26. Crime control in the smart city: the nexus between big data, predictive policing, surveillance, and smart nudges

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INTRODUCTION

'Ubiquitous city', 'creative city', 'learning city', 'edge city', 'fantasy city', 'dual city', 'enterprise city', 'tech city', 'digital city', 'wired city', 'cyber-city', 'knowledge city', 'innovation city', 'eco-city', 'intelligent city', 'data city', 'city of things', 'entrepreneurial city', 'competitive city', 'sustainable city', 'resilient city', 'safe city', 'harmonious city' – this is just a small selection of the many marketing terms that have been coined over the past 20 years to improve the urban quality of life (Schuilenburg, 2020; Hayward, 2021). While each of these prefixes has a different meaning, they all share the understanding that the city par excellence, as opposed to the countryside, is the epitome of innovation and progress for a more liveable future. In the past years, 'smart' has been added to this long list of prefixes, now that every self-respecting city is rapidly implementing policies, programmes, and services intended to transform it into a 'smart city'. These changes are happening in cities all over the globe, as smart cities can be found everywhere. According to the latest forecasts from the International Data Corporation, nearly US$124 billion was globally spent on smart city initiatives.[1] Singapore invests the most in smart city initiatives, closely followed by New York City, London, and Tokyo.

Although the term 'smart city' is increasingly sounding like the most logical form for urban development, there is quite a bit of confusion about what exactly a smart city is and how smart cities are influenced by social, political, geographical, and economic contexts (Kitchin, 2015). One of the most comprehensive definitions of smart cities is proposed by the International Telecommunication Union (2015), which is based on 120 definitions of smart cities from various sources, including academic literature, government agencies, international organisations, and tech companies:

> A smart and sustainable city is an innovative city that uses information and communication technologies and other means to improve quality of life, the efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects.

The central feature of this definition is the view that, with the exponential increase in data and the latest developments in the field of Artificial Intelligence (AI) and algorithms, all aspects of city functioning can be mediated and optimised through technological solutions (e.g., Kitchin, 2014; Cardullo & Kitchin, 2019; Joss et al., 2019). After all, more and more objects in the city, from networked street lighting systems to garbage containers, are connected to the Internet and equipped with sensors to collect data from their surroundings. Through the analysis of

these data, garbage containers know when they are full and street lights only turn on when needed.

Academic attention to the latest smart initiatives focusses on domains such as the economy, transport and mobility, energy, and healthcare regarding their context and perspective through which they are being conceptualised and applied. Injecting 'smart' solutions into these domains promises to organise the flows of resources, goods, services, and people much more efficiently than their 'dumb' predecessors. However, as cities are becoming smarter, there seems to be a growing consensus that when it comes to public safety, introducing smart technology to city surveillance can also help to reduce criminality and disorder (e.g., Schuilenburg & Peeters, 2018; Pali & Schuilenburg, 2020; Hayward, 2021; Schuilenburg & Pali, 2021). Smart technology, for example, will make it easier to detect and prevent crime by alerting public and private agents of security to take necessary action against (potential) offenders, from detecting criminal acts to identifying crime hot spots and the use of predictive policing by the police. In this light, this chapter explores how crime control takes place in smart cities worldwide.

The following section explores the term 'smart city', bringing various concepts and approaches of smart cities together by framing it as a 'catastrophe concept'. In the next section, we describe the methodology used to conduct the literature review on how smart initiatives are used to improve law enforcement and to police under the guise of public safety. The results section unpacks how crime control takes place in smart cities, as it relates to three different techniques: smart policing, smart surveillance, and smart nudging. Finally, we discuss the theoretical and practical implications of crime control in smart cities and address several directions for future thought, research, and action.

The Smart City: A Catastrophe Concept

Although the term 'smart city' has rapidly evolved into the dominant paradigm of urban development, the term is still vague and difficult to capture practically. Numerous features and purposes tumble over each other in the debate on smart cities, such as 'big data', 'efficiency', 'infrastructure', 'intelligent', 'monitoring', 'information' – and much more (e.g., Giffinger et al., 2007; Kitchin, 2014; Meijer & Bolívar, 2016; Morozov & Bria, 2018). As none of these terms fully capture the various tensions that characterise the dynamics of a smart city, we approach the smart city as a 'catastrophe concept' (Pali & Schuilenburg, 2020; see also: Sadowski & Bendor, 2018).[2]

Its success rests on the rhetorical pillar that urban life is increasingly confronted with numerous catastrophes. Through extensive data collection and processing, all kinds of economic, democratic, and natural crises can be avoided. Those crises come in all shapes and sizes, from: (1) growing unemployment; and (2) loss of democratic legitimacy; to (3) the risk of floods, droughts, and heatwaves. By constantly emphasising these disasters, combined with 'rising urban populations, ageing infrastructures, and shrinking tax revenues […] the picture is grim and cities appear close to fatal breakdown' (Söderström et al., 2014, pp. 314–315). Much is expected from the application of AI, big data, and algorithms to recognise patterns in huge amounts of urban data, making cities disaster-resilient. For example, a study by McKinsey, *Smart cities: Digital solutions for a more liveable future*, proposes more than 50 technological applications that bring these problems under control and improve the quality of life in cities by up to 30%.[3]

The rollout and use of smart technologies to avoid economic disasters can be seen as a specific form of 'corporate storytelling' (Söderström et al., 2014) – by tech companies such as Cisco and IBM, on how smart techniques will lead to greater economic growth and a higher quality of life. Ginni Rometty, the CEO who led IBM between 2012 and 2020, claimed that smart cities 'force economic growth and societal progress' (Rometty, 2013). IBM, which officially registered the trademark 'smarter cities' on 4 November 2011, defines a smart city as 'one that makes optimal use of all the interconnected information available today to understand better and control its operations and optimises the use of limited resources' (Albino et al., 2015, p. 5). In the same vein, Cisco, another tech company that popularised the smart city debate, offers the following definition: 'Scalable solutions that take advantage of ICT to increase efficiencies, reduce costs, and enhance the quality of life.' The key terms in both definitions are the 'more efficient' use of scarce resources in order to foster 'economic growth' by solving various economic problems, such as unemployment, scarcity of resources, poverty, misuse of state resources, and reduced economic development.

The second strand of smart city disaster discourse focusses on the 'democratic deficit' (Norris, 2011), illustrated by problems such as insufficient information to make informed choices and a lack of voice and ability of citizens to influence government decision-making. Smart cities present themselves as giving citizens more opportunities to have their say or actively participate in their neighbourhood projects (Kumar, 2017; Cardullo & Kitchin, 2019; Engelbert et al., 2021). Former San Francisco mayor Gavin Newsom stated: 'Technology has rendered our current system of government irrelevant, so now the government must turn to technology to fix itself' (Green, 2019, p. 40). According to this vision, smart technologies promise to transform politics, for instance, by introducing 'decision support systems' in which large groups of citizens can participate in political decision-making. In Barcelona, for example, residents actively participate in the governance of the city through the digital platform Decidim ('we decide') by launching, debating, and voting on proposals. Other smart techniques to solve the democratic crisis in cities and to get people more involved in political decision-making include hackathons, living labs, fab labs, smart urban labs, citizen dashboards, maker spaces, smart citizens' labs, gamification concepts, and open datasets (Galič & Schuilenburg, 2021; Schuilenburg & Pali, 2021).

A third ingredient of the smart city narrative on disasters is why cities need to start getting smarter about climate change issues, including air pollution, high temperatures, water shortages, and extreme weather events, such as floods, hurricanes, wildfires, and droughts (Obringer & Nateghi, 2021). To prepare for the future, the possibilities to make cities safer using smart technologies to mitigate extreme climate risks seem endless. Terms such as 'climate-resilient', 'climate-proofing', and the 'resilient city' suggest the ability of smart cities to protect their citizens from the negative impacts of climate change while retaining identity, structure, and key processes (Leichencko, 2011). This requires access to continuously updated data from the city's database, ranging from greenhouse gas (GHG) emission data to the forecast temperatures resulting from climate change effects. According to IBM, what is at stake here is nothing less than the survival of the world as we know it: 'It's clear now that the future of cities is the future of the planet. So it's essential that solutions be found' (cited in: Sadowski & Bendor, 2018, p. 548).

A closer look at current policies implemented by smart cities reveals that a fourth type of catastrophe has been added to the list of crises that cities are facing now and in the near future. In addition to economic, democratic, and natural disasters, municipal governments must also

ensure that public safety is a pillar of smart city implementation. As a consequence, smart cities are implementing various smart technologies to enhance public safety (e.g., Lacinák & Ristvej, 2017; Schuilenburg & Peeters, 2018; Pali & Schuilenburg, 2020). Confronted with problems of criminality and disorder, this leads to the question of which types of smart technologies can be discerned in smart cities worldwide.

Methodology

Our review of crime control in smart cities draws from a systematic analysis of documents and project descriptions of smart initiatives on public safety and security. This paragraph addresses the strategies used and choices made to gain a structured overview of the available material, with the aim of shedding light on the different ways crime control takes place within the context of smart cities worldwide.

Being aware that 'smart city' is still a fuzzy concept, the first stage of the literature review sought to retrieve a broad set of documents and project descriptions, such as commercial reports, proceeding papers, books, book chapters, and doctoral theses. An advanced search query was performed in Scopus, Web of Science, and Google Scholar by entering the following keywords in order to gain more insight into the available literature: smart city, smart city projects, smart technology, surveillance, crime, disorder, security, safety, and smart surveillance. Using Boolean operators, the following keyword combinations were inserted into these databases: 'smart city projects' AND 'security' OR 'crime' – 'smart city' AND 'crime' OR 'surveillance' – 'smart city' AND 'crime' OR 'disorder' AND 'surveillance' OR 'security' – 'smart technology' AND 'crime prevention' OR 'surveillance' – 'smart technology' AND 'smart surveillance' AND 'crime.' Each of these combinations produced over 10,000 hits.

The second stage consisted of the selection of relevant documents. A publication was only selected if it mentioned the term 'smart city' as well as one of the other keywords (e.g., 'surveillance', 'policing', 'criminality', or 'disorder') in the title, abstract, or keywords. These keywords were necessary to limit the literature search to publications directly relevant to the topic of this chapter. Based on these criteria, 137 potentially relevant publications were selected with a variety of different ways of crime control. We analysed these documents qualitatively to identify how the publications conceptualise the diversity in smart techniques and approaches of crime control. Although there is no universal diagram of the smart city, this led to the identification of three recurring techniques that are used in reducing criminality and disorder in the smart city: smart policing (i.c. predictive policing), smart surveillance (e.g., Amazon Ring doorbell camera), and smart nudging (e.g., navigational apps). To better understand these techniques, it was necessary to work with new search terms – the third and final stage of the literature review.

In the final stage, we were solely interested in publications that mention one or more of the techniques mentioned above in the context of smart cities. The following combinations of keywords were used during this stage: 'predictive policing' AND 'smart city', 'nudging' AND 'smart city' AND 'crime' OR 'disorder', 'nudging' AND 'smart city' AND 'crime' OR 'surveillance', 'smart homes' AND 'surveillance', 'smart homes' AND 'luxury surveillance', 'smart festivals' AND 'surveillance', 'smart classroom' AND 'surveillance', 'smart prison' AND 'surveillance', 'smart classroom' AND 'safety', 'smart classroom' AND 'disorder' OR 'crime', 'smart prison' AND 'surveillance' OR 'safety'. Through bibliographic snowballing, the additional search terms led to another 68 publications, adding up to 205 publications in

total. Subsequently, a full-text analysis was conducted in order to gain a better understanding of the three identified smart techniques of crime control. A total of 72 publications did not contain enough relevant information about these techniques and were, therefore, excluded from this literature review. The remaining 133 publications are the primary framework on which the analysis in the next section of this chapter is based.

SMART POLICING

In the literature that we analysed on crime control in smart cities, most of the documents deal with the technology of predictive policing as an essential element in shaping 'smart cities' into 'safe cities'. The number of smart cities that have started to utilise predictive policing techniques has increased substantially over the last decade. Different cities have developed their own predictive policing software 'to identify likely targets for police intervention and prevent crime or solve past crimes by making statistical predictions' (Perry et al., 2013, pp. 1–2). The objective of smart cities is to use the advantages of technological innovation and big data sets. The main goal is to predict increased chances of crime and disorder at particular times and places. The logic behind predictive policing is based on the assumption that criminal activity exhibits patterns that can be calculated and predicted using smart technologies such as AI and algorithms (Ferguson, 2017b; Lally, 2021). The enthusiasm of smart cities to use predictive policing is connected to a firm belief – at least on the side of municipalities and the police – that experimenting with smart technologies can enhance public safety as well as improve government efficiency. Predictive policing allows police forces to streamline law enforcement operations by distributing their resources and personnel more efficiently to identify problem areas. Efficient law enforcement operations are essential nowadays as many police forces today are short-staffed and struggle with limited capacity to control and prevent crime (e.g., Araujo et al., 2017; Shapiro, 2018; Lally, 2021; Schuilenburg & Pali, 2021; Tulumello & Iapaolo, 2021).

In smart cities, two types of predictive policing can be discerned: predictive mapping and predictive identification (Schuilenburg, 2021, ch. 5). Predictive mapping is concerned with time- and place-based predictions based on geospatial analyses. Predictions on *when* and *where* crime ('hot spots') will occur are based on the assumption that, just like certain settings encourage criminal behaviour, crime risks can be disrupted by allocating police patrols to designated high-risk areas (Ferguson, 2020). In contrast to predictive mapping, predictive identification goes a step further and is focussed on processing personal data to identify potential offenders, offender behaviour, or possible victims ('hot persons') (Egbert, 2019; Van Brakel, 2021).

PredPol, now commonly known as Geolitica,[4] is the American company that created the PredPol software – one of the most popular predictive policing software applications in smart cities to help police departments locate places where crime is likely to happen. Los Angeles, which recently released the smart city roadmap 'SmartLA 2028' envisioning a highly digital and connected future, was one of the earlier adopters of this software. PredPol identifies places with elevated crime levels in specific timeframes (Perry et al., 2013; Mugari & Obioha, 2021). Although the software contains segments of near-repeat modelling (Egbert & Krasmann, 2020), PredPol is largely based on a machine-learning algorithm to generate crime predictions. To predict when and where future crimes are most likely to occur, the software

requires data on three types of variables: the place of the crime, the type of crime, and the date and time of the crime (Shapiro, 2017).

Another American initiative, created by the software company Azavea, is HunchLab – a predictive policing application that integrates theories and models behind PredPol with risk-terrain modelling (Ferguson, 2017a). HunchLab is deployed in several smart cities, including Philadelphia. The software is able to generate individual crime predictions that can be integrated into specific crime categories, therefore tailoring its output to meet the police department's priorities (Azavea, 2015). To receive real-time predictions, officers on patrol carry a mobile device that incorporates HunchLab's software (Mugari & Obioha, 2021). Although the idea behind HunchLab is based on a similar logic as PredPol, HunchLab follows a risk-terrain model with components of near-repeat modelling. It uses a more heterogeneous approach based on crime theories combined with multidimensional risk classifications (Egbert, 2019). Additionally, HunchLab takes into account a much broader range of aspects, including non-crime data such as near-repeat patterns, baseline crime rates, socioeconomic circumstances, weather, and social occasions or holidays (Azavea, 2015; Shapiro, 2017).

In Europe, an example of predictive mapping takes place in Amsterdam, one of Europe's early adopters of the smart city concept. Here, the local police department has developed the 'Criminality Anticipation System' (CAS) to predict crimes ('hot spots') within a specific timeframe. Predictions are provided on a grid map of the city in subsequent boxes of 125 by 125 square metres each. The risk locations are coded on a heat map with three colours: red indicates a sharp increase in the likelihood that a crime will occur, orange indicates a medium increase, and yellow a low increase. Originally, CAS was used to predict where and when so-called 'High Impact Crimes' – crimes with a large impact on the victim, such as home burglary, street robbery, and mugging – were likely to take place (Willems & Doeleman, 2014). Now, CAS has been extended to include relatively minor crimes, such as pickpocketing, car burglaries, office burglaries, and bicycle theft (Hardyns & Rummens, 2018).

In German smart cities, such as Munich and Nuremberg, predictive policing applications are equipped solely for predicting burglaries. The Pre Crime Observation System (PRECOBS) is developed to forecast potential burglaries that follow an initial burglary, focussing on crime concentrations within a specific radius (Seidensticker et al., 2018; Egbert, 2019; Gerstner, 2019). Besides several German smart cities, PRECOBS has been implemented in Swiss smart cities, amongst which are Zürich and Basel (Hardyns & Rummens, 2018).[5] A distinctive feature of PRECOBS is the fact that it is operated by officers in charge of evaluating automated predictions, producing predictions manually and communicating alerts. In assessing the predictions' plausibility, the software operators are allowed to accept or deny a prediction. Only if accepted, the local police station is alerted, providing the station with a map, patrol recommendations, and intelligence on the initial burglary (Gerstner, 2019; Egbert & Krasmann, 2020).

Another example is seen in India's first smart city, Delhi, where the police use the Crime Mapping, Analysis, and Mapping System (CMAPS) – a predictive policing software capable of plotting and calculating crime hot spots. CMAPS is India's first attempt at creating a fully automated hot spot mapping system (Marda & Narayan, 2020). The digital system is capable of spatial hot spot mapping, using AI and algorithms, particularly plotting criminal behaviour patterns, suspect analyses, and potential crime areas (Alikhademi et al., 2021). As with any other predictive policing systems, CMAPS is used to optimise the allocation of police resources (Marda & Narayan, 2020). The difference between CMAPS and the predictive

policing systems mentioned before lies in the fact that CMAPS is operated based on emergency calls. CMAPS produces crime maps based on data from local emergency call centres. These crime maps relate to four types of crimes or disorderly behaviour: robbery, rape, snatching, and catcalling (Narayan, 2020).

Milan is Italy's leading smart city in adopting predictive policing techniques to forecast commercial robberies. The software KeyCrime, which is based on the near-repeat theory and crime linkages principles, was developed by the Milan police department.[6] This software enables police forces to connect different robberies to a known crime series. It analyses numerous criminal strategies for robbery, and individual characteristics of robbers, as well as victim crime reports. Around 80% of all enterprises in Milan have agreed to have their footage uploaded to KeyCrime. After a robbery has been reported, a team is set up to analyse the crime report, victim interviews, and surveillance footage (Costanzo et al., 2015; Mastrobuoni, 2020). Compared to other predictive policing software, KeyCrime produces slightly more individual crime predictions, as the information gathered is not limited to data about high-risk areas but expands to data about potential suspects, type of transportation used, and potential weapons (Mastrobuoni, 2020).

While smart policing has the potential to deliver significant gains, it also leads to various ethical and normative issues. Several critics have pointed out the dangers of predictive policing, such as self-fulfilling prophecies, discrimination, and marginalisation of certain groups along income and racial lines, due to the fact that crime data reflect longstanding institutional biases (e.g., Peeters & Schuilenburg, 2018; Pali & Schuilenburg, 2020; Galič & Schuilenburg, 2021). Various legal concerns are also regularly voiced in this context, including the issue of dirty data, function creep – data being reused for purposes other than those they were originally recorded for – fishing expeditions, spurious correlations, and the violation of the presumption of innocence (Pali & Schuilenburg, 2020; Schuilenburg, 2021). In the case of predictive identification, this can even lead to a form of, what the Germans call, *Gesinnungsstrafrecht*, referring to the fact that a belief that is considered wrong and not to be tolerated constitutes a criminal offence (Schuilenburg, 2021, p. 87).

SMART SURVEILLANCE

Parallel to the prediction of crimes by law enforcement organisations, we observe an increasing trend in smart cities to identify likely targets and early crime acts through smart surveillance, such as facial recognition systems, advanced video monitoring, and smell sensors (Peixoto & Costa, 2017; Khan et al., 2020; Shukla et al., 2020). With enough smart surveillance, 'the goal is to render the whole city — every place, every moment — knowable and controllable' (Sadowski, 2019). To provide an overview of surveillance technologies in smart cities, we distinguish between smart technologies applied in both public and private spaces. From the literature on smart cities, we discern the following smart private spaces: smart homes, smart classrooms, smart festivals, smart prisons, and smart vehicles. This paragraph focusses on smart homes, smart classrooms, and smart vehicles.

Smart Surveillance in Public Spaces

In public spaces, surveillance technologies are meant to improve public safety by tracking citizens and their activities through smart sensors and cameras (Musik, 2018; Tian et al., 2018). As sensors and cameras can all be connected through the Internet of Things, these technologies conceptualise a data analytics platform in which various physical devices communicate and collaborate (Alharbi & Soh, 2019; Cai et al., 2019; Ali et al., 2020; Tian et al., 2018; Yoon et al., 2020).

As part of their 'Safer Cities' vision, Japanese conglomerate NEC Corporation has developed various facial recognition systems and brought them to smart cities around the world. A good example is the intelligent video surveillance approach taken by the Surat City Police. In Surat, one of India's major smart cities, the Picture Intelligence Unit of the police uses a face recognition technology called NeoFace Watch,[7] developed by NEC, which takes the video feeds from CCTV cameras deployed at various locations in the city and matches them with the existing database of the police (Arikuma & Mochizuki, 2016; Zhang et al., 2019). The technology informs police forces in case of suspicious or criminal activities or if a subject face or person of interest is recognised. According to the Surat City Police, they were able to reduce the crime rate by 27% after the implementation of NeoFace Watch.[8]

Another smart city that works with NEC technology is Tigre City in Argentina, where the government deployed a city operation centre that collects vital information concerning public safety (Arikuma & Mochizuki, 2016). The city implemented a video surveillance system consisting of CCTV cameras and intelligent video analysis that is able to monitor the city 24 hours a day. Two types of cameras were installed across the city: 640 pan-tilt-zoom cameras (fitted with facial recognition and behaviour detection functions) along with additional licence plate readers. The behaviour detection system flags any type of actions recognised as suspicious, such as intrusion, object abandonment, and loitering (Vargas & Bergonzelli, 2014).[9]

In Songdo, South Korea, the smart city initiative to enhance public safety has been branded as the Songdo Sustainable City Project. This project includes implementing multiple electronic sensors and measuring devices in different types of buildings and city systems. On top of that, thousands of video cameras are in place to monitor the streets and recreational areas at all times. All data collected flow to a central technology platform, and advanced data analytics allow for optimising city processes (Kovalev et al., 2021). Vehicle registration detection cameras are used to identify stolen vehicles or vehicles that have no record of taxpaying. Moreover, sound sensors recognise unusual noise, resulting in CCTV cameras turning their angle to get a clear view of the situation (Park & Lee, 2020; Patel & Padhya, 2021).

In the literature on smart cities, there are more examples of smart surveillance technologies in public spaces to enhance public safety. Amongst others are the Dublin Traffic Management and Incident Centre, which gathers real-time information from a fixed network of 800 sensors, 380 CCTV cameras, and some additional traffic sensing cameras (Coletta & Kitchin, 2017), and in the smart city of Vienna, where traffic lights are 'smartified' by equipping them with motion sensors and camera detectors.[10] The detectors are capable of detecting pedestrians approaching the traffic light within an 8-meter radius. Additionally, these detectors analyse their direction of movement, after which a software algorithm generates a prediction indicating whether the pedestrian might want to cross the street.

Smart Surveillance in Private Spaces

The implementation of digital devices to make private homes 'smarter' has become a global narrative that promises to improve resource efficiency and decision-making, increase leisure time, and help residents to feel safe (Gram-Hanssen & Darby, 2018; Maalsen & Sadowski, 2019; Sadowski et al., 2021).[11] In regard to crime control, technologies such as microphones, human interface machines (e.g., voice recognition), wireless sensor networks, cameras, and motion detectors, along with various other Internet services, software, and smart devices, are installed in smart homes (Ali et al., 2020). An interesting example is the Amazon Ring doorbell camera enabling a homeowner to identify a visitor before opening the front door. According to users, the smart doorbell makes them feel safer in their homes and neighbourhood (Morris, 2021). In the United States, where the implementation of smart doorbells has seen a sharp increase, camera footage of the doorbell is shared with more than 400 police forces in what Amazon Ring calls the 'new Neighbourhood Watch'.[12]

Another public-private partnership is the one between Amazon and Brookfield Residential – a Canadian real estate developer that owns real estate in Canadian and American smart cities such as Calgary and Austin. Together, the companies offer a luxury smart lifestyle in technologically advanced homes by installing several smart devices, including a drone landing pad monitored by smart surveillance, in order to receive deliveries and protect residents from wrongful intruders (Woods, 2021). One more smart example to enhance safety in and around smart homes is Rovio, a mobile robot equipped with a microphone, webcam, and loudspeakers. Rovio is controlled via WiFi, and its main purpose is surveillance and telepresence. The mobile robot is used to localise or identify concrete objects as it uses movement and image analysis to track activities around the house (Borja et al., 2013).

Smart surveillance is also extended to educational spaces, resulting in smart campuses and smart classrooms. Smart campuses and classrooms refer to an elaborate use of systems (e.g., facial recognition), cameras, sensors, and other smart devices (e.g., microphones, mobile devices, wearables, pervasive computing) to ensure the safety of students in their environment. Examples of surveillance technologies applied in smart classrooms can contain different forms of analytics, such as video analytics, location analytics, affective learning, or smart identification cards to access particular buildings or services (Zhan et al., 2020). Additionally, smart classrooms provide an educational institution with the ability to integrate different data sources in order to track university performance outcomes (Kwet & Prinsloo, 2020).[13] Other than pedagogical purposes, smart campuses and smart classrooms are presented as useful to guarantee the school's and its students' safety. After recent terrorist attacks, shootings, and other violent attacks in American schools, security cameras and detection systems are deployed for continuous monitoring and observing of suspicious movements (Abdullah et al., 2019; Qureshi et al., 2021).

Finally, smart vehicles (or autonomous vehicles, intelligent cars, self-driving cars, etc.) are considered a private space increasingly smartified with surveillance technology. Automaker Ford and security company ADT, for example, have introduced Canopy, a combination of acoustic sensors, onboard cameras, radars, and GPS to determine potential intruders and keep vehicles, the gear inside them, and their owners, safe.[14] In having embraced a concept of 'luxury surveillance' (Gilliard & Golombia, 2021), car company Tesla has developed and employed smart surveillance in their cars for the road in order 'to spot, track and store license plates and faces, all there to make Tesla car owners aware of utilitarian forms of danger such

as thieves and vandals' (Eski & Schuilenburg, 2022: p. 242; see also Ahmad & Khan, 2019; Feldstein, 2019; Cooke, 2021). The inward luxury surveillance is enabled by infrared sensors that monitor driver attentiveness through facial recognition and warn drivers if they need to hit the brakes (Smith et al., 2008). Smart vehicle surveillance has proven useful to criminal investigations, as the information on recorded vehicle locations is used in police investigations into homicides and burglaries (Baig et al., 2017).

SMART NUDGING

A third and final type of smart technique to improve public safety in smart cities is a technique that directs human behaviour in the desired direction by influencing our consciousness (e.g., Guthrie, 2013; Gandy Jr. & Nemorin, 2019; Ranchordás, 2020; Schuilenburg, 2024). The verb 'nudge', meaning to push slightly or gently, is often used in this context. Contrary to traditional public safety tools and physical techniques such as roadblocks, barrel-shaped benches, and banning orders, nudges subtly point citizens in the right direction without restricting their freedom. In *Nudge*, Richard Thaler and Cass Sunstein define nudges as 'any aspect of the choice architecture that alters people's behaviour in a predictable way ("paternalistic aspect") without forbidding any options or significantly changing their economic incentives ("libertarian aspect")' (2009, p. 6). This concerns, for example, an electronic road sign showing a smiley face as a measure to discourage speeding. Depending on the speed of a passing car, the face smiles ('if you drive well') or looks sad ('if you drive too fast'). An important principle of this libertarian paternalism is that citizens make rational choices less often than is thought. People rarely make decisions based on an objective trade-off between pros and cons. Everybody knows, for example, that speeding is dangerous. Yet, everyone gives in to this temptation from time to time.

In relation to crime control in smart cities, three types of smart nudges can be discerned, which allow individuals to choose freely but also imply that certain behavioural options are made more attractive than others: (1) 'advice' (e.g., navigation apps), (2) 'persuasion' (e.g., smart objects), and area-oriented interventions such as, (3) 'influencing' the atmosphere of public spaces (Schuilenburg, 2024). The common denominator is the real-time collection and analysis of large amounts of data from the smart city with the aim of steering citizen behaviour towards norm-compliant behaviour in an unobtrusive, yet very powerful, way. In this context, scholars speak of 'e-nudges', 'big nudging', or 'hypernudging' (Yeung, 2017), a form of soft power that works through 'pleasing and seducing' instead of 'forbidding and punishing' (Schuilenburg & Peeters, 2018).

The first type of smart nudges are personalised apps that advise citizens in smart cities whether or not to take certain routes by public transport or car. Fitting examples are the GPS-driven navigational apps 'Ghetto Tracker' (they changed the name due to public backlash to 'Good Part of Town'), originally patented by Microsoft, and 'RedZone'. This app helps drivers stay safe by steering them clear of high-crime areas and unsafe neighbourhoods in unfamiliar cities. As the RedZone app description puts it: 'RedZone combines crime data from government agencies with reports from its community of users to provide a real-time guide to which areas of a city should be avoided.' Also available is the navigation app Waze with an 'Avoid Dangerous Neighbourhoods' functionality that not only provides up-to-date information about congestion on the road but also advises drivers not to drive through a 'higher crime

risk area', even if you could arrive at your destination faster. In this sense, an app is a tool that influences people's behaviour – a nudging tool.

The second type of smart nudges is objects that persuade citizens to make better choices. A simple example is the smart waste container on the corner of the street, which is not only equipped with a 'full sensor', but also makes a nice sound when you throw rubbish in it. Other types of embodied nudges are wireless networked street lighting systems that provide the safest walking path by integrating street lights with various sensors and other systems. At the campus of the Illinois Institute of Technology, Chicago, the project SafeWalks generates the safest paths to walk at night and also enables adaptive brightness capability for street lights in real time, determined by the route with the most pedestrian traffic. SafeWalks collects, among other data, information about crime rates, historical data on pedestrian traffic, and block-wise weather updates (Jin et al., 2016).

Finally, there are completely smart environments that automatically influence large groups of people to change their behaviour through subtle changes in public spaces. An interesting project takes place in the smart city of Eindhoven, the fifth-largest municipality in the Netherlands which, in 2011, was elected as the 'smartest region of the world' by the Intelligent Community Forum, with the aim of co-creating smart technological solutions to generate a safer city environment (Schuilenburg & Peeters, 2018; Galič, 2019; Doorman & Pali, 2021; Schuilenburg, 2024). A living lab has been set up between the municipality, the Technological University of Eindhoven, and commercial partners such as Philips to reduce crime and disorder in Stratumseind, a long pedestrian street full of bars and discotheques that attract about 15,000 to 20,000 young people on weekends. As part of the so-called 'De-escalate project', smart cameras with WiFi trackers and sound sensors are installed to follow and monitor the people on the street. The smart technologies are trained to detect aggressive behaviour and alert police officers automatically when intervention is needed. Moreover, a unique lighting system is installed to influence mood and behaviour with 'dynamic lighting scenarios' in public spaces (Galič, 2019). The street lighting automatically adjusts in colour and intensity to make the area safer, livelier, and more attractive, based on the number of visitors at any time of the day. The idea behind this is that the lighting system affects the atmosphere of the area in order to de-escalate aggression, violence, and other forms of nightlife crime. Blue light, for example, has a cooling effect on visitors because of its association with air and sea and is said to lower the heart rates of the visitors and reduce aggression. Based on live data and algorithms, the project is also experimenting with spreading the smell of oranges in order to reduce aggression and increase the feeling of public safety (Schuilenburg & Peeters, 2018; Pali & Schuilenburg, 2020; Schuilenburg, 2024).

Despite the growing popularity of smart nudging, much is still unclear about their effects and their legal and ethical challenges. Part of the problem is that it is extremely difficult for citizens to reconstruct either the intention or the means by which behavioural change is pursued through hypernudges. This can lead to manipulation and thereby restrict the right of autonomy or can be an intrusion into the privacy of citizens of smart cities (e.g., Hansen & Jespersen, 2013; Alemanno & Spina, 2014; Ranchordás, 2020). This can have countless unforeseen effects whose impact, depending on the context and the nature of the smart nudge, can potentially be considerable.

CONCLUSION AND FUTURE RESEARCH

Smart cities have started to experiment with a technology-based securitisation of public and private space. Given that this development is a quickly spreading and international phenomenon, this chapter's contribution to the growing literature on smart cities is that it explores how smart technologies are used in the field of crime control. Thus far, the potential and implications of crime control have remained an overlooked subject in the literature on smart cities. Returning to the question that began this chapter, there is a growing consensus that introducing smart technology to city surveillance can potentially help reduce criminality and disorder concerning public safety. We have discerned three types of crime control that are considered essential components of the smart city package: smart policing, smart surveillance, and smart nudging.

As the rise of smart cities seems inescapable, an important question not often explored in the literature is: Are smart techniques effective in crime control? Tech companies, for example, have always overstated the benefits of their technologies and understated how much they serve their own ends of power and profit (Marx, 2022). Despite the growing popularity of applications such as predictive policing, much is unclear about their effects. Scant evaluations of predictive policing yield variable and even contradictory results. While there is empirical evidence suggesting the effectiveness of predictive policing in a number of smart cities in the United States, other smart cities did not document unequivocally positive effects (e.g., Mohler et al., 2015; Mali et al., 2016; Ratcliffe et al., 2021).

In addition to the need for more empirical research into the effects of smart technologies in the field of crime control, this development raises a host of legal and ethical questions concerning the use of AI, big data, and algorithms to enhance public safety. For example, is there some kind of liability for producers of smart security technologies for discriminatory usage, such as a predictive policing algorithm that leads to the ethnic profiling of minorities?

Future research should also engage more successfully with legal and ethical risks such as dirty data, self-fulfilling prophecies due to the fact that crime data reflect longstanding institutional biases, and the identification of high-risk groups based on certain characteristics and categories (e.g., Benjamin, 2019; Brayne, 2021; Schuilenburg, 2021, Ch. 5).

Another issue for research presents itself when smart cities depend entirely on powerful tech companies for the mass collection and processing of personal data, relinquishing control of their expertise and intellectual property rights (Zuboff, 2019). In the so-called black box scenario (Pasquale, 2015) the use of self-learning algorithms can lead to loss of control, as decision-making processes become inaccessible – and therefore uncontrollable – not just from the outside but also to their users, who are no longer able to understand or explain them. Several critics have also raised ethical questions about the fact that citizens are now subject to much greater modes of surveillance than ever before in smart cities. One of the most recurrent ethical concerns about smart nudges, for example, is that the data-driven nudging approach rarely takes place transparently and, in many cases, is inherently manipulative (Peeters & Schuilenburg, 2017).

Finally, it should be recognised that, despite the alleged good intentions of smart technologies to enhance public safety, the question remains whether social and personal problems such as unemployment, peer pressure, and family problems, which are strongly correlated with the likelihood of getting involved in crime and anti-social behaviour, are soluble by a technological fix.

NOTES

1. https://www.businesswire.com/news/home/20200210005215/en/New-IDC-Spending-Guide-Forecasts-124-Billion-Will-Be-Spent-on-Smart-Cities-Initiatives-in-2020 (Visiting date: 10 February 2025).
2. Literally, the term 'catastrophe' means a 'sudden downward turn'. In the last decades, the term transformed into a category of crisis that denotes a process instead of an event (Horn, 2018).
3. https://www.mckinsey.com/business-functions/operations/our-insights/smart-cities-digital-solutions-for-a-more-livable-future (Visiting date: 10 February 2025).
4. https://www.predpol.com/law-enforcement/#predPolicing (Visiting date: 20 February 2025).
5. https://www.stadt-zuerich.ch/portal/de/index/politik_u_recht/stadtrat/weitere-politikfelder/smartcity/english/projects/precobs.html (Visiting date: 10 February 2025).
6. https://keycrime.com/ (Visiting date: 18 January 2025).
7. See: https://www.nec.com/en/global/solutions/biometrics/face/neofacewatch.html (Visiting date: 18 February 2025) for more information on NeoFace Watch.
8. https://www.dqindia.com/here-is-what-surat-city-police-did-to-cut-crime-rate-by-27/ (Visiting date: 18 January 2025).
9. https://www.nec.com/en/case/tigre/index.html (Visiting date: 28 January 2025).
10. https://smartcity.wien.gv.at/en/smart-traffic-lights/ (Visiting date: 18 February 2025).
11. Although the first 'wired homes' were built in the early 1960s, the term 'smart house' was first used in an official way in 1984 by the American Association of House Builders (Harper, 2003).
12. https://www.washingtonpost.com/technology/2019/08/28/doorbell-camera-firm-ring-has-partnered-with-police-forces-extending-surveillance-reach/ (Visiting date: 11 January 2025).
13. An interesting, smart campus project is found at Curtin University in Australia's smart city of Perth. The initiative was launched in 2017 and included the utilisation of CCTV, sensors, Internet monitoring, and extensive data surveillance. The smart campus allows Curtin University to collect information about the day-to-day reality of students and teachers on campus, including study patterns, course attendance, social interaction between students, and building trends (Kwet & Prinsloo, 2020).
14. https://www.cnet.com/roadshow/news/ford-adt-canopy-ring-security-car/ (Visiting date: 18 February 2025).

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