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Spatial analyses of crime in a host city: contextualizing current crime for future mega-event delivery in Los Angeles

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ABSTRACT

Winning the bid to host the Olympic Games and other large events offers host cities opportunities such as exposure, status, and tourism. However, hosting the events also include negative externalities impacting the local community and businesses. We examine the spatial distribution of crime in Los Angeles to expand upon the existing literature and corresponding theories that examine the relationship between crime and event sport tourism, as well as offer an applicable analysis of crime that can be used by future mega-event host cities to identify spaces potentially vulnerable to criminal activity. Spatial analysis of the incidents' data was based on GIS embedded machine-learning analyses and a hot-spot statistical examination. Both analyses demonstrated a concentration of criminal incidents across different types in downtown Los Angeles and clusters of crimes in other areas of the city, some of which are near other venues that will be used in future mega-event delivery.

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Introduction

Winning the bid to host the Olympic Games and other large events offers host cities and the countries in which they are located opportunities such as exposure, status, tourism, and potential increases in the number of exports, particularly in the era of growing global competition (Alexandris & Kaplanidou, 2014; Rojas-Méndez, Davies, Jamsawang, Duque, & Pipoli, 2019; Shoval, 2002; Song, 2010). However, winning the bid often results in the 'winner's curse', which is a paradox that involves such challenges as insufficient revenues to cover hosting expenses, negative impacts on the local community and businesses nearby the venues involved, as well as other various negative externalities (Baade & Matheson, 2016; Duignan, Pappalepore, & Everett, 2019; Lee & Taylor, 2005; Müller, 2017; Nunkoo, Ribeiro, Sunnassee, & Gursoy, 2018).

Among these negative externalities, which are the unintended consequences that are felt by other parties, is the potential increase in criminal activity related to tourists' presence, which includes violent crimes, such as theft and assault, and other crime types, such as the potential increase in human trafficking (Campaniello, 2013; Paraskevas & Brookes, 2018). Negative externalities are part of the overall relationship between sport, crime, and

criminal activity by players, teams, fans, and the community (Forsdike & Fullagar, 2021; Ge & Humphreys, 2021; Peachey, Schulenkorf, & Spaaij, 2019) and further indicate the relationship between sport tourism and crime (Hritz & Ross, 2010). Of particular concern is that sport venues are also considered to be generators of crime and other negative externalities, though the degree to which they do varies across sport venues and types of sport events (Jakar, Gordon, & He, 2023).

This study takes into consideration the anticipated influx of tourists at large events and the responsibility of the host cities ('guardians') to assure the safety of visitors ('victim's journey') and examines the spatial distribution of crime in Los Angeles ('activity spaces') and how that distribution relates to the sport mega-events that will be held there in the coming years (Paraskevas & Brookes, 2018). Los Angeles will host the 2026 FIFA World Cup and the 2028 Summer Olympic Games. City officials must address the potential increase in crime that results from each of these events in addition to existing crime rates and the corresponding geographical distribution of such criminal incidents so as to plan appropriately for effective event delivery.

For that purpose, we examine the spatial distribution of crime in Los Angeles to expand upon the existing literature and corresponding theories that examine the relationship between crime and event sport tourism, as well as offer an applicable analysis of crime that can be used by future mega-event host cities to identify spaces potentially vulnerable to criminal activity. Our analytical approach derives from hot spot policing theory, whereupon policing is based on the identification and intervention in areas that have larger concentrations of crime (Braga, Papachristos, & Hureau, 2014). In the case of Los Angeles and this study, current data reveal existing hot spots and their proximity to sport venues, whereas the upcoming events may be associated with future hot spots. While focused on crime patterns, this study also contributes to the existing literature that has sought to address the important relationship between, and analysis of, sport, tourism, and geography (Daniels, 2007; Gibson, 1998; Higham & Hinch, 2006; Wise & Kohe, 2020).

Regardless as to whether the FIFA World Cup and/or the Olympics increase crime rates, particularly those where tourists are victimized, Los Angeles is a large city with existing crime that needs to be addressed. Therefore, we do not focus on the relationship between sporting events and resultant increases or decreases in crime. Instead, we focus on the theoretical contextualization of the spatial distribution of existing crime in relation to the venues, some of which are already built, and sites to be used for upcoming sport mega-event delivery (Giulianotti & Klauser, 2010). This study has two research questions. The first question is to what extent are some areas within Los Angeles susceptible to crime? The second question is how are these areas related to those venues that have been selected to host large sport-related events? The answers to these questions should demonstrate the degree to which visitors and locals are exposed to criminal activity in a host city, as well as suggest what may be required to secure these venues for the effective delivery of future event sport tourism.

Using Los Angeles' extensive database of over a million crime reports, which includes the geolocation of criminal incidents, we analyze the spatial distribution of crime in the city through the use of Geographical Information System – (hereon 'GIS') based machine-learning cluster analysis and hot spot analysis to identify areas within the city that have higher crime rates generally, as well as certain crime types specifically.

Comparing the clusters and hot spots in relation to where the events will be hosted demonstrates the relevance of hot spot policing theory to securitizing sporting events effectively. Consequently, identifying the potential relationships between the spatial distribution of crime and sport venues indicates the need for sport managers to take hot spots into account when considering the externalities associated with sport events and the venues in which they occur.

In the next section, we outline literature that examines the relationships between tourism, crime, and the securitization of sport events. A description of Los Angeles' spatial distribution of the venues where events will be delivered during the 2026 FIFA World Cup and 2028 Summer Olympics and the securitization of those venues will follow. Then, we describe the methods and the data included in the spatial analyses. After that, we explain the results of the analyses, which are then followed by a discussion of the results from both theoretical and practical perspectives. We conclude with final remarks then offer suggestions for future research.

Literature review

Sporting events and crime

Examinations of sporting events and their relationship to crime have increased in recent years (e.g. Block, 2021; Copus & Laqueur, 2019; Jakar & Gordon, 2022; Masiero, 2022; Menaker, Sheptak, & Barton, 2021). Research involving empirical analyses of spatio-temporal crime patterns in sport typically indicate that criminal activity increases at both the venues and their surrounding areas on days of sport events. This is particularly the case for elite professional team sport in both U.S. (e.g. Billings & Depken, 2011; Kurland & Hill, 2021; Menaker et al., 2021; Pyun, 2019; Pyun & Hall, 2019) and non-U.S. contexts (e.g. Breetzke & Cohn, 2013; Kurland, Johnson, & Tilley, 2014). Scholarship examining the impact of mega-events on crime, though, depend on the scale and measures of the analyses and, as such, have been mixed (e.g. Baumann, Ciavarra, Englehardt, & Matheson, 2012; Chen et al., 2022; Piquero, Piquero, & Riddell, 2021).

Organizers and hosts of sport mega-events need to take into consideration different securitization factors when preparing for the events, including the protection of the athletes involved (Timm, Kamphoff, Galli, & Gonzalez, 2017; Toohey & Taylor, 2008), security at the venues (Hall, Cooper, Marciani, & McGee, 2011), protection of tourists and visitors (Chang & Singh, 1990; Leopkey & Parent, 2009; Ribeiro, Correia, Biscaia, & Bason, 2021), and finally, maintenance of residents' security, which may be affected by the event (Gursoy & Kendall, 2006). Organizers need to attend particularly to the securitization factors because of the increased tourism during the events (Fourie & Santana-Gallego, 2011). Sport venues' location in urban areas is a contributing factor because of the impact its presence has on visitors and local residents, specifically those who live in close proximity to the venues (Giulianotti, 2011).

Ryan (1993) proposed a five-part typology that outlines the relationship between tourism and crime. These five types address the possibility that (1) the tourist is a coincidental victim; (2) tourist attractions are subjected to increased criminal activity, but they are not necessarily the subjects of crime; (3) tourist attractions that are subjected to increased criminal activity where the tourists are the target; (4) criminal activity that is

organized around tourism; and (5) crime and terrorism is directed at tourists. Some of the negative externalities associated with large sporting events are due to the likelihood that these events create spaces prone to each of the five types (Yu, McKinney, Caudill, & Mixon, 2016). Host cities need to take into consideration how hosting events relates to crime and the experiences of tourists who visit these cities (Larsen, Brun, & Øgaard, 2009).

Following Ryan's (1993) tourism and crime typology, the notion that hosting large sport events is associated with four of the types is likely. Important to note is that three of the five types (types 2, 3, and 4) directly involve a spatial component of where tourists are likely to be, and the other two (types 1 and 5) are likely to benefit from the presence of tourists in specific spaces. To that extent, this study takes a spatial approach to examine the relationship between crime and the location of sporting events as a pre-emptive analysis. This is in contrast to most studies of crime and sport venues, which typically involve post-hoc analyses (e.g. Khalilzadeh, 2021; Mares & Blackburn, 2019; Menaker et al., 2021; Pyun & Hall, 2019; Pyun, Humphreys, & Khalil, 2022). From a theoretical perspective, this study takes into consideration crime pattern theory, which emphasizes how spatial interactions are pivotal when addressing where crime occurs (Brantingham & Brantingham, 2013).

Theoretical framework

Crime pattern theory (Brantingham & Brantingham, 2013) has gained prominence in the growing line of research investigating sport events and crime (Kurland & Piza, 2018). It provides constructs that are specific to the spatio-temporal elements of criminal behavior by focusing on the pathways that people use throughout their daily lives, the various spaces, or 'nodes', in which they spend the majority of their time, while also attempting to account for motivated offenders' awareness and attention.

Significant to analyses of sporting events and crime, crime pattern theory emphasizes the importance of venues that have the capacity to attract crime or generate crime. Crime attractors draw intending offenders to them because of known individuals who are suitable targets. In contrast, a much broader population of individuals visit crime generators, which includes potential offenders who may not intend to commit a crime but may nevertheless take advantage of an opportunity to do so should one become available. Criminologists have largely accepted this dichotomy despite the caveat that empirical analyses do not always support this discrete categorization as clearly as the theory that underlies it would suggest (Kurland et al., 2014). Nevertheless, much of the research suggests that sport venues are crime generators (e.g. Chen et al., 2022; Kurland et al., 2014; Vandeviver, Bernasco, & Van Daele, 2019). To this point, scholars (Chen et al., 2022; Kurland et al., 2014) have suggested that studying the impact of elite sport events on crime in all areas of a city is important given that a sport venue's criminogenic effect has not yet been established (Groff, 2011; Payton, Stucky, & Ottensmann, 2015; Ratcliffe, 2012a, 2012b).

That sport venues are largely criminogenic reinforces the need to effectively ascertain the dimensions of criminal activity around them in advance as the city prepares to deliver upcoming mega-events and host tourists. While crime pattern theory focuses on the complexity of criminal behavior that also includes locational attributes, hot spot policing addresses the concentration of criminal activity. As a result, hot spot policing is a spatially predictive measure that is based on existing crime patterns (Braga et al., 2014). In theory,

and at times in practice, policing can focus on specific areas with identified higher crime rates in an effort to reduce overall crime rates rather than spreading their efforts throughout cities (Braga, 2005). Hot spot policing, however, is only successful where crime is not displaced (Braga, 2001). A key component in hot spot policing is the decision-making regarding police patrolling and presence in specific areas (Telep, Mitchell, & Weisburd, 2014). It is one of the crime theories associated with the policing of tourist destinations and venues that are oft affiliated with concentrated criminal activity (Khalilzadeh, 2021). Hot spot policing has, though, been criticized because of both its propensity to only offer short-term solutions and crime reduction (Rosenbaum, 2019), as well as citizens' perceptions that it emphasizes increased police presence in 'mostly disadvantaged minority neighborhoods' (Roh & Robinson, 2009, p. 164).

Previous studies have examined the relationships between sporting events and criminal incidents, noting the increase in crime during large events and the decrease during specific events, such as when competitions occur (Campaniello, 2013; Copus & Laqueur, 2019; Piquero et al., 2021; Yu et al., 2016). The different relationships between crime and sporting events include such phenomena as the potential increase in domestic violence (Card & Dahl, 2011), the increase in police stops near venues on event days and police stops on days without events (Jakar & Gordon, 2022), and the relationship between 'indecent behavior' and sports (Gotberg & Wiersma-Mosley, 2022; Mares & Blackburn, 2019; Ostrowsky, 2018).

Los Angeles venues, events, and tourism

In 2018 and 2019, Los Angeles hosted an estimated 50 million visitors, though that number decreased as a consequence of the COVID-19 pandemic. That the number of tourists visiting the area will increase to pre-pandemic figures, however, is likely. Tourism and hospitality represent a large segment of the area's job market; during 2019 there was an estimated 775,000 employees working in the leisure and hospitality industry in the Los Angeles MSA. In the Los Angeles-Long Beach-Glendale metropolitan division itself there was an approximate 547,000 employees in leisure and hospitality. Of those employees, 46,000 of them were employed in the performing arts and spectator sport industries (St. Louis Federal Reserve – FRED). Evidently, Los Angeles already boasts a substantial tourism industry. Hosting large events may not increase the number of tourists overall due to the potential substitution effects (Funk, Alexandris, & Ping, 2009; Konovalova & Vidishcheva, 2013; Li, Blake, & Cooper, 2011), but the events will likely lead to a larger concentration of visitors in a short period of time than is typically the case.

The increased tourism in the city has coincided with some noteworthy sport-related projects and events that occurred during the 2010s and early 2020s. In 2014, The Southern California Committee for the Olympic Games (SCCOG) officially announced the bid to host the 2024 Olympic Games as one of four US candidate cities (SCCOG, n.d.). On September 13, 2017 the International Olympic Committee officially awarded the 2028 Summer Games to Los Angeles. In 2016, the National Football League's (NFL) St. Louis Rams relocated to Los Angeles, while the NFL's San Diego Chargers also relocated to Los Angeles the following year. Both teams were playing in a temporary stadium until SoFi Stadium opened in 2021. SoFi Stadium was also a pivotal part of the city's Olympic Games bid and was mentioned as a possible site for some of the games in the joint USA-Mexico-

Canada proposal to host the FIFA World Cup in 2026. The World Cup was awarded to the joint hosts in 2018 with Los Angeles as one of the host cities (Los Angeles Sports & Entertainment Commission, n.d.). The other major events involve sport performance and athletes, primarily Major League Baseball's (MLB) Los Angeles Dodgers' participation in the 2018 MLB World Series and triumph in 2020, as well as LeBron James moving to the NBA's Lakers in 2018 and leading the franchise to a Finals championship in 2020.

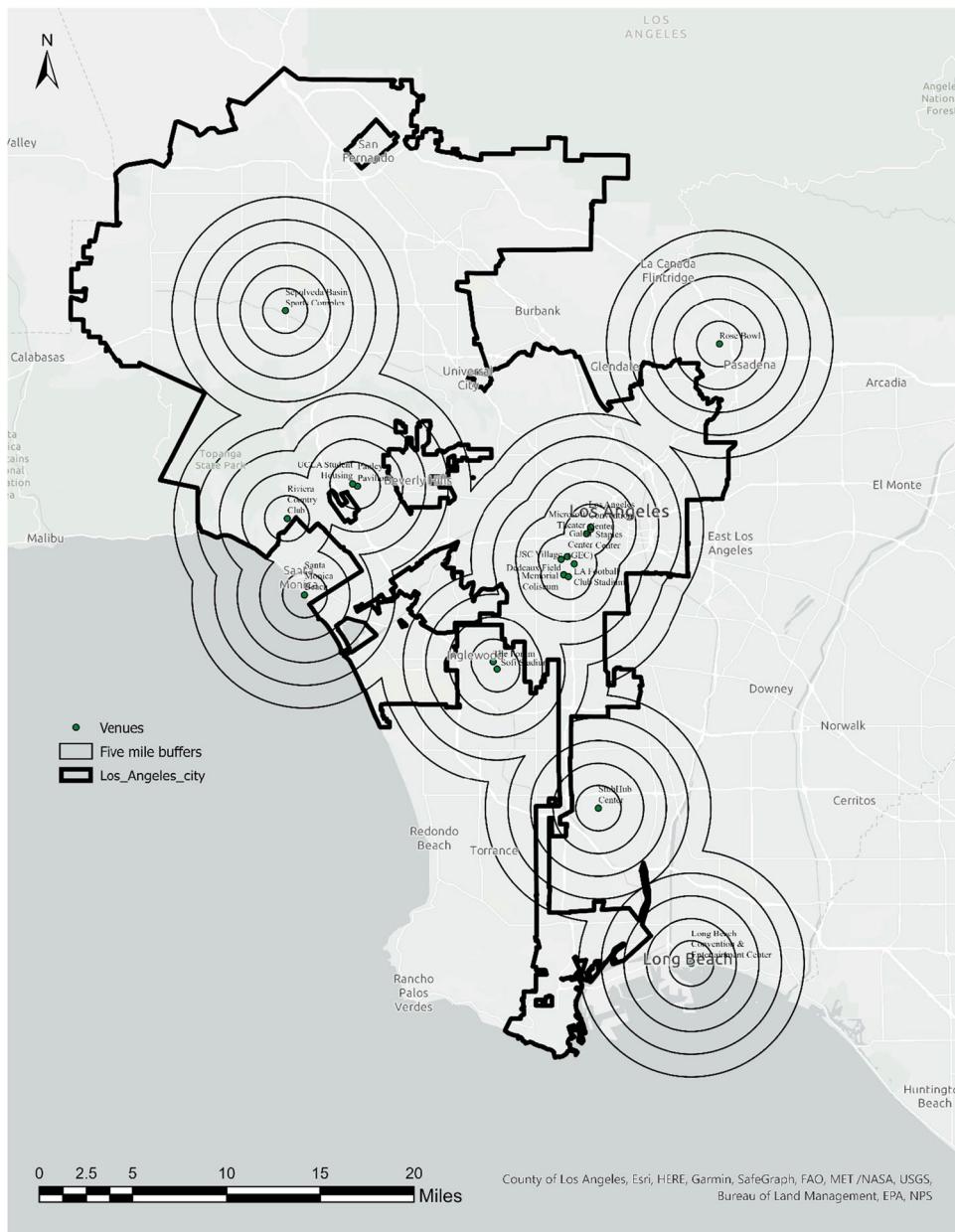


Figure 1. Los Angeles' Olympic and FIFA World Cup venues.

Los Angeles, a metropolitan area with more than 13,000,000 people and a city with close to 4,000,000 people, is home to 11 major league franchises. Major intercollegiate athletic programs, such as UCLA and USC, are also present in Los Angeles. Several of these athletic programs' venues will be used in the Olympics, including some university facilities that will house athletes during the Games (Figure 1). Figure 1 depicts the venues that will be used in the 2028 Summer Olympic Games that are already used regularly for sporting and cultural events, which includes one-to-five-mile radius rings around the venues. These rings will be used in the empirical analysis of sensitive areas and are further discussed in the Methods section.

Methods and data

Analysis

As noted above, there is an apparent relationship between large sporting events, criminal activity, and tourism and both the overall and spatial distribution of criminal activity (Andresen & Tong, 2012; Barker, 2004; Campaniello, 2013; Walters, Shipway, Miles, & Aldrigui, 2017). Considering such relationships, this study exhibits an advanced spatial analysis of reported criminal incidents in Los Angeles between 2010 and 2019 using machine-learning tools that, as it appears, have not been used in previous sport management studies but are apparent in studies using advanced spatial analyses of crime (Kumar & Chandrasekar, 2011; Thomson, Espin, & Samuels-Jones, 2020; Wang et al., 2013a; 2013b).

The spatial techniques outlined later in this section were used to identify areas within the city that were prone to overall incidents during the 2010–2019 time frame, as well as specifying the different types of crime involved. Our focus is on the spatial distribution of incidents to identify crime-related clusters nearby sporting venues in Los Angeles. These venues include all of the sites that Los Angeles will use to host its portion of matches during the 2026 FIFA World Cup, as well as the venues that will be used during the 2028 Summer Olympic Games. In the following paragraphs, we briefly describe the data's structure and some limitations concerning the data, followed by an overview of the analytical tools used to analyze the crime data.

Data for Los Angeles' criminal incidents from 2010 to 2019 include a total of 1,885,578 incidents and merits a big data analytical approach given that the dataset satisfies the 'three Vs': it was regularly updated (velocity), is a very large dataset (volume), and has different categories and types of incidents (variety), as well as other characteristics consistent with big data (Kitchin & McArdle, 2016). These traits and spatial characteristics of the data lend themselves more specifically to the analysis of the intersection between big data and human geography (Kitchin, 2013). Important to note, therefore, is that the data are essentially exhaustive as they include the entire population. We address this cautiously, though, given that the data consist of reported incidents only and that many crimes, such as domestic violence, are often not reported to the police. This failure to capture all criminal instances that have occurred in Los Angeles may have some implications on the spatial distribution of these incidents and is one of the study's limitations. Another limitation is that data are continuously updated; the analysis is not necessarily predictive of the spatial distribution of future crime. This limitation is

contrasted, however, by the methods used in this study that can be updated regularly and continuously reexamined.

Spatial analysis of the incidents' data was based on two different ESRI (Environmental Systems Research Institute) GIS, embedded, machine-learning analyses and a statistical examination based on hot spot inquiry. Recently, some scholars who have investigated the relationship between sport venues, event delivery, and crime have advocated for the value of GIS-based analyses given the capacity of GIS to locate data within very small geographic areas to examine changes relative to periods of time before, during, and after events (Jakar & Gordon, 2022, 2024). In accordance with the sport-specific use of this technology, density-based clustering was used in this study to identify clusters within the data, as opposed to intuitive visual clustering, and where the clusters are relative to the sport venues. Incidents were mapped using the longitude and latitude included in the incident report database. Incident data were projected using their coordinates and then separated into three subcategories in addition to the collective dataset: (i) violent incidents, which include incidents that were either violent or potentially violent; (ii) sexual assault incidents, and (iii) human trafficking and prostitution. We also examine the data for all the years combined and separately for only 2019. We include the data for 2019 as a proxy for annual data to compare incidents in a specific year as opposed to the aggregated dataset. The spatial analysis was then used to identify clusters within five, one-mile-long rings around each of the venues examined in this study. We opted to use 2019 data and not more recent data because of the COVID-19 pandemic that substantially altered tourist activity, and overall activity, in 2020, which included hosting several sport events without fans.

Two, machine-learning, density-based clustering techniques were used in this analysis to identify individual incident clusters within the data. These techniques have been previously used to identify and predict incident clusters such as crime and car crashes (Anderson, 2009; Kim, Joshi, Kalsi, & Taheri, 2018). Both techniques identify clusters and outliers based on a minimal number of incidents in each cluster using a K-nearest-neighbor and the DBSCAN (Density-Based Spatial Clustering of Applications with Noise) that uses a defined distance clustering algorithm and HDBSCAN that calculates a self-adjusting distance. K-nearest-neighbor is largely based on defining the number of clusters and the algorithm identifying the clusters by dividing N observations into clusters continuously based on the number of observations (N) until all possible clusters have been identified and optimally predicted (Likas, Vlassis, & Verbeek, 2003). DBSCAN discovers clusters with arbitrary shapes and identifies noise that does not necessarily fit into a cluster of points or, in this case, incidents (Ester, Kriegel, Sander, & Xu, 1996; Sander, Ester, Kriegel, & Xu, 1998).

The second method used to identify clusters was based on a hot spot, embedded analysis in ArcGIS. Getis-Ord Gi^* statistic is calculated to test for data randomness and is based on the summation of incidents within units covering the entire city as opposed to the cluster analyses using each individual incident (Getis & Ord, 2010). Our analysis was conducted on two main datasets that were then divided into four groups, which included all the incidents (All), sexual assault incidents (SA), human trafficking incidents (HT), and violent incidents (VI). Hot spots were identified using the entire dataset and then separately for each year to identify the existence of consistent patterns over time. The analysis of hot spots is based on a z-score (Gi^*) as follows:

$$G_i^* = \frac{\sum_{j=1}^n w_{ij}x_j - \bar{X} \sum_{j=1}^n w_{ij}}{S \sqrt{\left[n \sum_{j=1}^n w_{ij}^2 - \left(\sum_{j=1}^n w_{ij} \right)^2 \right] / (n-1)}} \text{ where: (1)}$$

$$S = \sqrt{\frac{\sum_{j=1}^n x_j^2}{n} - (\bar{X})^2} \quad (2)$$

$$S = \sqrt{\frac{\sum_{j=1}^n x_j^2}{n} - (\bar{X})^2} \quad (3)$$

Where x_j is the number of incidents in each unit (ranging from 6 incidents in a cell to 18,274 when counting the incidents in the entire period included in the analysis), w_{ij} is the spatial weight between cell i and cell j , n is equal to the total number of features (cells), which in this study included 997 cells (ESRI, 2022; Getis & Ord, 2010).

Data

Our spatial analysis of crimes in Los Angeles between 2010 and 2019 was based on the publicly available crime data provided by the Los Angeles Police Department. More recent data is available but given the likely anomalies in 2020 as a consequence of the COVID-19 pandemic, we do not include post-2019 data.

Using the 1,885,578 records in the dataset, we categorized the incidents displayed in Figure 2. In Figure 2 the overall distribution of instances contains overlapping points,

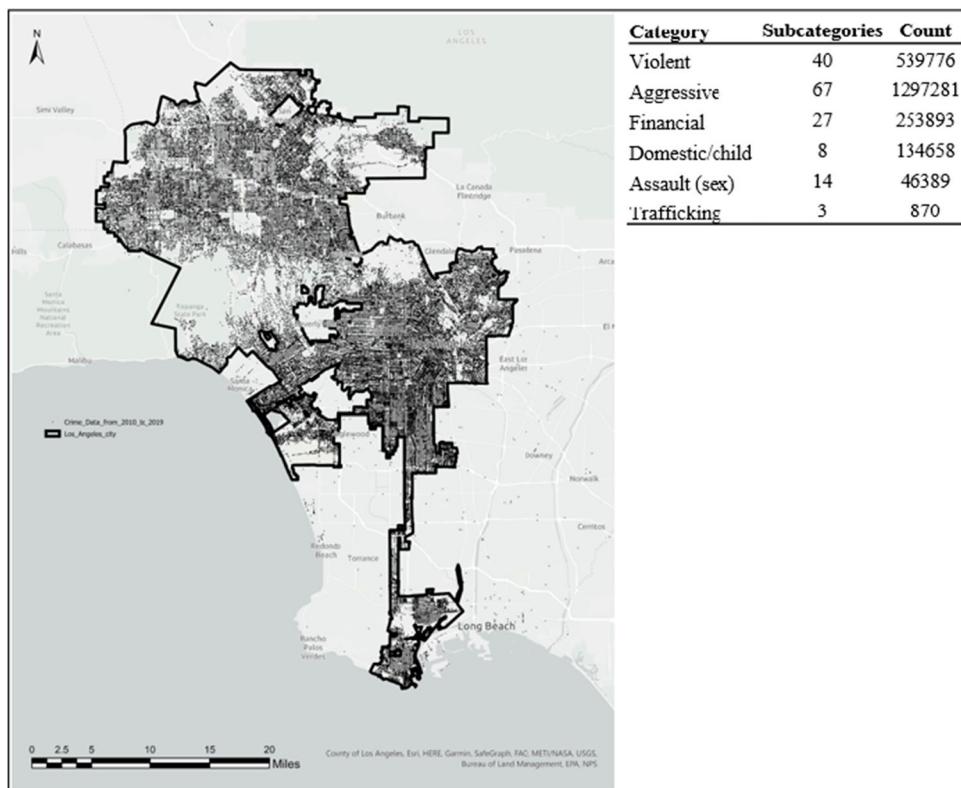


Figure 2. Overall distribution of reported crimes 2010–2019.

which emphasizes the importance of robust spatial analyses as opposed to relying solely on visualization. Counts of crime groups in [Figure 2](#) include duplicates between the categories, hence the sum would be greater than the actual number of incidents. The overall spatial analysis, though, is based both on the total count and separately for each of the categories.

Results

Our results from the different analyses depict the existence of clusters nearby venues that will be used to deliver events during the 2026 FIFA World Cup and 2028 Summer Olympic Games in Los Angeles. Because of the substantial number of tests, we do not include all the results in this section in map formats but an examination of all the maps depicts similar results. We include a summary table at the end of this section for all the spatial tests conducted. The following paragraphs present and describe the results we include in this paper in relation to the sporting events and the overall distribution of crimes using the four categories we include in the analysis. The order of results is the hot spot analysis followed by the two types of cluster analyses.

In the hot spot analyses, which are based on identifying statistically significant differences between spatial units that, in this case, are the census tracts, the test identifies three types of hot spots: (i) those that are statistically significant and associated with a high volume of crimes (i.e. 'hot spots'), (ii) tracts that have no statistical significance, (iii) and tracts that are identified as being associated with a low volume of crime (i.e. 'cold spots'). Examining the distribution of crimes throughout the entire 10-year period ([Figure 3](#)) reveals a clear cluster of hot spots near the downtown area in each of the four categories; whereas the overall volume of crime and violent crimes encapsulate the entire downtown area, the sexual assault-related crimes are not similarly widespread as those crimes related to human trafficking. All four maps in [Figure 4](#), though, clearly indicate hot spot clusters at the 99%, 95%, and 90% percent confidence nearby sport venues located downtown, as well as within two miles of the new stadium, which is located southwest of downtown. The venues located north of downtown appear to be, according to the hot spot analysis, in areas that are cold spots and are therefore arguably less sensitive than the other venues.

The main difference between the distribution of hot spots in the maps, which show all the recorded crimes and those only in 2019 ([Figure 4](#)), is that there are no real hot spots in 2019 outside of the downtown area other than one small area when accounting for all reported crimes. Therefore, according to the hot spot analysis, there may be a shift in the distribution of crimes throughout the city with some areas experiencing an increase.

Cluster analyses of the data using the self-adjusting, machine-learning algorithms reveal that, in the case of all crimes in 2019, there is an apparent cluster once again near downtown and another north of the city in the San Fernando Valley ([Figure 5 – top left](#)). Unlike the hot spot analysis, the clusters are not designed to identify areas of low and high volume but rather focus on general identification of clusters; they distinguish between clusters and do not signify change in volume. [Figure 6](#) indicates that for all crimes in 2019 there are two apparent clusters in the downtown area and a cluster north of downtown. In the case of only violent crimes, three clusters are distributed, including one in the south that is located further away from the venues. Therefore,

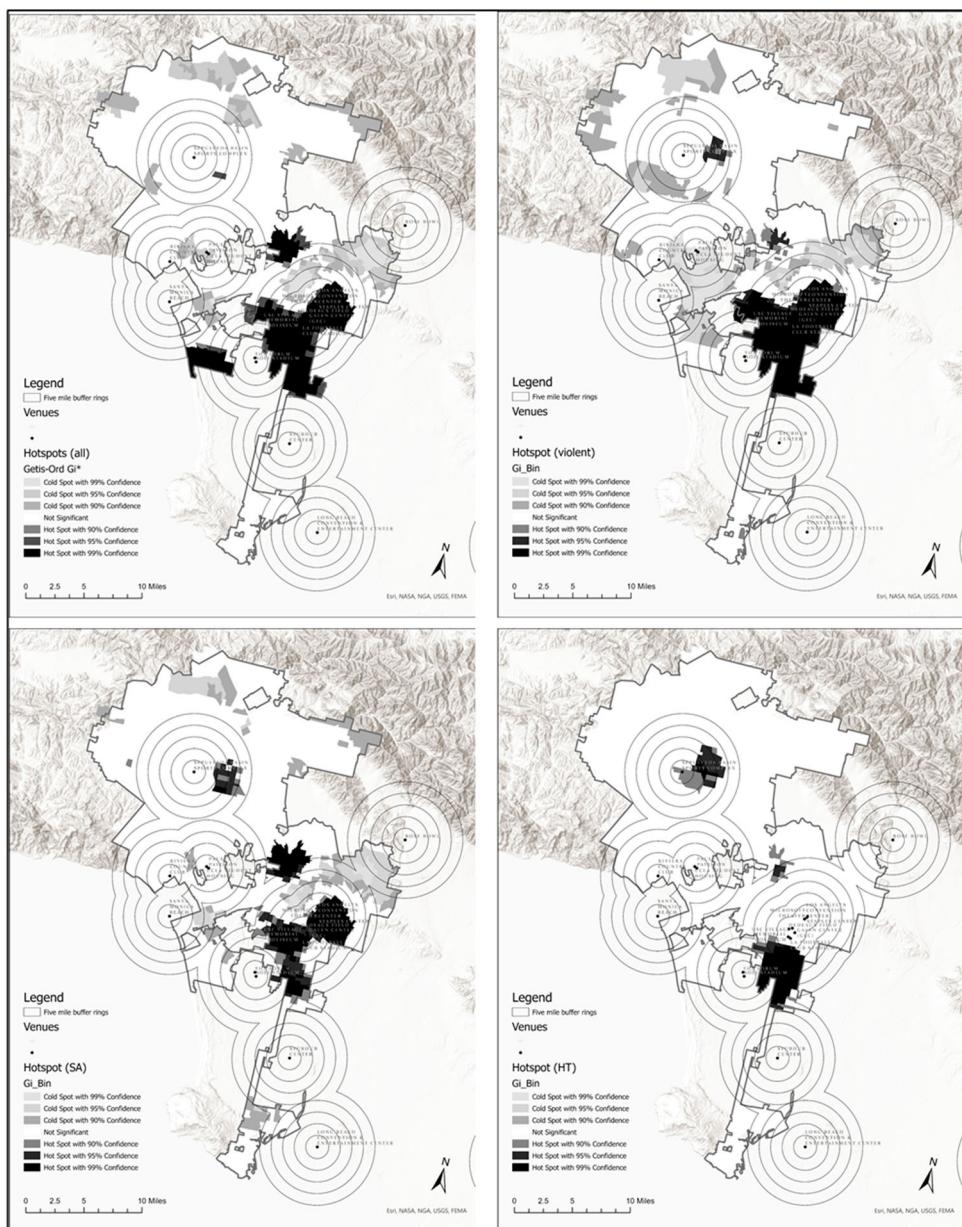


Figure 3. Hot spot analysis of the four categories.

violent crimes within this cluster should not directly affect visitors based on the current patterns given their distance from sport venues. The machine-learning algorithm did not identify any clear clusters of sexual assault throughout the city. Clusters of human trafficking-related data do appear to be present, though, which may be a result of the lower volume of reported incidents. In this study, we only include maps from the self-adjusting, machine-learning algorithmic analysis. Nevertheless, the presence of clusters near the downtown venues are still apparent in the pre-defined algorithms.

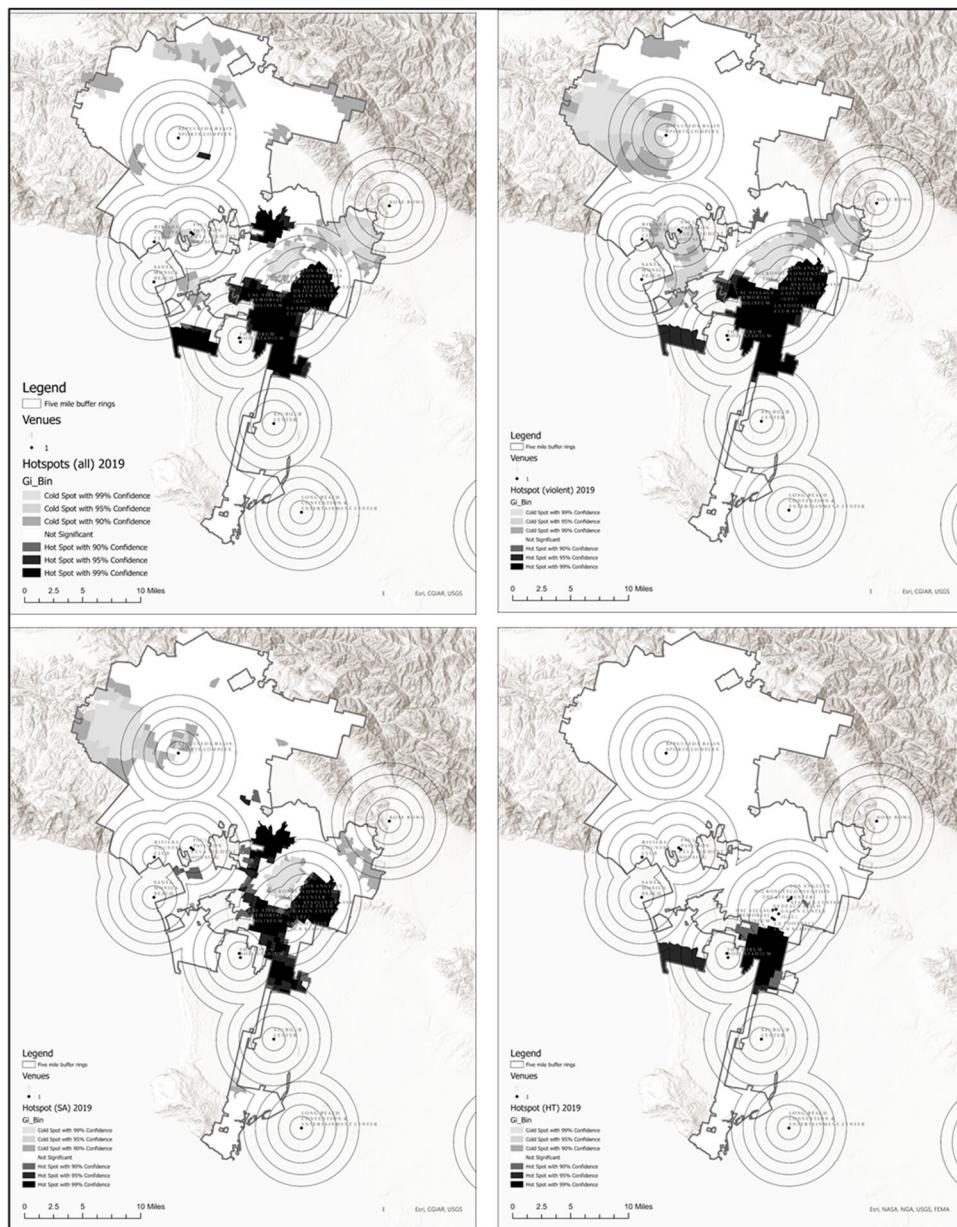


Figure 4. Hot spot analysis for the four categories (2019).

While the maps provide a clear visualization of the data and spatial distribution analyses used in this study, they were primarily used to identify venues that are located nearby areas that could be more 'sensitive' and consequently require additional attention when prioritizing the securitization of visitors and contest participants. There is an apparent clustering of incidents in the city's downtown area on all the maps, which is not surprising. Some figures do indicate, though, that the clustering may extend beyond the downtown area and that other clusters exist in other parts of the city, as well. There

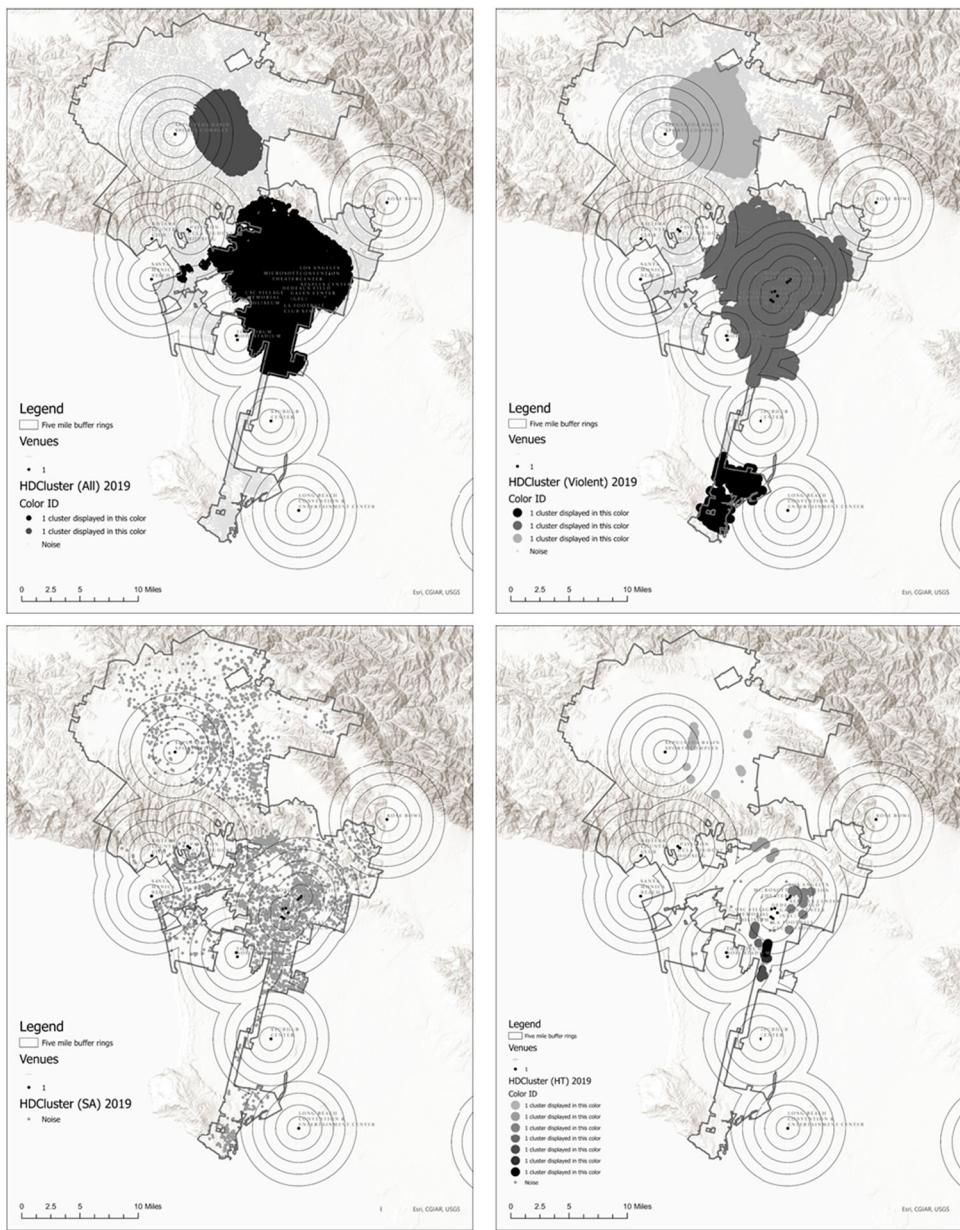


Figure 5. HDCluster 2019.

are also instances where the clusters are near downtown but do not cover the entirety of the downtown area like others do. Lastly, it is important to point out is that the figures and analysis are at a micro level. Consequently, creating clusters on smaller spatial units can reveal different clustering patterns closer to the venues as opposed to an overall cluster analysis of the entire city. Figure 7 is a summary of the hot spot and cluster analyses for crimes overall and 2019 observations relative to the five-mile rings surrounding each of the venues.

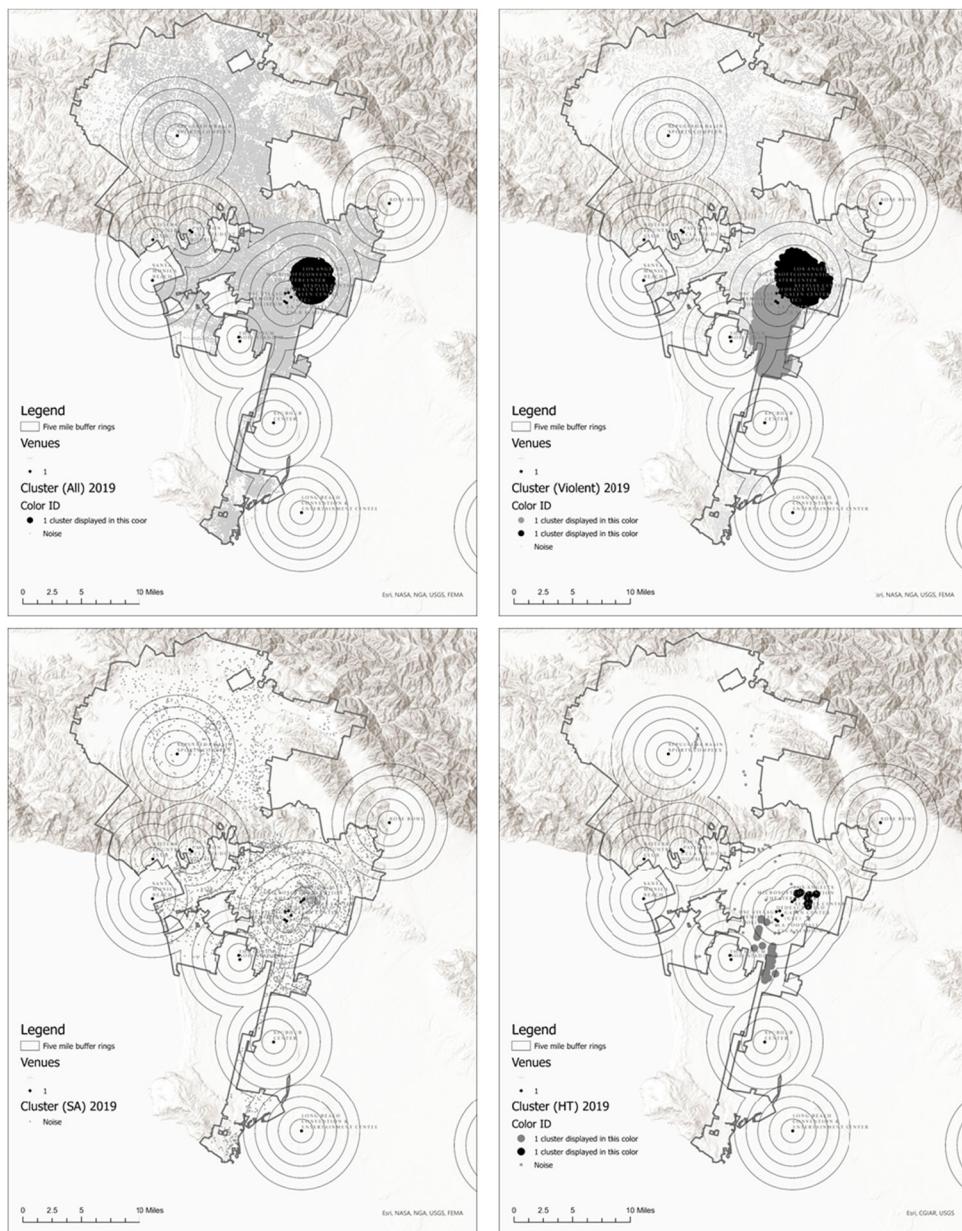


Figure 6. Cluster 2019.

There are some venues that are located outside Los Angeles' city borders. The summary figure (Figure 7) only refers to data from Los Angeles. Consequently, the few venues that are located outside the city boundaries such as SoFi Stadium, may have a significant level of crime whose data are not included in this specific study. Cluster analyses for all the years using clusters of at least 10,000 incidents essentially depict that the entire city is itself a big cluster of incidents. Data solely for 2019 provides a likelier insight as to where clusters exist relative to the venues that will be used for the aforementioned

Method (All) ¹	Hot spot					Cluster					HDCluster ¹					Hot spot (2019)					Cluster (2019)					HDCluster (2019)						
Miles	Miles					Miles					Miles					Miles					Miles					Miles						
Venues	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		
Dedeaux Field																																
Galen Center (GEC)																																
LA Football Club Stadium																																
Long Beach Convention Center	NA	NA				N	N	A			NA	NA				N	N	A			N	N	A			N	N	A				
Los Angeles Convention Center																																
Memorial Coliseum																																
Microsoft Theater																																
Pauley Pavilion																																
Riviera Country Club																																
Rose Bowl	NA					NA					NA					NA					NA					NA						
Santa Monica Beach							NA														NA											
Sepulveda Basin Sports Complex								NA													NA											
SofFi Stadium	NA					NA					NA					NA					NA					NA						
Staples Center																																
StubHub Center	NA					NA					NA					NA					NA					NA						
The Forum																																
UCLA Student Housing																																
USC Village																																

¹HDCluster = self-adjusting spatial cluster

Figure 7. Summary table of spatial analyses.

events. That the venues located in the city's downtown are surrounded by a higher volume of incidents in all the analyses that were conducted, though, is clear from the maps and the summary figure (Figure 7). Figure 7 does not present a fully accurate depiction of the distribution of incidents and clusters as it only indicates if a cluster or hot spot was identified somewhere within the buffer. Maps such as those included in this study provide a more distinct overview of where a higher volume of reported incidents relative to the venues are present.

Discussion

While there are some tangible and psycho-social benefits to hosting mega-events (Hiller & Wanner, 2018), the revenues from these events rarely justify the financial costs (Mills & Rosentraub, 2013). In addition to these costs, host cities incur negative externalities, including the increase and change in crime volume and geographical distribution that affect visitors as well as locals (Andresen & Tong, 2012; Decker, Varano, & Greene, 2007). We first discuss this study relative to the theoretical framework and its contribution to the growing research of sport, crime, and tourism. This will be followed by a discussion on the potential methodological contributions of this study to the intersection of sport tourism and crime.

The current study incorporates two theories from crime literature into the analysis of sport and crime-related negative externalities. Firstly, we address how 'activity spaces', which are host venues in this study, impact the 'guardians' who are the hosts and the 'journeys' that visiting tourists take throughout the host cities (Paraskevas & Brookes, 2018) with specific emphasis on those venues involved in mega-event delivery. Secondly, our analytical framework is based on the theory of hot spot policing, which examines how crime is often concentrated (Braga et al., 2014). In the case of sport tourism, hot spots are a concern because they can often be nearby sport venues (Jakar & Gordon, 2022) and are consequently of prime importance to event hosts.

This study further establishes how theories often included in both tourism and crime-oriented research are relevant to sport tourism studies that address the relationships between sport events and those who attend them. Although our focus is on mega-events, several other sport events draw tourists who are either attending or participating in the event, such as international marathons (Huggins, 2013; Papanikos, 2015; Zouni, Markogiannaki, & Georgaki, 2021). The relationship between the cities that host mega-events and the activity spaces where those events are delivered is crucial given the commitment that civic authorities make to protect visitors and locals during such events (George & Swart, 2015). Moreover, as the popular discourse involved in sport event hosting often centers on its purported economic benefits, crime carries with it a price tag of its own, the costs for which local citizens are responsible (Pyun, 2019).

Los Angeles serves as a prime example of the relationship between mega-event delivery and crime by virtue of its population size, geography, number of sport venues, and theoretical and practical implications that emerge therefrom. Hosting the FIFA World Cup and Olympic Games are challenging for a city that already has a high volume of tourism and clear crime concentrations in areas where tourists currently visit. Since previous research suggests that sport venues are crime generators (e.g. Chen et al., 2022; Kurland et al., 2014; Vandeviver et al., 2019), one may assume that the delivery of

future mega-events in a large, metropolitan area, like Los Angeles, will result in further increases in crime near those sport venues where mega-event competition will occur. As such, future potential event hosts, in conjunction with local law enforcement, may find value in using GIS to determine the ideal sites for future sport event delivery and/or to plan for the allocation of resources based on the differences of crime distributions near potential competition sites.

In this study, spatial techniques, including those embedded in GIS machine-learning, were used to identify the spatial geography of crime and how it relates to sites that will host major sporting events. Using the spatial distribution of extensive crime data and two spatial distribution techniques, we identified areas within the city that are prone to more extensive criminal activity. GIS spatial analyses are used in sport-specific scholarship only marginally, despite GIS' applicability to examine spatial trends of interest to a variety of sport-specific sub-disciplines (Jakar & Gordon, 2022; Kim & Kim, 2022; Kim, Kim, Lee, & Inoue, 2023; Seifried, 2011; Wicker, Hallmann, & Breuer, 2013). To that end, there is evidence that GIS can be used to examine both the theoretical and practical implications of sport, including the spatial distribution of externalities and other factors related to participation, fandom, and locationally-based decision making (Jakar & Binesh, 2024).

The current study focuses specifically on the spatial distribution of crime and not the temporal analysis of crime, which could identify the immediate impact of sport events on crime in Los Angeles. There are clear patterns in Los Angeles' geographical distribution of crime, and some of the areas with greater volume are within a short vicinity of the sites that will host competitions, athletes, and visitors during upcoming mega-events. These crime hot spots nearby host venues are challenging from a tourism management perspective given the hosts' responsibility to maintain safe events and create positive experiences for tourists attending them (Walters et al., 2017).

Our analytical methods address the potential of future studies that could use similar methods and tools to analyze both smaller-scaled spatial analyses nearby venues and spatio-temporal analyses examining change during events. This study also addresses the growing interest in studies that utilize big data analyses to examine the relationship between sport, tourism, and externalities, and offers another means to analyze such data (DeSchriver, Webb, Tainsky, & Simion, 2021). Future micro-oriented studies can investigate the relationship between crime and venues that currently host large sport events to analyze the spatio-temporal relationship between crime volume and venues (Jakar & Gordon, 2022).

Since the Olympic Games are spread throughout the city, however, we believe that the macro approach taken in this study reveals a more extensive pattern that can also be related to mobility between the venues and tourist attractions. Addressing the relationship between event sport tourism and crime is crucial in both sport management and tourism management scholarship, as well as the tourist industry itself, given that the relationship directly affects a variety of stakeholder groups involved in mega-event delivery, including event managers, competitors, locals, tourists, and local and national law enforcement organizations (Graham, 2012).

Conclusion

The conclusions and implications from this study are divided into three categories: theoretical contributions and future research related to the geographical distribution of crime

and mega-sport events; sport and tourism industry-related implications concerning the identification of vulnerable areas and how it relates to host cities; and the methodological contributions and recommendations for future research using similar methods in sport tourism studies.

An analysis of crime in Los Angeles, that will host two mega-events in the upcoming years, the 2026 FIFA World Cup and 2028 Summer Olympic Games, was conducted to arrive at an understanding of relevant crime 'hot spots' relative to the sport venues that will be used in the delivery of these mega-events. Both hot spot and cluster analyses demonstrated a concentration of criminal incidents across different types in downtown Los Angeles, with both types of analyses yielding various hot spots and clusters of crimes in other areas of the city, some of which are near other sport venues that will be used in future mega-event delivery. Given that previous research largely suggests that sport venues are crime generators, the results indicate that the city of Los Angeles and its corresponding law enforcement and emergency personnel ought to prepare for the aforementioned future mega-events with the awareness that those venues within crime hot spots and/or clusters may experience an increase in criminal incidents at and around them. Delivering safe events for tourists and locals is dependent upon the identification of existing and potential crime trends.

In addition to the practical implications for host city officials and academic research on sport tourism and crime, this study contributes to the use of advanced big data analytics and advanced machine learning tools in sport-related studies. The use of GIS embedded tools, including hot-spot analysis and machine learning cluster analyses, in the current study indicates the value for sport tourism and other sport-related scholarly disciplines and practitioners alike. GIS is already extensively used in tourism-related studies and other disciplines. Our opinion is that GIS should be further utilized to examine sport tourism-related studies, particularly those analyzing externalities, such as crime, that impact sport tourists.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Conflicts of interest

We have no conflicts of interest to disclose.

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