

Artificial Intelligence & Smart City Ethics: A Systematic Review

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Abstract—Smart city technologies have enabled the tracking of urban residents to a more granular degree than previously was possible. The increase in data collection and analysis, enabled by artificial intelligence, presents privacy, safety, and other ethical concerns. This systematic review collects and organizes the body of knowledge surrounding ethics of smart cities. Authors used a keyword search in 5 databases to highlight 34 academic publications dated between 2014 and 2022. The work demonstrates that articles are generally focused on ethical concerns of privacy, safety, and fairness, specific technology-based reviews, or frameworks and lenses to guide conversation. This paper helps to organize a cross-disciplinary topic and collects the body of knowledge around smart city ethics into a singular, comprehensive source for practitioners, researchers, and stakeholders.

Keywords—artificial intelligence, smart cities, ethics, privacy

I. INTRODUCTION

Smart cities are often defined by information and communication technologies that allow for data generation, analysis, and distribution in hopes of improving city services and general welfare [1, 2]. Some of the most common advances enabling the growth of smart cities are based on artificial intelligence (AI) technologies [3]. Ethical concerns surrounding AI technologies are well documented [4-6]. More recently, there has been an emergence of peer-reviewed publications surrounding ethical concerns of smart city technologies. Urban data have been classically viewed as snapshots of a particular city aspect in time [7]. Data such as censuses or city mapping provide a high-level view, and only at a particular moment in time. As technologies have advanced, data can be obtained in a less aggregate form, and with increasing frequency. These changes have led to a micro-level view of cities and their residents, where individuals' actions can be monitored or recorded daily. Smart cities rely on a variety of technologies that increase the granularity of data collected, such as a common example of a smartphone being used to request ride-share services [8]. In response to a vast increase of data collection from multitudes of city devices, there has been an uptick of literature surrounding the ethics of data collection, privacy, fairness, and equity in the smart city context. This body

of literature is an important tool for smart city practitioners, researchers, and stakeholders to engage with a topic that spans disciplines, exists today, and likely will continue to grow in importance. As such, in this systematic review, we aim to collect and categorize the knowledge surrounding ethical concerns of artificial intelligence in smart city technologies.

II. RESEARCH METHODOLOGY

To review the body of knowledge surrounding ethics and smart cities, we performed a systematic literature review. Systematic literature reviews provide a snapshot of the academic knowledge surrounding a specific topic, often evaluating a research question answerable by synthesizing already published literature [9]. As described by Littell et al., a systematic literature review has six key steps: topic formulation, study design, sampling, data collection, data analysis, and reporting [10]. To this end, the following several sections of this review are formatted to follow this guide.

A. Topic Formulation

As we suggested in the introduction to this paper, the field of smart cities is growing rapidly, fueled by advancing AI developments, as well as the connectivity between each device that exists in a city network today. The implications to privacy, safety, and fairness of these developments equals that to the pace at which smart city research grows. Categorizing the body of knowledge published in a specific field can assist in both starting and aiding conversations between stakeholders and practitioners. The ethics of artificial intelligence, and more specifically smart cities, is a popular publication topic within several disciplines. We chose to focus this systematic review specifically on knowledge from scientific or technical publications. We believe this review can be beneficial to researchers interested in the field, as well as stakeholders wishing to engage in the conversation.

B. Study Design

To collect articles for this review, we performed a keyword search through several academic databases, including EBSCO (Academic Search Complete), Web of Science, ScienceDirect,

and IEEE Explorer. Furthermore, we included results obtained from Google Scholar. The inclusion of Google Scholar was to potentially find articles missed in journal specific databases. A study by Bramer et al. showed a combination of databases for systematic review papers yielded efficient, accurate results [11]. Keyword search terminology remained consistent throughout the search process. To efficiently identify articles related to ethics and smart cities, Boolean search techniques were used. Boolean search techniques return relevant documents, as well as decrease time spent for researchers manually reviewing large quantities of possibly relevant literature [12]. The basic operators used in a Boolean search include AND, OR, NOT, and quotation marks. One search was performed per database and initial and final article results were recorded. Our keywords included “ethics” AND “smart cities” AND “artificial intelligence”. Keywords were selected based on a review of common phrasing in possibly relevant literature, as well as a several comprehensive publications on smart city terminology [13, 14].

C. Sampling

To identify potentially relevant studies, while also eliminating excess, non-related content, we set forth several inclusion and exclusion criteria before initial article collection. Collected articles would be included from academic sources, as well as published in English. We did not set a date inclusion range, due to the growth of smart city technology spanning several decades. Exclusions included unpublished work or other non-academic sources, such as web blogs.

D. Data Collection

Keyword searches and article collection occurred in the same time period for all databases. Due to the overlapping nature of citation and reference platforms, such as Web of Science, and journal specific databases, such as ScienceDirect, article repetition occurred in each search. To include only one instance of each article, all returned results were downloaded and imported into EndNote reference manager. From here, duplicate articles were removed in order of the database search, where if an article was brought up in the first database search, Academic Search Complete, it would be removed from subsequent database listing, Web of Science, etc. Once initial article collection was complete, a manual review of all possible articles was performed. This included reading article titles and abstracts to determine relevance. If unclear, sections of the paper would be read until we could satisfactorily justify inclusion or exclusion of the article. Initial and final search result numbers can be found in Table 1.

TABLE I. DATABASE SEARCH RESULTS

	EBSCO (ASC)	Web of Science	Science Direct	IEEE Explorer	Google Scholar	Total
Initial Articles	6 (6.5%)	20 (21.5%)	3 (3.2%)	14 (15%)	50 (53.8%) ^a	93
Final Articles	2 (5.9%)	9 (26.5%)	1 (2.9%)	5 (14.7%)	17 (50%)	34

^a. Google Scholar results were limited to the first 50 returned articles for efficiency.

Database search results showed that there is not a large quantity of literature published on ethics of smart cities. Citation and reference platforms, such as Web of Science and Google Scholar were able to return more results than journal-specific search platforms. Of the 93 total articles initially reviewed, 34 articles were included in our final analysis. 59 removed articles were determined to be irrelevant or duplicate from several database searches.

III. RESULTS

A. Data Analysis

In our article review, 34 publications were selected for full analysis and comparison. These publications ranged from 2014 - 2022 and have generated 1615 citations in total. Of the 34 final articles included in our review, the top cited articles are listed in Table 2.

TABLE II. TOP ARTICLES BY CITATION COUNT

	Paper Title	Author	Number of Citations ^b
1	<i>The ethics of smart cities and urban science</i>	Kitchin, R.	388
2	<i>IoT security, privacy, safety, and ethics</i>	Atlam, H. F. & Wills, G. B.	186
3	<i>Getting smarter about smart cities: Improving data privacy and data security</i>	Kitchin, R.	150

^b. Citation counts were generated exclusively from Google Scholar in December 2022.

As mentioned previously, the earliest included article was published in 2014, and the latest inclusions were published in 2022. Figure 1 shows the trend of publications by year, increasing sharply since 2019.

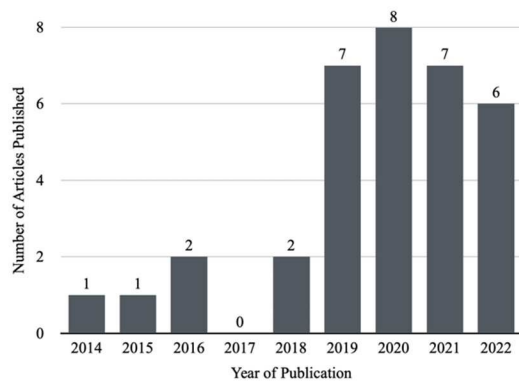


Fig. 1. Publication Trend by Year.

B. Reporting

Selected publications surrounding ethics in smart cities range in scope and topic; however, can be largely classified into several dimensions, organized by main concern with advancing AI technologies. The concerns of privacy, safety, and fairness are the most common in reviewed publications. Ethical questions surrounding each concern are often due to a select number of AI technologies, including the Internet of Things and big data analytics. Most of the reviewed papers follow two frameworks, either the several concerns around a singular technology, or vice versa, the multiple technologies leading to a singular concern. A third publication type is generally focused on providing a framework, lens, or case study to discuss ethics in smart cities. As such, the following discussion will be organized into the common themes of reviewed literature, including concerns of privacy, safety, and fairness, AI technologies, and novel lenses in which to discuss ethics of smart cities.

IV. DISCUSSION

A. Privacy, Safety, and Fairness

Ethical dilemmas surrounding privacy, safety, and fairness are chief among researcher concerns in smart cities. Across several articles, Kitchin identifies many smart city technologies that have potential to reduce the amount of privacy urban residents have, including traffic cameras, closed-circuit television, street infrastructure sensor networks, smart card tracking, and ride-share or taxi GPS systems [7, 15, 16]. He argues that whether data are collected by a government or a private company, this information can be analyzed to track or predict individuals' movements and travel patterns. Bianchini et al. further this line of thought by pointing out that the means of data acquisition, and the data transfer process, also pose risks to privacy and fairness [17]. Several other articles are similarly themed, highlighting risks surrounding individuals' privacy in smart cities [18-22]. An article by Scheltema discusses embedding ethics around privacy within the AI technologies, countering bias, or privacy violations, at the source [23]. Jameel et al. further support the possible solutions to privacy concerns, presenting several options for ethical solutions [24]. Dominguez et al. highlight the work of the city of Portland in developing privacy principles related to the increasingly smart

nature of the city [25]. Fairness is also frequently discussed as it relates to the future of smart cities. A notable example of smart city fairness is presented by Pandey and Caliskan [26]. This study on ridesharing in Chicago discusses disparate impacts on ride prices, due to AI bias. Ranchordás examines the ethical implications of “nudging”, where cities attempt to utilize technology and data collection to influence resident behavior [27]. While nearly every reviewed paper touches on a concern in some way, the examples highlight the multitude of ethical challenges in smart cities.

B. IoT & Big Data

The Internet of Things refers to the interconnectivity of devices that surround us every day, and their ability to communicate and connect with each other, often without human interaction [28]. The IoT in a smart city context includes sensors, cameras, monitoring stations, and other devices that create a network across an urban area. As mentioned previously, many researchers are concerned with the privacy implications of such a network; however, privacy is not the only concern surrounding the growth of the IoT in smart cities. Increasing connectivity between city devices and the smart network approach suggests the reliance on IoT devices for critical infrastructure, such as power or water. Righetti et al. point out that regulations surrounding data management in critical infrastructure are paramount. The authors use examples of hacking red light timings, air quality sensors, or water quality monitors to typify the security concerns around IoT connectivity in smart cities [29]. Chatterjee et al. expand upon the safety of IoT devices in a case study of Indian cities [30]. In this paper, the authors describe a conceptual model for combining human input with data security and testing the efficacy of the model with a survey-based approach. This supports another work by Chatterjee, that asserts ethics must be at the forefront of practitioners minds when implemented IoT devices in smart cities, and that describing the possible negative impacts of the technology to stakeholders will improve overall security of the device network [31]. While several reviewed papers describe incorporating ethics in the human side of device implementation, Sholla et al. propose a device-side solution to ethics in IoT devices [32]. Their ethics of operation approach creates fuzzy rules for context specific machine ethics. The authors believe this approach could be scaled and adapted for large networks, such as smart cities.

Big data in a smart city context can refer to the continuous monitoring and data recording of IoT devices, which generates vast quantities of information. Storing and analyzing these data presents logistical and ethical challenges for smart city practitioners and researchers [33]. As such, a subset of papers focuses on ethical concerns specifically surrounding big data in an urban context. One such paper presents a review of common issues surrounding big data and proposes a framework to mitigate ethical concerns. Chang asserts that public awareness, enriched datasets, secure storage and management of data, and ethical analytic rewards can benefit all stakeholders in a smart city [34]. Trust in the AI systems of smart cities is generally agreed upon to be important, as well as the security and

management of the data generated [35-38]. The concerns around big data in smart cities previously referenced are discussed theoretically; however, Löfgren and Webster point out that discourse needs to shift to a critically realistic point of view, one that attempts to ameliorate existing problems, and shape the future of smart cities, rather than continually point out speculative flaws [39].

C. Frameworks & Case Studies

Several reviewed papers proposed frameworks, lenses, or other guiding principles for stakeholders, practitioners, and researchers to discuss ethics in smart cities. Kitchin introduces a reframing of smart cities, by dividing lines of thought into two categories, conceptual or practical [40]. This divide attempts to provide entry points into the conversation around ethical concerns of smart cities. Ziosi et al., noting that debates around ethics in smart cities are piecemeal and not entirely agreed upon, propose four dimensions to cluster ethical concerns [41]. The four overarching categories of network infrastructure, post-political governance, social inclusion, and sustainability emerged from a review on smart cities. Calvo suggests a “cyberethical ecosystems” approach, in which discussions on moral validity of smart cities, monitoring mechanisms, and channels for reporting are all made public and accessible to stakeholders in the system [42]. To further improve smart cities for both humans and nature, Helbing et al. propose value-sensitive design for emerging technologies [43]. The authors assert that by reimagining smart cities into a “digital democracy”, resilience and efficiency of the systems would be improved. Connecting smart cities with nature is further expanded upon by Yigitcanlar et al. This paper defines the concept of green AI regarding smart city development, and advocates for AI systems that address sustainability and equity [44]. Three reviewed articles utilize case studies to highlight ethical implications of smart cities [45-47]. Bunders and Varró argue that in five Dutch cities, citizen stakeholders are engaging with smart city technologies, but further research into institutional dynamics of the process is needed [45]. Interviews performed by Ryan and Gregory mimic many of the previously discussed themes of data security, transparency, public-private collaboration [46]. Finally, Sawhney uses the example of an AI parking system in Amsterdam to frame the conversation surrounding urban mobility and the rights of citizen stakeholders [47].

V. CONCLUSION

The growth of smart cities in the last decade has fueled research into benefits, drawbacks, future opportunities, and ethical concerns. While ethics of artificial intelligence is a well published field, articles specifically reviewing ethics in smart city technologies is a newly popular subject. This systematic review attempts to highlight the variety of published academic literature, while organizing the knowledge by focus of article. The review demonstrates a recent increase in publication numbers, and that relevant literature can be found in several academic databases, indicating smart city ethics research is a topic of interest to multiple disciplines. Privacy of urban residents is an extremely common theme in reviewed

publications, while data security and fairness also appear often. Frequently, these ethical concerns are described as being generated by two common AI technology topics, IoT devices and big data analytics. Furthermore, the number of frameworks, lenses, and thematic guides published indicates a barrier to entry in discussing smart city ethical concerns.

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