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Protocol – A systematic review and conceptual framework of key performance indicators for urban public safety smartness for cities in Andalusia, Spain

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Structured Summary

Background: The smart city approach is one of the most widely implemented urban development frameworks to solve the challenges brought about by urbanization. While the smart city approach has been evaluated across several urban dimensions. However, the extent to which the key performance indicators (KPI) assess security and safety dimensions is unknown. This protocol presents a systematic review of current KPIs to fill this gap.

Objectives: This protocol details the work plan for a systematic review of KPI for public safety smartness designed to provide a comprehensive summary and their limitations in the scientific literature. Particularly, the study seeks to critically review the applicability of current public safety KPI to the Andalusian context. Specifically, the systematic review aims to synthesize: (RQ1) What indicators have been designed and used to measure urban public safety smartness; (RQ2) Within which smart city dimensions have the KPI been located; and (RQ3) How are the KPI defined and measured?

Design: This systematic review follows the PRISMA statement. Five databases are searched for thematically relevant studies published in English or in Spanish. Studies included peer-reviewed publications, books, book chapters, conference papers, government and company documents, technical reports and doctoral theses. After the initial search, a pilot study was conducted on a sample of the total number of titles identified through the databases searches. After acceptable inter-rater reliability was reached among the three coders, screening of abstracts was carried out by the first author. Next, full-text screening of documents will determine the final sample. Finally, data will be extracted from the final selection of documents.

Keywords: smart city, smart security, public safety, key performance indicators, KPI

1. Introduction

Over the last two decades, cities have been facing numerous challenges caused by increasing urbanization processes. The global population in urban areas was around 55% in 2018, which is expected to increase to over 68% by 2050 (United Nations, 2019). Developed countries show even higher urban population percentages. For example, the urban population in the United States is 83.1% (Central Intelligence Agency, 2022). Similarly, 81% of Spaniards live in urban areas. In Andalusia, the southernmost Spanish peninsular autonomous communities, 82.5% of the population lives in urban areas, even though 65% of the territory is rural (Instituto de Estadística y Cartografía de Andalucía, 2022). Management of high population densities, mobility, environmental pollution, reduction of green spaces and provision of public services, such as public safety, are among the challenges of urbanization for cities. In response to these problems –and thanks to the possibilities offered by information and communication technologies (ICTs)– many countries are increasingly "smart city" urban development approaches (Caragliu et al., 2011; Fernández-Anez et al., 2018).

There is no unified, coherent, and widely accepted definition of "smart city" in the scientific literature (Ramaprasad et al., 2017; Del-Real et al., 2021). Therefore, this research embraces the definition provided by Anthopoulos (2017, p. 8), who defined the smart city as "the utilization of ICT and innovation by cities (new, existing or districts), as a means to sustain in economic, social and environmental terms and to address several challenges dealing with six (6) dimensions (people, economy, governance, mobility, environment, and living)". This definition implies that the smart city implements technology and innovation to address economic, social and environmental challenges, citing the six dimensions developed by Giffinger et al. (2007) that later inspired several KPI frameworks.

The smart city model has spread worldwide, leading to urban projects developing and implementing technologies to improve transportation, education, energy use, and urban environment sustainability (Hall et al., 2000). However, studies show that these projects do not usually address the dimension of public safety –or smart security– to the same extent as other dimensions, even when it can be considered a basic need for citizens' well-being (see, e.g., Mathes & Edwards, 1978). Recent studies support the idea that crime prevention and public safety affect all other factors of city life – and thus should constitute a substantial part of any smart city planning (e.g., Laufs et al., 2020; Mohamed et al., 2020).

Despite the increasing importance of public safety as an integral part of the smart city framework, studies assessing this dimension are scarce. Instead, literature on smart cities has focused on developing indicators to rank cities according to their "smartness"

level. A preliminary literature review suggests that little to no attention has been put on public safety smartness. When studies include it, they include generalist KPIs such as crime rate. An example of this affirmation can be found in the set of indicators proposed by the CITYkeys project (Bosch et al., 2017). In this HORIZON 2020 project, the authors proposed to measure smart city security based on crime rate, cybersecurity of its systems, and data privacy. However, the previous statement must be proven with more substantial evidence. In this regard, we have not identified a systematic review that provides a comprehensive summary of the current KPIs used to measure public safety smartness and their limitations in the scientific literature. This systematic review aims to fill this gap.

There are several systematic reviews related to the smart city concept published. They address topics such as sustainable energy and health (Hakpyeong Kim et al., 2021; Pacheco Rocha et al., 2019). Among these reviews, there are general frameworks such as the one proposed by Shen et al. (2018); and dimension-specific ones, such as the one offered by Debnath et al. (2014), to measure the level of smartness of city transportation systems or the another by Papastamatiou et al. (2017), to assess the smartness of energy systems. However, there is only one systematic review on the security of the smart city (Laufs et al., 2020), and it does not focus on reviewing indicators but rather on smart security interventions. Therefore, the premise of the present study is the gap existing in the literature regarding the evaluation of public safety smartness. This protocol describes a systematic review proposal aiming to synthesize and critically review the KPIs used to date to measure smart public safety.

2. Objectives

We propose a systematic review of the KPIs used to assess public safety smartness to critically review the applicability of current public safety KPIs to the Andalusian context. Specifically, the following research questions will be addressed:

- RQ₁: What indicators have been designed and used to measure urban public safety smartness?
- RQ₂: Within which smart city dimensions have the KPI been located?
- RQ₃: How are the KPI defined and measured?

3. Methods

3.1 Protocol and registration

We decided to conduct a systematic review instead of using other methodologies (e.g., literature review) because this research method better meets the objectives of

reproducibility, bias minimization, and reliable knowledge synthesis about a specific topic. Systematic reviews are ideally suited to compile and synthesize the available evidence on a subject and adequately answer the research questions (Salvador-Oliván et al., 2018). This systematic review follows the guidelines established by the PRISMA 2020 statement (Preferred Reporting Items for Systematic Reviews and Meta-analysis) to achieve adequate replicability, reliability and transparency standards.

3.2 Eligibility Criteria

To be included in the systematic review, searched documents must fit into the following criteria:

- The full text is open access, available through institutional access, or provided by researchers who were contacted for this purpose;
- It is written in English or in Spanish;
- It is a peer-reviewed publication, a book, a book chapter, a conference paper, a government or company document, a technical report, or a doctoral thesis;
- It is not a correction, erratum or retracted article;
- It proposes or uses at least one KPI for assessing public safety smartness;
- It answers at least one of the research questions.

3.3 Information sources

In order to identify relevant documents which could answer our research questions while minimizing possible biases in the conclusions (Counsell, 1997), an exhaustive search is carried out in multiple databases that are relevant to our field of study and suitable for systematic reviews (Gusenbauer & Haddaway, 2020):

- Dialnet
- EBSCO (Criminal Justice Abstracts)
- IEEE Xplore
- Scopus
- Web of Science

3.4 Search process

Exhaustive searches were carried out in the abovementioned databases, previously selected for their suitability to the study objectives. These databases were obtained through institutional access provided by the University of Cadiz (Spain). This phase of the systematic review was completed following three steps. First, we constructed search terms by identifying the four primary keywords of our study – i.e., "smart", "city",

"indicator", and "performance". At first, we considered choosing more specific words for our object of study, such as "safety" and "security", among others. However, after a few searches in the databases, we decided to use more general terms broadly related to smart cities. We made this decision because some documents that include public safety indicators may not refer to it in the title or in the abstract. Therefore, to avoid missing a large sample of records due to the concept of "public safety/security" not being included in the title and abstract, we decided to open up the first search. Thus, the final decision to include a document in the systematic review was postponed until the full-text screening phase. Secondly, we defined our query by finding synonyms for these keywords and using Boolean operators:

- Smart: smart OR intelligen*
- City: cit* OR urban*
- Indicators: indicator*
- Performance: performance OR evaluation

Finally, we verified these search terms in the selected databases to obtain the best possible string of words for the study objectives. Table 1 shows the queries used in the five databases and our results.

Table 1. Search terms within each database.ⁱ

Database	Keywords	Results
Web of Science	((AB=(smart OR intelligen*)) AND AB=(cit* OR urban*)) AND AB=(indicator*) AND AB=(performance OR evaluation)	560
Scopus	ABS (smart OR intelligen*) AND ABS (cit* OR urban*) AND ABS (indicator*) AND ABS (performance OR evaluation)	761
Dialnet	(smart OR intelligen*) AND (cit* OR urban*) AND (indicator*) AND (performance OR evaluation)	51
EBSCO	Abstract (smart OR intelligen*) Abstract AND (cit* OR urban*) Abstract AND (indicator*) Abstract AND (performance OR evaluation)	12
IEEE Xplore	("Abstract":smart OR "Abstract":intelligen*) AND ("Abstract":cit* OR "Abstract":urban*) AND ("Abstract":indicator*) AND ("Abstract":performance OR "Abstract":evaluation)	167
Dialnet (Spanish)	(smart OR inteligent*) AND (ciudad* OR urban*) AND (indicador*) AND (rendimiento OR evaluación)	48
Total		1599

ⁱQueries were adapted to each database. The total includes duplicates. Searches were carried out on July 5, 2022. It should be noted that a Spanish version of the string of words was used in Dialnet since it is a Hispanic scientific dissemination portal. We aimed to locate Spanish documents that could be relevant.

3.5 Selection of sources of evidence

3.5.1. Screening

The results of each search were exported in RIS format, including the abstracts of the documents when possible, and then imported into Zotero. This bibliographic reference manager allows the creation of collections with all publication data. Furthermore, from this application, it is possible to export the content to Excel, where the review of duplicates was carried out, resulting in a sample of 950 articles.

Subsequently, a screening tool was developed after a research team work meeting in July 2022 (see Appendix 1). The screening tool was tested in a pilot study to check the level of agreement among the researchers. The three researchers independently screened a random sample of 20 abstracts selected from the 950 documents selection. The level of agreement was calculated using Fleiss' kappa (Fleiss, 1971). This indicator can range from -1 (no agreement) to +1 (full agreement), values close to 0 indicating that agreement was no better than chance. The agreement obtained was almost perfect (kappa (κ) of 0.853), with a percentage of agreement around 90% (Landis and Koch, 1977). After concluding the pilot study, the first author screened the full list of titles and abstracts, resulting in a total of 102 articles for full-text review (see Figure 1).

3.5.2. Other sources

Over the course of designing this systematic review, we noticed that some of the documents that use KPIs to rank cities according to their smartness level do not always include extensive descriptions of how the KPIs were designed. For example, one article described the process of developing a performance measurement system for smart European cities; however, the specific characteristics of each indicator –and how they were designed– are briefly mentioned and then referenced in several reports (Huovila et al., 2012). We thus decided that if a document uses a KPI system developed by the same authors, but the specific characteristics of the indicators are not detailed in that document, we will proceed to retrieve the additional reports where the methodology is explained, provided that such reports are referenced in the document.

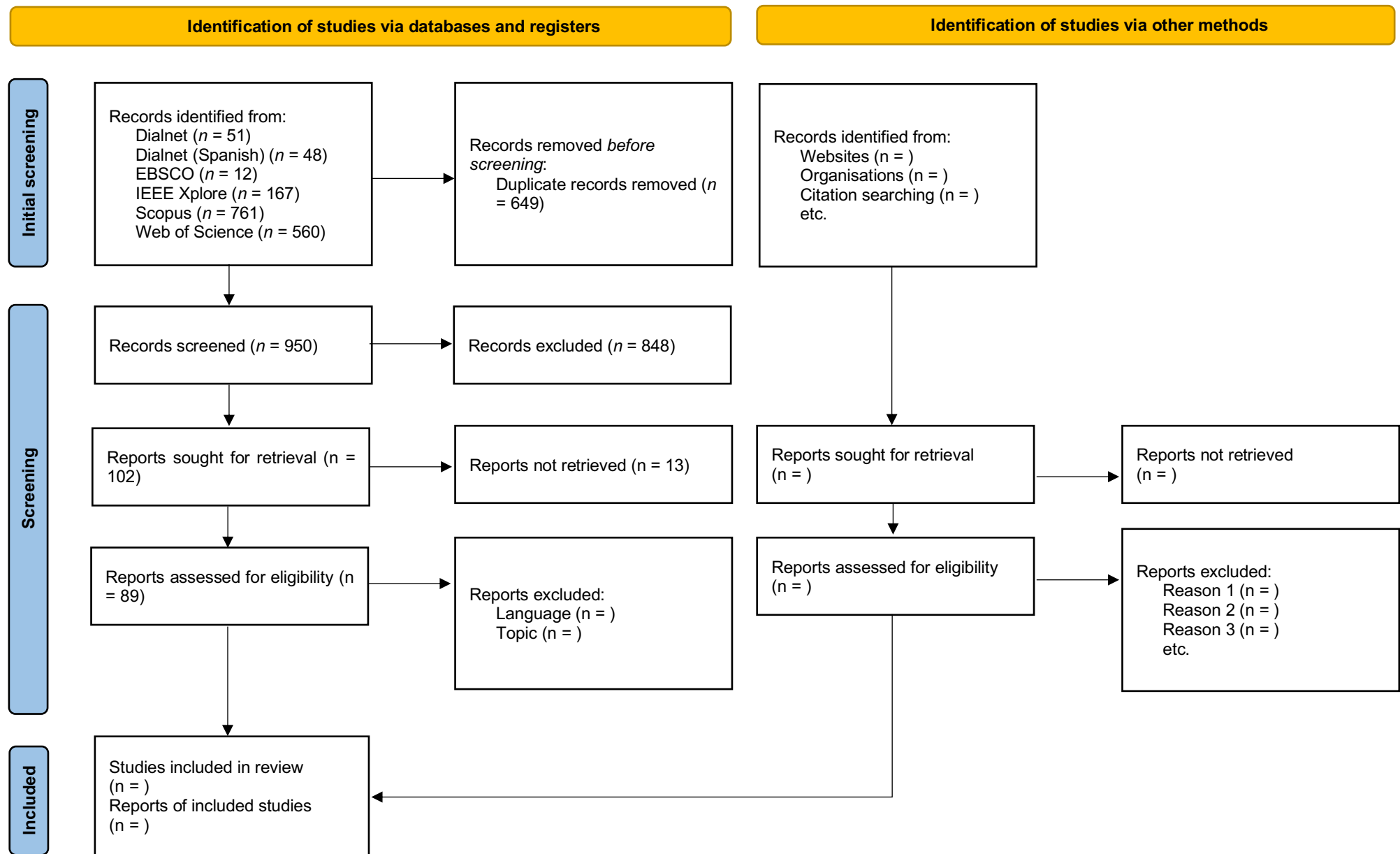


Figure 1. Search stages of the systematic review.

3.6 Data charting and synthesis of results

The literature identified for full-text review will be then summarized in a spreadsheet. The purpose is to provide a descriptive analysis of the characteristics of our sample. Moreover, this process will further help us assess the inclusion of studies. The spreadsheet will contain the following information:

- Identification number
- Author(s)
- Title of the publication
- Year of publication
- Journal
- Study region (if applicable)
- Type of publication (e.g., journal, book chapter)
- Discipline (e.g., urban studies, criminology)
- Aims
- Data (if applicable)
- Methods (if applicable)
- Research question
- Reason for exclusion (if applicable)

The final selection of literature will be then review for data extraction. We will create several variables addressing the three research questions: indicators, dimensions, definition and measures. These variables will be added to the abovementioned spreadsheet. The analysis will consist of descriptive analysis of the final dataset. The presentation of the results will be organized according to the three research questions. After presenting the results of the systematic review, we will critically review their applicability to Andalusian cities. Based on the results of the systematic review and our critical analysis, we will finally propose a conceptual framework for designing KPIs of smart public safety in the context of Andalusian cities.

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Appendixes

Appendix 1. Screening tool

The selection tool used includes the following questions:

Citation and title

1. Is the publication a single book, article, book chapter, conference paper, government or company document, technical report or doctoral thesis?

- a. Yes or Unclear: continue screening
- b. No: stop screening

Abstract screening

2. Is the Smart + city (or related) concept explicitly included in the abstract?

- a. Yes or Unclear: continue screening
- b. No: stop screening

3. The abstract clearly mentions an evaluation methodology/set of indicators/evaluation indicators.

- a. Yes or Unclear: continue screening
- b. No: stop screening

4. Does the proposed/used set of indicators or methodology aim to assess the smartness of the city as a whole or the smartness of public safety or/and security?

- a. Yes or Unclear: continue screening
- b. No: stop screening

Final decision: Should this document be included?

- a. **Yes:** all screening questions answered "Yes" or "Unclear"
- b. **No:** at least one screening question answered "No"

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