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Urban security and crime prevention in smart cities: a quantitative systematic review

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Abstract

The scientific literature on crime prevention in urban contexts is very vast, nevertheless it is still limited in the Smart Cities context. With the aim of assessing how this phenomenon has been studied to date from an evidence-based approach, a quantitative systematic review has been conducted on the basis of gathering information from the most recent scientific literature (2014-2019) on strategies for improving urban safety in smart city scenarios. Specifically, it was systematised according to different variables such as research designs, results of the implementation of measures to improve urban safety, crimes assessed, fields of application of the measures and problems associated with the use of these measures. As a result, most of the studies examined are of a cross-sectional, non-experimental nature. Also, most results are descriptive, and the preventive measures evaluated have positive effects. Similarly, most of the applications are connected with civil, preventive and police settings. Finally, this paper analyses the importance of following up on this emerging line of research.

Keywords: *smart cities, crime prevention, smart policing, urban security, systematic review.*

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1. Introduction

As the population grows in cities and the scarcity of resources increases (Townsend, 2013; Eremia, Toma & Sanduleac, 2017), it is changing the way cities are being managed to be more efficient and, therefore, smarter in terms of the application of new technologies and the use of the available resources (Maestre, 2015; Kummitha, 2019). Such conventional cities are moving towards the so-called "smart cities" (Kummitha, 2019).
It is a concept that began to be used in the 1990s as a result of the development of new technologies in modern city infrastructures, mainly in the United States (Alawadhi et al., 2012). As it is a concept that has been around for a century, there are many definitions of the concept of smart city, as well as being common with some variants such as "intelligent city" or "digital city", as explained by Albino, Berardi and Dangelico (2015). Broadly speaking, a Smart City is defined by the ability to create or adopt solutions to the challenges and opportunities of transforming cities into more productive and liveable places for their citizens (Alawadhi et al., 2012; Vidal-Tejedor, 2015; Mueller, 2017), by taking advantage of new technologies and the hyper-connectivity of the Internet of Things (Zanella & Vangelista, 2014). This definition of the concept, focused on the use of new technologies to improve some aspect, is the one that has been used to carry out the present study.

This use of new technologies can also be used to improve the security of a place. To learn more about this topic, a search of information related to crime prevention in smart cities was proposed. The information found was very scarce and no previous reviews were found either. For this reason, it was considered relevant to carry out a study along these lines, as there are no similar published studies that can provide a vision of what has been done worldwide in security management using systematized technologies.

2. Theoretical framework

Among its different fields, security management in smart cities holds a relevant position due to its features and functionalities (Colado, Gutiérrez, Vives & Valencia, 2014). The smart economy, smart people, smart governance, smart mobility, smart environment and smart living are examples of this (Lombardi et al., 2012; Deloitte, 2015; Khatoun & Zeadalli, 2016). Vidal-Tejedor (2015) provides several examples as the following. Regarding the Smart economy, the security related to the financial field, such as online fraud, can be identified. Smart people can be defined as services to increase the comfort and security of citizens (alarms, security systems, flood prevention, prevention of social isolation of the elderly, among others.). Smart governance refers to the security of public administration and the use of data systems such as open government data (Lodato, French & Clark, 2018). Smart mobility covers the monitoring of traffic flows, the detection of driving offences, information on accidents, the prioritisation of emergency vehicles,

among other examples. Under Smart environmental we may find domotics, which includes, for example, prevention of fire through smoke sensors or prevention of theft using alarms with motion sensors. Finally, Smart living refers to risk assessment in buildings, town planning and urban sensors, among other examples. Smart cities security would consist, in broad terms, in the organization of disorderly urbanizations, in safer cities through the implementation of hyperconnected sensor networks and security systems, the management of accidents, breakdowns or critical situations. through police, medical and logistics coordination of rescue (among other actors) or computer security and protection of large masses of data (Colado, Gutiérrez, Vives & Valencia, 2014).

Within this new scope, the most relevant elements for the management of public safety in smart cities are data and its analysis: history, records, road traffic, beliefs, among other data that may be of interest (Ghosh, Chun, Shafiq & Adam, 2016). The use of statistical data and its controls can be proposed by Truntsevsky, Lukiny, Sumachev & Kopytova (2018) as an example through a mobile app that uses geographic information systems that shows the crime levels in an area on a colour map which can be modified based on historical data. The users with the application are able to know the position and modify their route or transport according to their preferences, and the security authorities are able to adapt their support to the preventive requirements of the moment.

When having a large amount of data, Smart cities must consider, precisely, the protection of that data against possible cyberattacks to the city systems (Rivero, 2017). For this, it is of vital importance the encryption of the data (Khatoun & Zeadally, 2016), the continuous monitoring of the sensors, the performance of audits to the companies that have access to the data, among others. Therefore, governments must opt for a balance between transparency and confidentiality at the level deemed convenient (Macmanus, Caruson & Mcphee, 2013). Citizens must be aware of what data is collected, the manner in which personal data is obtained and the protection given to the personal data to prevent it from a third party or for purposes unrelated to the declared ones (see European General Data Protection Regulation, GDPR).

Likewise, by means of a smartphone you may also have apps that benefit from the data collected in the city and may facilitate the daily routine of the citizen, such as applications that show on a map the most and least lighted streets of a given route (Kumar, 2019). Such an application may be interesting both for citizens, who can change their route on more illuminated streets, and for the city managers, who are able to get an idea of the areas where they have to improve the level of illumination. Furthermore, for emergency management there is, for instance, Bartoli and others' proposal (2013) for a platform that uses ICT and methods of analysis of the whole flow of information that is overlooked in an emergency scenario (ie. first responses, authorities and citizens). Also, they may

propose initiatives to foresee possible terrorist acts by using data from different intelligence sources together with algorithms, as is done in law enforcement agencies (Sormani et al., 2016). Lastly, the use of drones is also becoming more common in rescue operations due to their size, their ease of movement and high-definition cameras carried that make possible to monitor the area in which they are located (Vattapparamban et al., 2016).

In view of the range of choices available in smart cities, it is necessary to know what and how has been done in relation to security in this context previously. This will enable us to summarize relevant information that will help us to understand the state of the art and to identify shortcomings or strengths to be addressed. This study is intended to be a means of gathering previous evidence and setting new benchmarks for the scientific community. This study is organized into the following sections: the objectives of the study; a methodological section which describes the approach used to conduct the quantitative systematic review, including the steps followed and the variables analyzed; a results section, both at qualitative and quantitative terms; a conclusion section and a discussion section.

3. The present study

Considering that nowadays there are very few studies on crime prevention in smart cities and cities are growing very quickly through many technological achievements which can be used to this end, the main objective of this systematic review is to assess how security in smart cities has been studied to date from an evidence-based approach. To find out, several specific objectives are proposed, including the following:

1. To identify the more common features of the studies, including which countries are leading in the publication of research in this field, the disciplines of the journals in which they have been published and which have been the most used study designs;
2. To better understand the efficacy of the measurements taken in the research;
3. To specify the level of interest that has been raised by the implementation of artificial intelligence in related projects;
4. To identify the criminal behaviours most often targeted for prevention and the principal fields of implementation of the used measures;
5. To detect the challenges associated with the performance of the research.

4. Data and methodology

A quantitative systematic review of literature was conducted for this study in line with PRISMA guidelines (Moher, Liberati, Tetzlaff & Altman, 2009) and Pickering & Byrne (2014) to identify peer-reviewed papers on crime prevention strategies in smart cities.

These reviews consist of a scientific literature query using online databases and other sources to find the major published studies of a given topic. With these studies, the expert builds his/her own database with the appropriate information to assess the state of the art of the literature in the fields. Such a method is recommended for reliable, quantifiable and reproducible findings, and for identifying gaps in the field (Pickering & Byrne, 2014).

a. Literature search

Both Scopus and ProQuest were used as databases. They were chosen because of their broad range of papers, the ease of applying filters to the search and their high reputation as scientific search engines. The use of more search platforms was considered but, finally, it was not considered necessary since the two selected search engines already offered a large number of documents to review in the line of investigation.

In the beginning, the keywords to be searched in the databases were carefully chosen based on the topic of study. The keywords that fit the study would be: Intelligent Cities, Crime Prevention, Artificial Intelligence, Criminology, Intelligent Technology, Criminal Intelligence, Security, Intelligent Police, among other examples, but if you search for documents that contain all these keywords, the results are null. So finally, the selected keywords were "crime prevention" OR “security” AND "smart cities" OR "artificial intelligence".

Furthermore, studies were limited to peer-reviewed full text articles (not only abstracts or summary of papers) and published in scientific journals in English (for being the most used language in the scientific field) and Spanish (the native language of the authors). These papers have been limited in time to the last 5 years to restrict the sample to only current papers and look at the most up-to-date scientific material possible. In addition, documents have been filtered according to the kind of contribution, focusing interest on articles or principal articles and not book chapters or conference reviews to all follow a standard of structure and quality. The study selection process was organized in six stages to be incorporated in the quantitative systematic review. Those stages are outlined in the following flowchart (see Figure 1):

1. The identification of the studies on specialised scientific databases through keywords search.

2. A record after the filters are applied: studies identified after applying the filters indicated above.
3. Identification of titles duplicated: filtering by the headings duplicated from both databases and remove them.
4. Abstract screening: scanning the abstracts of the papers to find out whether the paper is about crime prevention in smart cities.
5. Full article review: full text reading to gain in-depth knowledge of the content and ultimately to select it for consideration.
6. Studies included in the quantitative systematic review

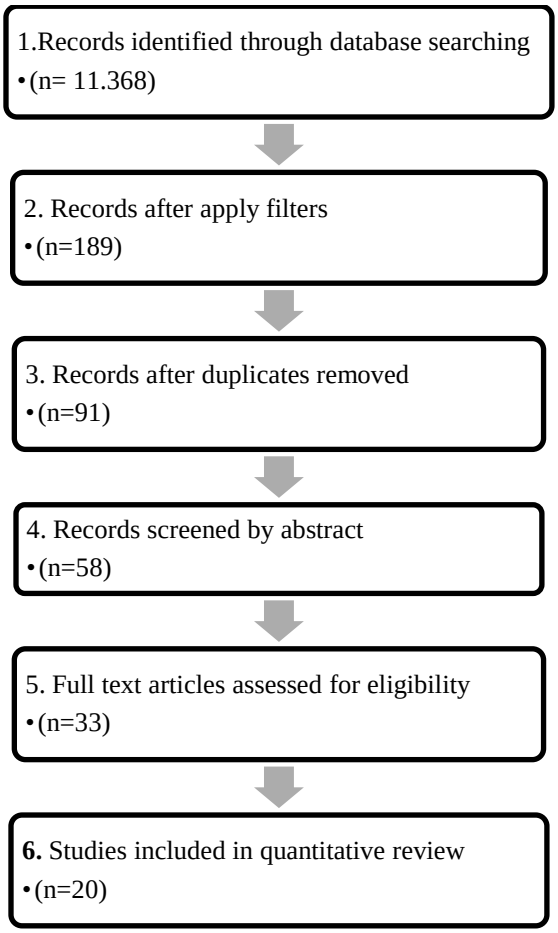

Figure 1. Flow Diagram of the systematic review

Once the 33 articles in step 5 had been read, 13 were rejected as their content did not coincide with the theme of this study. Thus, there are 20 articles included in the review. The articles chosen may not specifically deal with smart cities, but they meet some standards of the definition offered, such as taking advantage of new technologies or developing new systematized methods to improve the security of a place.

b. Selected variables

Variables are organized by categories according to the features to be compared (see Table 1). To respond to the objectives listed above, the following variables have been chosen. Under the first category, the features of the study such as location, year of publication and journal discipline are considered, because they are basic variables for finding out more about the state of academic interest.

The following category is focused on the research design: timing of data collection, approach and research method, to understand whether these studies have been conducted at specific points in time or have continued over time, whether they have available data that can be compared quantitatively at different points in time or have been based on qualitative data, or whether they have conducted entirely experimental studies or have chosen less experimental options.

Other category looks at the results through statistics (descriptive or inferential) and the effects of the obtained result from being aware of the results and identifying which measures have been effective and which have not, as well as finding out whether the results are descriptive or may have been taken further by means of inferential statistics. The security strategy behind each study is also categorized whether they use Artificial Intelligence (tools that thanks to technological development can carry out actions to maximize the performance of a task) or unsystematized strategies (that use analog measurements, without the use of automated processes by default), as well as the typology of the criminal behavior to be prevented and the implementation of the preventive measures given that understanding the issues to be faced is central and will determine the measures to be implemented, as will understanding the use or lack thereof of artificial intelligence systems. There is finally a category on the challenges and limitations faced in the studies through the difficulties that other researchers experienced, it is possible to explore alternatives or improvements without dragging out the previous challenges for future research.

Table 1. Categories and variables of the study.

Category	Variables	Modalities
Study characteristics	Year of publication	-
	Location	Country
	Journal discipline	Law Computing / Technology Security Criminology Sociology / Political science Ethics
Design	Data collection timing	Transversal Longitudinal
	Approach	Quantitative Qualitative Mixed
	Research method	Experimental Quasi-experimental Non-experimental
Results	Statistics scope	Descriptive Inferential Mixed
	Effect of the result obtained	Positive Negative Mixed Null
Security strategy	Measures used	Use Artificial Intelligence Use conventional strategies
Crime prevention	Crime typology	Incivism/vandalism Against collective security Against sexual indemnity Against heritage Homicide Injuries Other crimes
Application	Use	Civil Military Dual
	Objective	Investigation Mitigation Prevention
	Field	Police Judicial Both
Limitations	Difficulties associated	Data management Decision making Effective implementation Other problems

Note. The encoding was designed to synthesize the information of each paper and to ease its review. The number "1" was allocated for those modalities of the variable observed in the article, "0" for the modalities that were not given, and "99" for the modalities that were not specified.

5. Results

a. Study characteristics

Concerning the first objective of the review about the more common features of the studies, findings show that about half of the studies were conducted in Europe (40% of them in the UK) and 35% in Asia, of which 57% came from South Korea. Likewise, most of the papers were published in security journals (25%) or in sociology and political science journals (25%), being followed by technological journals (22%).

As regards the design of the studies, three aspects are of interest. The first is the timing of data collection, with 70% of the data being of a cross-sectional nature. Secondly, that most studies take a qualitative or mixed approach (90%), while only two studies are quantitative. Lastly, the used research method are mainly non-experimental or quasi-experimental studies (95%), with only one study being experimental. These results are probably due, in part, the difficulty of conducting longitudinal studies, even more so on such current issues, as these have been under development for a short time, as well as the difficulty of considering such experimental studies in the context of smart cities.

b. Effectiveness of the measures

The findings obtained by the different papers are mostly descriptive (90%) with positive effects in 60% as compared to a unique study that obtained negative results (5%). Furthermore, up to 30% of the studies obtained both positive and negative effects (i.e. mixed effect). Given these data, the measures implemented in the different studies were found to be effective. The measures that have worked and have shown positive results have been based on the use of artificial intelligence, mainly in relation to data analysis. Video-analysis, movement patterns, spatial-analysis or crime prediction have been techniques used by researchers that have obtained good results. These, in turn, are based on the use of other tools such as camcorders, sensors or Geographic Information Systems (GIS). Another type of measure to reduce crime that obtained good results is the one proposed by Carreño, Ochoa & Fortino (2015), who opted for an anonymous collaborative system via mobile phone where people can report information that they believe is relevant in terms of security. Likewise, other measures that have worked have been those related to street lightning. For example, pedestrian crossings and traffic signs that light up according to traffic density (EASST, 2018) or the lighting of leisure areas according to the influx of people in the area (Cho, Jeong, Choi & Sung, 2019). On the other hand, only one study obtained negative results, referring to organized crime dedicated to the virtual drug market through mobile phones (Berry, 2018).

c. Use of Artificial Intelligence

Use of AI potentially opens up a wide range of avenues for enhancing urban safety in cities. However, only about half of the studies reviewed have used AI in their research, while the other half have used conventional or unsystematized approaches. AI strategies addressed in the studies are largely in terms of data analysis (75%) and the use of multimedia systems (45%), as might be the case of video surveillance cameras.

d. Application of the measures

Most of the crimes studied are social and physical crimes (69%), which include vandalism/incivism, community security and property crimes. Whereas the remaining crimes are more against the person (31%), such as homicide, injuries and/or sexual crimes. Furthermore, the use of its application has been almost entirely civil (95%), for the purpose of preventing crime (74%) or mitigating it (22%), and conducted from police settings (100%)

e. Difficulties associated

Lastly, concerning the last target of this quantitative systematic review, researchers met with challenges during their studies. These challenges are mainly associated with data management (44%) and the effective implementation of their approaches (26%), as well as with decision-making issues (25%). Additionally, several papers identified poor access to data on criminal activities in their countries and the absence of any standards or guidelines that could be followed on crime prevention in smart cities given the scarce information available.

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f. Qualitative analysis of literature

Table 2. Summary of qualitative results of the systematic review

Authors, year and country	Discipline	Design	Results	Security strategy	Crime typology	Area of application	Limitations
Elmaghraby, A. S. Losavio, M. M. (2014, United States)	Security Ethics	Transversal Qualitative Non-experimental	Descriptive Mixed effect	Use IA Data analysis	Not specified	Civil use Crime mitigation Police field	Data management Effective implementation
Byun, J. Y. Nasridinov, A. Park, Y. H. (2014, South Korea)	Computing Technology	Transversal Qualitative Quasi-experimental	Descriptive Positive effect	Use IA Data analysis Multimedia systems	Not specified	Civil use Crime mitigation Police field	Not specified
Carreño, P. Gutierrez, F. J. Ochoa, S. F. Fortino, G. (2015, Chile)	Computing Technology Sociology Political science	Transversal Mixed Quasi-experimental	Descriptive Mixed effect	Use conventional strategies Multimedia systems	Incivism/Vandalism Crimes against heritage and against the socio-economic order	Civil use Crime prevention Police field	Data management
Chiodi, S. I. (2016, Italy)	Criminology	Transversal Qualitative Non-experimental	Descriptive Mixed effects	Use conventional strategies CPTED Citizen participation	Incivism/Vandalism	Civil use Crime prevention Police field	Effective implementation
Arikuma, T. Mochizuki, Y. (2016, Japan)	Other	Longitudinal Qualitative Quasi-experimental	Descriptive Positive effect	Use IA Multimedia systems	Other crimes	Civil use Crime prevention Police field	Data management
Lin, Y. L. Chen, T. Y. Yu, L. C. (2017, Taiwan)	Computing Technology	Transversal Quantitative Quasi-experimental	Inferential Positive effect	Use IA Data analysis	Incivism/Vandalism Crimes against collective security	Civil use Crime prevention Police field	Not specified
Perrot, P. (2017, France)	Security Criminology Sociology Political science	Longitudinal Mixed Quasi-experimental	Descriptive Positive effect	Use IA Data analysis	Crimes against heritage and against the socio-economic order	Civil use Crime prevention Police field	Data management Decision making
Prislan, K. Slak, B. (2018, Slovenia)	Law Security Criminology	Transversal Qualitative Non-experimental	Descriptive Positive effect	Use IA Data analysis Multimedia systems	Not specified	Civil use Crime prevention Crime mitigation Police field	Data management Effective implementation
King, T. Aggarwal, N. Taddeo, M. Floridi, L. (2018, United Kingdom)	Sociology Political science Ethics	Transversal Mixed Non-experimental	Descriptive Positive effect	Use IA Data analysis	Crimes against collective security Crimes against sexual freedom and indemnity Crimes against heritage and against the socio-economic order	Civil use Crime prevention Police field	Data management Decision making Effective implementation
Fiott, D. Lindstrom, G. (2018, European Union)	Security Ethics	Transversal Qualitative Non-experimental	Descriptive Positive effect	Use IA Data analysis Multimedia systems	Crimes against collective security	Dual use Crime mitigation Police field	Data management Decision making
Truntsevsky, Y. V. Lukiny, I. I. Sumachev, A. V. Kopytova, A. V. (2018, Russia)	Computing Technology	Longitudinal Quantitative Non-experimental	Descriptive Null effect	Use IA Data analysis	Incivism/Vandalism Crimes against heritage and against the socio-economic order Crimes of homicide Crimes of injuries	Civil use Crime prevention Police field	Not specified

Authors, year and country	Discipline	Design	Results	Security strategy	Crime typology	Area of application	Limitations
					Other crimes		
Tahir, Z. Malek, J. A. (2018, Malaysia)	Security Sociology Political science	Transversal Mixed Quasi-experimental	Descriptive Positive effect	Use conventional strategies CPTED Multimedia systems	Incivism/Vandalism Crimes against heritage and against the socio-economic order	Civil use Crime prevention Police field	Not specified
Eastern Alliance for Safe and Sustainable Transport (2018, Kyrgyzstan)	Sociology Political science	Transversal Mixed Quasi-experimental	Descriptive Positive effect	Use conventional strategies CPTED Data analysis	Crimes against collective security Crimes of homicide Crimes of injuries	Civil use Crime prevention Police field	Not specified
Schuilenburg, M. Peeters, R. (2018, Netherlands)	Sociology Political science	Longitudinal Mixed Quasi-experimental	Descriptive Positive effect	Use conventional strategies Data analysis Multimedia systems	Incivism/Vandalism Crimes against collective security	Civil use Crime prevention Crime mitigation Police field	Not specified
Berry, M. (2018, United Kingdom)	Sociology Political science	Longitudinal Qualitative Non-experimental	Descriptive Negative effect	Use conventional strategies Data analysis	Crimes against collective security	Civil use Crime prevention Police field	Data management Decision making Effective implementation Other problems
Lee, J. Y. Kim, K. D. Kim, K. (2019, South Korea)	Computing Technology Criminology	Transversal Mixed Non-experimental	Descriptive Positive effect	Use conventional strategies Data analysis Multimedia systems	Incivism/Vandalism Crimes against heritage and against the socio-economic order Crimes of homicide Crimes of injuries	Civil use Crime prevention Police field	Data management
Cho, Y. Jeong, H. Choi, A. Sung, M. (2019, South Korea)	Security	Transversal Mixed Quasi-experimental	Descriptive Mixed effect	Use conventional strategies Multimedia systems	Incivism/Vandalism Crimes against collective security Crimes against sexual freedom and indemnity Crimes against heritage and against the socio-economic order Crimes of homicide Crimes of injuries Other crimes	Civil use Crime prevention Police field	Data management Other problems
Vitunskaite, M. He, Y. Brandstetter, T. Janicke, H. (2019, United Kingdom)	Computing Technology Security	Transversal Qualitative Non-experimental	Descriptive Mixed effect	Use conventional strategies Data analysis	Not specified	Civil use Crime prevention Police field	Data management Decision making Effective implementation Other problems
Catlett, C. Cesario, E. Talia, D. Vinci, E. (2019, United States / Italy)	Computing Technology	Longitudinal Mixed Experimental	Inferential Positive effect	Use IA Data analysis	Crimes against heritage and against the socio-economic order	Civil use Crime prevention Police field	Not specified
Kitchin, R. Dodge, M. (2019, United Kingdom)	Security Criminology Sociology Political science	Transversal Qualitative Non-experimental	Descriptive Mixed effect	Use conventional strategies Data analysis	Incivism/Vandalism Crimes against collective security Crimes against heritage and against the socio-economic order	Civil use Crime prevention Crime mitigation Police field	Data management Effective implementation

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g. Quantitative analysis of literature

Table 3. Summary of quantitative results

Category	Variables	Modalities	N	%
Design	Temporality of data collection	Transversal	14	70
		Longitudinal	6	30
	Approach	Quantitative	2	10
		Qualitative	9	45
		Mixed	9	45
	Research method	Experimental	1	5
		Quasi-experimental	9	45
		Non-experimental	10	50
Results	Statistics scope	Descriptive	18	90
		Inferential	2	10
		Mixed	0	0
	Effect of the result obtained	Positive	12	60
		Negative	1	5
		Mixed	6	30
		Null	1	5
Security strategy	Measures used	Use Artificial Intelligence	10	50
		Use conventional strategies	10	50
Crime prevention	Crime typology	Incivism/vandalism	9	45
		Against collective security	9	45
		Against sexual indemnity	2	10
		Against heritage	9	45
		Homicide	4	20
		Injuries	4	20
		Other crimes	2	10
Application	Use	Civil	19	95
		Military	0	0
		Dual	1	5
	Objective	Investigation	1	5
		Mitigation	5	25
		Prevention	17	85
	Field	Police	20	100
		Judicial	0	0
		Both	0	0
Limitations	Difficulties associated	Data management	12	60
		Decision making	5	25
		Effective implementation	7	35
		Other problems	3	15

Note: the percentages have been calculated in relation to the total number of articles reviewed (n= 20). For this reason, there are variables that can exceed 100% when different modalities occur at the same time as criminal typologies, the objective of its application and the difficulties associated with the research.

6. Discussion and conclusions

Our view at this point is clearly that there is still a lot of work to be done, but some aspects of this review are fairly clear. These include several points. Through the results we see that the most common crimes to be prevented are social or property crimes, such as vandalism or theft. Makes sense because these are crimes usually committed on the street or in public areas (Cho, Jeong, Choi & Sung, 2019; Schuilenburg & Peeters, 2018), so these are areas where the administration in charge of managing public security has more scope to work directly than if these crimes were committed in the private areas (King, Aggarwal, Taddeo & Floridi, 2019). In addition, given that these are crimes in public settings, it facilitates the administration's development of public policies that include the use of technological systems capable of being installed in the same streets or in public spots (Arikuma & Mochizuki, 2016; Byun, Nasridinov & Park, 2014). It opens up a novel way of preventing crime by combining these systems with other public security policies, in accordance with the objectives pursued by public managers.

As noted, most studies obtained positive results with the measures developed. These were in specific spaces and with specific recipients. This is an aspect that fits that the study that obtained negative results is linked to large criminal organizations that operate virtually. Managers of public safety are called upon to opt in favor of the development of new methods of crime prevention by taking advantage of technology and putting the data obtained to correct use (Zanella & Vangelista, 2014). These methods are used both to achieve the objective of preventing crime and to provide know-how and information to help public administrations. That is why there are advantages in smart cities in terms of public security which should be seized upon (Maestre, 2015).

At the same time, the use of artificial intelligence in the approaches is increasing, especially in connection with the management of large-scale data (Ghosh, Chun, Shafiq & Adam, 2016). Artificial intelligence presents benefits that should be taken advantage of, since it facilitates and simplifies processes that can be complex if accomplished manually (Truntsevsky, Lukiny, Sumachev & Kopytova, 2018). The automation allows data to be generated constantly and to obtain results in real time (Bartoli et al., 2013). Consequently, its implementation will be particularly useful when dealing or managing large amounts of data and conducting suitable analyses.

Furthermore, an ethical applicability of artificial intelligence may be challenged by posing some dilemmas depending on the circumstances. As commented above, there are concepts such as transparency, confidentiality, and citizen privacy to be considered and limits to be established that cannot be exceeded (Macmanus, Caruson & Mcphee, 2013; Kitchin & Dodge, 2019). It is also necessary to explain to citizens these concepts and offer the possibility to complain if the measures used violate their rights in some way (Elmaghraby & Losavio, 2014). In summary, the implementation of security systems in smart cities implies a profound ethical reflection in which different stakeholders

participate in the establishment of an appropriate framework for the display of the solutions (Prislan & Slak, 2018).

Considering the above-mentioned issues, it becomes clear that research in this field would have to be followed up and further steps would have to be considered to enhance security in smart cities, by exploiting the potential they offer. For comprehensive and realistic studies on this subject, it is of the utmost importance that managers of public security administrations trust in the figure of the expert in criminology who, in collaboration with a multidisciplinary panel, will be able to offer a sound picture of the behaviors to be prevented, and how to interpret the results generated. In this way, experts in the field could focus on finding new ways to prevent crime in smart cities, develop projects, apply, and evaluate them.

Finally, to be truly useful, all this work developed must be shared with other administrations so that they can adapt the experiences of other places according to their own needs. It would be interesting to have communication between administrations and the creation of a standard of how to proceed or a model to be followed for public managers to apply concrete measures according to the phenomenon to be treated.

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