart cities.

The research has limitations to which attention should be drawn. Due to the adopted literature review methodology, presented in the section on methodology, the specific approach direction was obtained, which selected inclusion criteria in view of the literature review procedure process. Using a different literature review methodology or choosing different boundary conditions could result in different findings in the context of sport in a smart city. However, it should be noted that the selected databases come from the most prominent and recognised publishers. The chance of avoiding influential papers exists but is rather low.

## Author Contributions

NP identified the references, performed the research, analysed and interpreted the results, and wrote the manuscript. AO planned the study, evaluated the research findings, and supervised the work. All authors discussed the results and contributed to the final manuscript.

## Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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