

Addressing Crime through Innovative Technology

Technology Implementation Guide

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Letter from the Director of the COPS Office

Colleagues:

The pace of advancement in technology seems to grow more rapid with every development. We adopt a new device, and almost as soon as we feel familiar with its interface, it is replaced by an improved release. But keeping abreast of modern technology and its capabilities is just as important for law enforcement agencies as it is for the general public; communities deserve police who are as well equipped as possible, and technology allows law enforcement to communicate with one another, investigate incidents, analyze data, and present and preserve evidence while not compromising their own accountability—all to a greater degree than was possible without technological advancements.

These publications examine the use of existing and emerging technologies by law enforcement agencies. The implementation guide documents a thorough systematic review, by a team of CNA analysts, of research on law enforcement and public safety use of various technologies and discussion of their use, benefits, and potential pitfalls by agencies around the country. It is accompanied by six case studies highlighting particular agencies and their uses of specific technologies to advance their mission to serve and protect their communities.

We appreciate CNA's work and the cooperation of the agencies whose technology programs are highlighted in this publication suite. We hope it will inspire your departments to consider ways in which cutting-edge technology can help you work with your communities to keep everyone safe.

Sincerely,



Hugh T. Clements, Jr.
Director
Office of Community Oriented Policing Services



Introduction

Police departments have evolved since the advent of modern policing in the early 19th century, with their roles and purposes constantly changing to meet the needs of the communities they serve. In that time, technology (defined here as tools or systems that enhance law enforcement's ability to perform its duties) has also evolved, particularly since the 1990s, and police departments are increasingly incorporating modern technology into their daily functions. One of the earliest instances of technology use by police departments was the adoption of the police radio, which allowed officers to have constant communication with one another while patrolling different beats.

Since the adoption of the police radio, technology has advanced in ways that benefit not only officers but also the public. Technology provides police departments with the ability to improve accountability and transparency, improve the quality of investigations, effectively allocate resources, and improve levels of trust with their communities. However, given the rapid pace of technological advancement in policing, a review of the various tools presently used in police departments is needed to better understand what is effective in achieving common goals.

Using a systematic review framework, the CNA team searched relevant literature examining police, technology and innovation, public safety, crime reduction, and community relationships and identified 1,500 articles for initial review. These articles included academic research, government publications, unpublished studies, and other grey literature. The team completed a more in-depth review of the identified articles, using nine criteria to determine eligibility for this systematic review.

The in-depth review yielded 98 articles eligible for the final review. These 98 studies examined police departments' use of various technologies such as body-worn cameras (BWC), information technology (IT) (e.g., CompStat), closed-circuit television (CCTV) cameras, spatial analysis software, uncrewed aircraft systems (UAS, often called drones), license plate readers (LPR), social media and other public websites, mobile phones or computers, and gunshot detection. Final review included literature coding, which identified the following information from the articles:

- Department or agency discussed
- Agency type
- Research question
- Data source
- Sample or respondents
- Technology (category and specific)
- Study type

- Evaluation type
- Research approach
- Research methods
- Study included cost-benefit analysis (CBA)
- Outcomes (category and specific)

The purpose of the present study is to provide a guide for employing any new technology, discuss insights on technologies currently being used in law enforcement agencies in the United States, and summarize findings and outcomes from the articles reviewed. It also provides a broader discussion on lessons learned for agencies implementing a new technology, including how to determine a need for technology, positive practices when implementing the technology, and anticipated benefits for modern technologies. In addition, it discusses how law enforcement can use technology as a tool to improve crime prevention, investigations and case clearances, accountability and transparency, and community relations.

Technology has the potential to aid crime analysts in identifying crime trends, detectives in making arrests, and agencies in maintaining officer standards and building a stronger level of trust between communities and the officers who serve them. Both researchers and police departments therefore have the responsibility to take initiative in reviewing tools and practices to ensure department resources are effectively used.

Technology provides police departments with the ability to improve accountability and transparency, improve the quality of investigations, effectively allocate resources, and improve levels of trust with their communities.

Methodology

Technology is a rapidly changing and rapidly improving component of both crime prevention and community relations in the criminal justice field. Although local police departments are continuously implementing new technology, criminological research is still exploring how and when local police departments can best use technology. Similar to many other fields of study, research in policing covers a wide range of topics and has the potential to overwhelm local police departments. However, before implementing new technology, best practices dictate that police departments conduct preliminary reviews and examine both a technology's predicted successes and its potential unintended consequences (for instance, see Rowe, Pearson, and Turner 2018). The present study provides a systematic review of criminological and police research aimed at addressing critical lessons for local police departments when making the decision to implement technology to enhance public safety, reduce crime, and build relationships of trust within the community. Furthermore, this study discusses innovative ways that law enforcement agencies are using emerging and existing technologies to accomplish these goals.

Systematic reviews provide an "informed . . . up-to-date and complete understanding of the relevant research evidence" (Lasserson, Thomas, and Higgins 2019) by conducting an exhaustive search for evidence that addresses the relevant question (Montori et al. 2005). A systematic review of the use of technology in policing is necessary to help identify the types of technology being used in local police departments as well as the processes by which an agency should determine its technological needs, implement new technologies, and evaluate the impacts and consequences of the technology's use (including impact on crime statistics as well as collateral community impacts and consequences). Systematic reviews, while popular in medical research (Lasserson, Thomas, and Higgins 2019), are seen less frequently in criminological research. Prior systematic reviews of policing have focused on community-oriented policing (Gill et al. 2014), hot spot policing (Braga et al. 2019), and police legitimacy (Mazerolle et al. 2013). At the time of the initial literature search for the present study, a systemic review of technological innovations in policing and its impact on public safety, crime reduction, and community relationship building had not taken place in the past decade. Thus, the present study will consider both published and unpublished works to assess the impacts of technology on public safety, crime rates, and police departments' relationships with their communities.

Searching strategies

The CNA team conducted the initial search in the spring and summer of 2020, identifying eligible studies in Google Scholar and the National Criminal Justice Reference Service to ensure that results included not just published academic research but also government publications, unpublished studies, and other grey literature. While peer-reviewed academic articles provide insight into this topic, publication bias is a known problem for systematic reviews (Gill et al. 2014). The main research question was separated into key concepts, and the team developed associated search terms and adapted them for appropriate use in both Google and Google Scholar.

To ensure unbiased results, the team attempted to include all potentially relevant studies. Searches began with the following key concepts: police, technology and innovation, public safety, crime reduction, and community relationships. The team employed Boolean operators (e.g., “AND,” “OR,” “NOT”) to refine the search terms and produce more tailored results. The team restricted the time frame on Google Scholar to articles published between 2010 and the search date (2020) and used the following string: `~police AND (technology) AND (innovation OR camera OR drones OR predictive) AND (safety OR crime OR community)`. The tilde (~) enhanced the search by returning hits with synonyms of the keyword used, *police*, such as *law enforcement*, *cops*, or *officers*. They then downloaded all articles from the first 100 pages of Google Scholar’s results for further review, that is, the first 1,000 articles. To help ensure that grey literature was also included, the team conducted an additional search of the National Criminal Justice Reference Service (NCJRS). The team used the following string in the Google search engine to search NCJRS’s articles: `~police AND (technology) AND (innovation OR camera OR drones OR predictive) AND (safety OR crime OR community) site:ncjrs.gov filetype:pdf` (restricting results to PDF format to ensure the search returned final documents rather than drafts). From these results the team downloaded articles published in or after 2010 and discarded results that were obviously irrelevant (e.g., requests for proposals).

From the combination of these searches, the team identified 1,150 articles for initial review. In addition, between the time of the initial search and publication of this review, the team conducted a second search to identify additional studies and articles published in 2021 and 2022. From these searches, the team downloaded the first 350 articles in Google Scholar, bringing the total number of articles reviewed to 1,500.

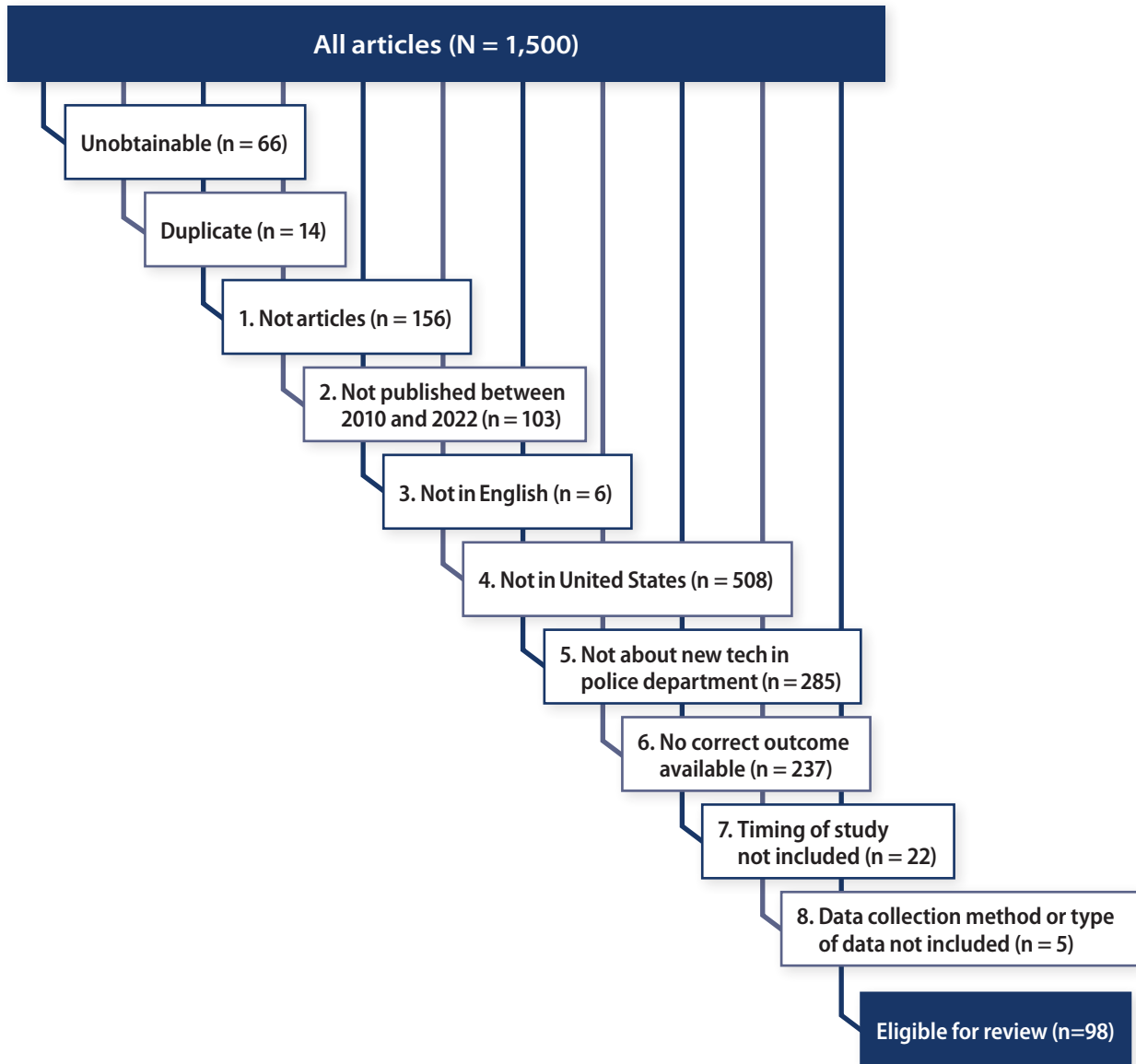
Inclusion criteria

Consistent with best practices, the team developed searching strategies and inclusion criteria before beginning the systematic review (Lasserson, Thomas, and Higgins 2019) to ensure that the development of the inclusion and exclusion criteria remained free from author bias (McKenzie et al. 2019). The team developed inclusion criteria to focus on specific topics of interest and to ensure that findings would be applicable to the target audience (i.e., police in the United States). The team also sought studies that included an evaluation component, so they could provide evidence-based guidance to law enforcement, and required articles to specify their data collection methods, so they could code how the research was carried out. In addition, studies did not need to have been published in a peer-reviewed journal to be included in this review. More specifically, the team used the following ordered criteria to determine inclusion eligibility:

1. Results must have been articles, studies, or reports. Books and book chapters were not included.
2. Studies, articles, and reports must have been published between 2010 and 2022. As technology is ever-changing, this time frame ensured that the team reviewed recent developments and advances in law enforcement.
3. The study, report, or article must have been either written in or translated to English.
4. The police department must have been located in the United States.
5. The article, report, or study must have included a description of new or innovative technology being used by one or more local police departments. For example, the use of LPRs was included; however, using the technology to simply increase police officers' presence in a neighborhood was excluded.
6. For quantitative studies, the outcome variable must have included either public safety outcomes, crime reduction outcomes, or community relations outcomes. These outcomes must have been clearly operationalized within the article, report, or study. For qualitative studies, themes surrounding public safety, crime reduction, or community relations must have emerged in the findings.
7. The team included all study designs and methodology, including purely descriptive studies.
8. The article, study, or report must have contained information on the timing of the study and data collection, the type of data used, the data collection methods, and clearly defined methodology. For example, the team excluded law review articles simply reviewing a new type of technology being implemented.

To be included in the final review, reports, articles, and studies needed to meet all eligibility criteria. From the 1,500 initial search results, after discarding articles that were unavailable or that were duplicates of other results, the team applied the eligibility criteria and ultimately identified 98 articles for full literature coding. As seen in figure 1, articles that did not meet the eligibility criteria were excluded for a variety of reasons, though the most common reason for exclusion was that the police department was not in the United States. Other common reasons were that the articles did not focus on new technology in policing or did not include a requisite outcome variable. Once the review team determined that the article did not meet one of the eligibility criteria, review of that article ceased. Figure 1 indicates where in the ordered review process the article was determined to not meet the inclusion criteria.

Figure 1. Literature review process



Literature coding

As the final stage of the literature synthesis, the research team read and coded the 98 articles deemed eligible for this review. Table 1 describes the coding schema.

Table 1. Coding schema

Coding item	Description
Department/agency	The department or agency (if named) implementing the technology
Agency type	Federal, state, sheriff, municipal
Research question	The specific research question for the article
Data source	Primary or secondary data and the type of data (e.g., survey data, administrative, document review)
Sample/respondents	Community members, police officers, government officials, court officials, corrections personnel, incidents
Technology (category)	BWCs, CCTV cameras, drones/UASs, gunshot detection, facial recognition, LPRs, mobile computers, situational awareness / information-sharing software, social media / public websites, spatial analysis software, IT, cell phones
Technology (specific)	The specific technology being implemented (e.g., geographic information system [GIS], LPR, risk modeling, ShotSpotter®) based upon the category
Study type	Peer reviewed, grey literature, unsure
Evaluation type	Outcome evaluation, process evaluation, both, or neither
Research approach	Quantitative, qualitative, or mixed methods
Research methods (specific)	Specific research methods based on research approach (e.g., randomized control trial, descriptive)
Study included CBA	Yes or no
Outcomes (category)	The outcomes collapsed into summary categories (e.g., community complaints, community relationships/perceptions, crime reduction, officer behavior)
Outcomes (specific)	The specific outcomes of the study

Summary of included studies

As seen in table 2, articles that met the inclusion criteria reflected a wide range of technologies, research approaches, literature types, and evaluation types. The most common technology discussed in the articles reviewed was BWCs, which were discussed in more than half of the articles (51 percent, n=50). The next most frequently reviewed articles (15 percent, n=15) related to law enforcement agencies using IT (including CompStat) as part of their crime reduction strategies. Other technology types were less frequently represented, with CCTV cameras representing 9 percent (n=9) of the articles reviewed, and all other technologies having six or fewer articles per category. Research approaches were primarily quantitative in nature (71 percent, n=70), with the remaining generally split between qualitative alone or some type of mixed methods. Approximately 59 percent of the articles reviewed were published in peer-reviewed journals, whereas the rest were considered grey literature. Finally, more than half of the articles reviewed (62 percent, n=61) included a focus on outcomes, though it is also noted that 16 percent were coded as non-evaluative studies, including studies (Elmes and Roedl 2012; Sakiyama 2017; Heen, Lieberman, and Miethe 2018; Todak, Leban, and James 2021; Wy, Gaub, and Koen 2022) in which authors employed analytical methods to examine the perceptions of certain technologies as well as exploring relationships in the study area (e.g., spatial analysis).

Table 2. Summary of article characteristics

	n	%		n	%
Technology category*			Research approach		
BWCs	50	51	Mixed methods	18	18
CCTV cameras	9	9	Qualitative	10	10
Cell phones	0	0	Quantitative	70	71
Drones/UASs	6	6	Literature type		
Gunshot detection	1	1	Grey literature	40	41
Situational awareness/ information-sharing software	3	3	Peer review	58	59
IT (e.g., CompStat)	15	15	Evaluation type		
LPRs	7	7	Outcome evaluation	61	62
Mobile computers	2	2	Process evaluation	9	9
Social media / public website	5	5	Outcome and process	12	12
Spatial analysis software	6	6	Non-evaluative	16	16

* There are more than 98 articles reflected here as some articles covered multiple technology categories and were counted in all applicable categories.

Technology Categories

Body-worn cameras

BWCs are audio and video recording devices worn by law enforcement officers during their normal course of duty. BWCs can be mounted in a variety of locations, including on an officer's chest, head, or face. BWCs have grown substantially in popularity since 2014, and at least seven states have laws mandating their use.¹ BWCs' increased use is due largely to community demands for increased transparency and accountability around police use of force.



While policies vary by department, typically there are prescribed situations when officers must activate their BWC (i.e., begin recording). Officers are typically required to “tag” the videos for certain features (such as a use of force by the officer or the subject), redact private information, and upload them to a virtual evidence management storage site. Video footage can be reviewed by supervisors as part of regular compliance audits, used as evidence in court cases, and reviewed when community members make complaints about their interactions with officers. Because of the ubiquitous implementation of BWCs, a substantial proportion of reviewed articles focused on BWC use. Of the 98 articles included, 50 (51 percent) focused on BWCs. Table 3 summarizes the key features of BWC articles included in this review.

Table 3. Summary of BWC article characteristics (n=50)

	n	%
Research approach		
Mixed methods	6	12
Qualitative	6	12
Quantitative	38	76
Literature type		
Grey literature	20	40
Peer review	30	60
Evaluation type		
Non-evaluation	6	12
Outcome evaluation	35	70
Process evaluation	3	6
Outcome and process	6	12

1. Those states are Colorado, Connecticut, Illinois, Maryland, New Jersey, New Mexico, and South Carolina (NCSL 2021).

As shown in table 3, most of the articles (76 percent, n=38) examining BWCs used quantitative methods and, in contrast to other technology included in the review, most articles included an evaluation of BWC use (88 percent, n=44). Thirty of the articles (60 percent) were peer reviewed and 20 were grey literature (40 percent).

Overall, the articles find that BWCs are associated with positive outcomes for agencies, aligned with those agencies' reasons for implementation. For example, articles found that BWC use is associated with decreased use of force (Ariel, Farrar, and Sutherland 2015; Jennings, Lynch, and Fridell 2015; Braga et al. 2017; Braga et al. 2018; Alotaibi 2019), decreased community complaints (Katz, Choate, et al. 2015; Ariel, Farrar, and Sutherland 2015; Jennings, Lynch, and Fridell 2015; Braga et al. 2017; Hedberg, Katz, and Choate, 2017; Braga et al. 2018; Heumann, Kavin, and Chugh 2018), decreased lethal force events (Alotaibi 2019), and improved community perceptions of police (Crow et al. 2017).² In addition, BWCs were associated with an increased number of criminal charges initiated, criminal charges filed, and guilty pleas or verdicts for domestic violence cases (Katz, Choate, et al. 2015). Other articles examined whether BWCs affected police productivity and quality of police work and found that BWCs were associated with positive changes in this area, including officers using BWCs following policy more often than those without (Heumann, Kavin, and Chugh 2018) and officers self-reporting that they are better officers with BWCs than without them (Hickman 2017). There are mixed findings on whether wearing BWCs is associated with declines in numbers of arrests. For instance, Headley, Guerette, and Shariati (2017) found that BWCs were related to a decrease in arrests, whereas Katz, Choate, et al. (2015) found a significant increase in arrests.

One of the biggest challenges with implementation of BWCs is that officers do not always activate cameras when they should. There are substantially higher benefits of BWCs when officers activate the cameras as intended than when they do not (Headley, Guerette, and Shariati 2017). In addition, researchers (Jennings et al. 2017) caution that implementation of BWCs alone is not sufficient to improve transparency and accountability; they also recommend that agencies consider adopting BWCs alongside other strategies to reduce police use of force.

Research also identified potential challenges associated with BWC implementation. For example, officers in one study (Katz, Choate, et al. 2015) expressed frustration with how long it took to download video footage, as well as how long it took to complete reports associated with BWC footage. Officers also expressed concerns about how footage could be used against them (Jennings et al. 2017; Katz, Choate, et al. 2015). Perhaps not surprisingly, research finds that agencies are more likely to use BWCs if they are perceived as easy to use (Stinson 2018).

2. Agencies should consider how community demographics may impact changes in perception. For instance, Crow et al. (2017) found that younger individuals and non-White individuals were less likely to report improved perceptions.

Information technology to facilitate crime reduction

Articles in this category related to the collection, management, and use of organizational data. Considering the range of organizational data possible, this category was fairly broad and included common technologies, such as record management systems (RMS) (Koper, Lum, and Willis 2014); crime-, subject-, and vehicle-location technology (Gaither et al. 2017; Thorkildsen et al. 2019; Pang and Pavlou 2019; Weisburd et al. 2015); Crime Gun Intelligence Centers (Koper, Lum, and Willis 2014; Flippin, Katz, and King 2021); and predictive technology, both for predicting crime as well as predicting individuals who have a higher probability of being victims or perpetrators of crime (Hunt, Saunders, and Hollywood 2014; Saunders, Hunt, and Hollywood 2016; Jabri 2021; Ratcliffe et al. 2021; Tulumello and Iapaolo 2022). Because of the range of articles found in this category, this category may broadly be defined as technology that facilitates a crime-fighting function, either through aggregated data or through real-time information for street-level personnel.

As seen in table 4, the characteristics of the articles within this section varied. Of the 15 total articles reviewed, a majority had a quantitative research approach (73 percent, n=11) and about one-fifth were mixed methods (20 percent, n=3), with the remaining article (7 percent, n=1) being qualitative. Fewer than half of the articles (40 percent, n=6) were peer reviewed, with the remaining 60 percent (n=9) being considered grey literature. Most of the articles (67 percent, n=10) were outcome evaluations; 26 percent (n=4) were some other type of evaluation; and one study (7 percent) was non-evaluative in which the author (Keith 2015) performed logistic regression to determine significant factors such as IT that are predictive of forming collaborative partnerships with the community.

Table 4. Summary of IT article characteristics (n=15)

	n	%
Research approach		
Mixed methods	3	20
Quantitative	11	73
Qualitative	1	7
Literature type		
Grey literature	9	60
Peer review	6	40
Evaluation type		
Outcome evaluation	10	67
Process evaluation	2	13
Outcome and process	2	13
Non-evaluation	1	7

Studies evaluating IT have generally found mixed results. For instance, Hunt, Saunders, and Hollywood (2014) found that area-based predictive policing did not result in decreases in crime. In addition, Saunders, Hunt, and Hollywood (2016) found that individuals on Chicago's Strategic Subjects list (targeted as high-risk of being the victim or perpetrator of a shooting) were not more likely to be victims of shooting, though they were more likely to be arrested for shootings. In two separate articles, Pang and Pavlou found that the use of crime analysis can help officers make more informed decisions, reduce officer-involved shooting (OIS) events (2016), and improve officer safety (2019). Similarly, Jabri (2021) and Ratcliffe et al. (2021) found that algorithm-induced police presence reduced property crime.

These studies were limited in part by their methods of data collection. Particularly when using current crime data to predict future crimes, there is the potential for the current data to be biased, thereby leading to biased enforcement when relying on the outputs (Lum and Isaac 2016). In addition, data alone should not be considered a panacea, and improvements to IT themselves do not impact measures of productivity; rather, organizational and management practices have greater weight (see Koper, Lum, and Willis 2014). Overall, while a data set can be an important crime-reduction tool, it must be placed within the larger organizational mission and managed appropriately. Each of the studies included in this section focused on specific implementations of IT and was narrow in scope. This narrow scope is good for the reliability of the individual study but lessens the generalizability of the conclusions with respect to the benefits of IT when discussed broadly. For example, Pang and Pavlou (2019) were measuring the benefits of IT only in relation to officer safety, and their findings should not be used to discuss the impacts of IT on efficiency in investigations. The conditions in which IT is used must be taken into account when discussing its impact.

Closed-circuit television cameras

CCTV cameras are used by law enforcement departments to identify and control crime in public places (Caplan, Kennedy, and Petrossian 2011). *Closed-circuit* refers to broadcasts that are transmitted to a limited (closed) number of monitors. Police agencies use CCTV cameras with the expectation that they will deter and detect criminal activity because individuals may be less likely to commit criminal offenses when they know they are being monitored. CCTV cameras can also be used by law enforcement to monitor public areas without having to engage in face-to-face contact unless necessary. Finally, police agencies can also use CCTV cameras to aid and assist in investigations. The video footage captured from the CCTV cameras can be circulated to help identify individuals involved in crimes and may provide significant evidentiary value during prosecution.



As shown in table 5, most of the articles examining CCTV (89 percent, n=8) used a quantitative approach, and 67 percent (n=6) were peer reviewed, with the remaining 33 percent (n=3) being grey literature. About 67 percent of the articles (n=6) included an outcome evaluation, while two articles (22 percent) included a process evaluation. One article (13 percent) did not include an evaluation but examined the relationship between police-community racial asymmetry and the use of surveillance technology (Hendrix et al. 2018).

As noted earlier, the theoretical underpinning of CCTV monitoring is that the likelihood of “punishment that [the] cameras signify is enough to deter criminal activity in places where cameras are present” (Caplan, Kennedy, and Petrossian 2011, 256). However, research

Table 5. Summary of CCTV article characteristics (n=9)

	n	%
Research approach		
Mixed methods	1	11
Quantitative	8	89
Literature type		
Grey literature	3	33
Peer review	6	67
Evaluation type		
Non-evaluation	1	11
Outcome evaluation	6	67
Outcome and process	2	22

about the effectiveness of public CCTV in deterring crime has showed mixed results. For example, Caplan, Kennedy, and Petrossian (2011) found in a quasi-experimental assessment of CCTV cameras in Newark, New Jersey, that CCTV cameras were able to deter overall vehicle thefts and shootings, though this was in part moderated by location, finding insignificant results for areas that had a higher proportion of thefts compared to others. However, other studies have touched upon the fact that CCTV cameras can help detect other environmental barriers to crime reduction, including the need for improved lighting, fence installments, and increased security personnel (Shah and Braithwaite 2013).

One of the biggest limitations in the CCTV research is that most of the data come from large departments (Shah and Braithwaite 2013; Hendrix et al. 2018; Jennings et al. 2017), are not randomly selected (Johnston 2013; Sousa and Madensen 2016) or are lacking a control group (Shah and Braithwaite 2013). These realities limit the generalizability of the research, especially where rural and small urban areas are concerned.

It is equally important for law enforcement agencies to understand that technology is only as good as the manner in which it is employed. If it is employed minimally or is not well integrated into other policing functions, it is unlikely to yield a significant impact on crime.

— La Vigne and Lowry 2011, 54

Limitations of CCTV for crime prevention and investigation have to do with the cost of CCTV programs: Positive outcomes are typically observed in agencies with adequate resources to sufficiently staff and outfit CCTV programs. Properly implementing CCTV requires a high concentration of cameras being actively monitored and well integrated into law enforcement crime control and investigative activities (La Vigne and Lowry 2011; La Vigne et al. 2011; Piza et al. 2015). Departments need a well-established CCTV infrastructure before they are able to see such positive effects. If cameras are not highly concentrated or supported, all it may take to commit a crime out of sight of them is turning around a corner (Piza et al. 2015). Finally, there is a large variety in types of CCTV devices and the ways in which they are integrated into policing, and the technical limitations of these systems can prove to be quite challenging. For example, if footage can be manually downloaded only from certain locations and cannot be accessed through automatic downloads at all, it may result in minimal use of camera footage in supporting investigations (La Vigne and Lowry 2011).

Spatial analysis software

Spatial analysis software can encompass any software that uses the geolocation of events to make informed decisions about crime reduction tactics. Terms and systems included in this broader concept may include GIS, risk terrain modeling, crime forecasting, hot spots policing, or any other process used to identify areas of high crime that may be indicative of where future crimes might occur.

This process can be reflective (i.e., responding to recent past spatial crime patterns) or predictive (i.e., mining data to determine precursors of future increases in crime) (see, for example, Caplan, Kennedy, and Miller 2011; Kennedy, Caplan, and Piza 2011). In addition, this type of technology may be used to understand spatial concepts related to deployment of resources (e.g., exploring how the distribution of patrol cars impacts crime patterns; see Weisburd et al. 2015). Given the limited resources available to some police agencies, it is important to understand diminishing return on investment if agencies are sacrificing patrol functions in other, lower-crime areas.

In this review, the team identified six articles that discussed some type of spatial analysis software or related analytical approach. As shown in table 6, nearly all of them (83 percent, n=5) were quantitative in nature, and twice as many articles (67 percent, n=4) were found to be grey literature as had been published in peer-reviewed journals (33 percent, n=2). In addition, five (or 83 percent) evaluated outcomes, while the remaining article (17 percent) was not evaluative in nature.

Studies that looked at the effect of spatial analysis software generally have found significant predictive power using crime data mapping. For instance, Elmes and Roedl (2012) found that observed crime clusters had identifiable space-time relationships, thus

Table 6. Summary of spatial analysis software article characteristics (n=6)

	n	%
Research approach		
Qualitative	1	17
Quantitative	5	83
Literature type		
Grey literature	4	67
Peer review	2	33
Evaluation type		
Non-evaluation	1	17
Outcome evaluation	3	50
Process evaluation	2	33

enabling the development of proactive crime reduction models. Further exploring this, Caplan, Kennedy, and Miller (2011) found that the likelihood of a shooting significantly increased in higher risk cells in a risk terrain model. They also found that the risk terrain model was a better predictor of crime than hot spot mapping, a finding also made by Kennedy, Caplan, and Piza (2011). Furthermore, the Kennedy study found that predictive models were most efficient when primarily focusing on the high and significant correlations to the predicted event (as opposed to maintaining other, less correlated variables).

One potential pitfall in using spatial analysis software is overestimating the accuracy of the data or their implications. As with any analysis process, the findings will be only as reliable as the data used and, where potential bias exists in law enforcement data (particularly when that data is being used to predict future crime), the process may serve only to reinforce the presence of disparate outcomes (for a broader review, see Ferguson 2017). Agencies should also be aware that the quality of mapping may vary depending on the crime, environment, technique, and parameter settings being used. Given these considerations, agencies should consider spatial analysis software to be a pointer system rather than a crystal ball.

Terms and systems included in the broader concept of spatial analysis software may include GIS, risk terrain modeling, crime forecasting, hot spot policing, or any other process used to identify areas of high crime that may be indicative of where future crimes might occur.

Drones/UASs

Unmanned aerial vehicles (UAV), or drones, are aircraft that can be operated remotely. UAV refers to the aircraft, which is one part of an unmanned aircraft system (UAS) (Anania et al. 2019; Heen, Lieberman, and Miethe 2018; Marte et al. 2018). The UAS includes the UAV, its human operator, and a communication system between the human operator and the UAV. As the name implies, UAVs do not have any human crew physically on board (Anania et al. 2019).



Chula Vista (California) Police Department Drones as First Responders [DFR] program drone

Instead, a human operator controls the UAV remotely from the ground. The Federal Aviation Administration (FAA) classifies all remote-controlled aircrafts as UAVs, no matter their size or sophistication (Marte et al. 2018). This means that one could use the term UAV to describe a toy, a sophisticated autonomous flying device capable of recording video, or anything in between.

Research on UASs is extremely limited. From the more than 1,000 articles initially identified, only six that met the inclusion criteria focused on the use of UASs (see table 7), and all of these viewed the use of UASs from the community perspective. While privacy concerns related to the use of UASs are certainly valid and important, to fully understand the benefits of UASs, researchers need to expand the focus of their studies. As of publication, the CNA team was not able to identify any rigorous studies on UASs' impact on, for example, crime reduction, officer safety, community safety, or police accountability.

Table 7. Summary of UAS article characteristics (n=6)

	n	%
Research approach		
Mixed methods	2	33
Quantitative	4	67
Literature type		
Grey literature	2	33
Peer review	4	67
Evaluation type		
Outcome evaluation	1	17
Other	5	83

While law enforcement agencies and criminological researchers seem to agree that the use of UASs is beneficial for crime investigation and prevention, there is a concern about how the use of UASs impact local community members' privacy rights and, in turn, their perception of the law enforcement agency.

As previously discussed, law enforcement agencies use UASs to obtain pictures or videos in areas of interest or to provide a real-time video feed of public spaces (Anania et al. 2019; Heen, Lieberman, and Miethe 2018; Marte et al. 2018). Law enforcement agencies can also use UASs for crime scene photography, search and rescue, crowd management, or identifying crime. Since the change in FAA restrictions on the use of UASs by public safety users in 2016, such as no longer requiring UAV operators to be licensed, increased numbers of law enforcement agencies have begun using UASs in their investigative and crime prevention work (Heen, Lieberman, and Miethe 2018). While law enforcement agencies and criminological researchers seem to agree that the use of UASs is beneficial for crime investigation and prevention, there is a concern about how the use of UASs impact local community members' privacy rights and, in turn, their perception of the law enforcement agency. This concern about the community support for the use of UASs was the focus of most articles reviewed (see the discussion in "Community Buy-In" beginning on page 31).

LPRs

Automated license plate readers (ALPR or LPR) are automatic scanning devices that use infrared technology to scan license plates using optical character recognition (OCR) to convert images into text. LPRs can operate in a fixed location (e.g., at a busy intersection) or be portable and used in squad cars or other vehicles. Once a license plate is scanned, LPRs can then compare the results against lists of stolen vehicles or open warrants (Merola and Lum 2014; Ozer 2010). LPRs can thus benefit law enforcement agencies as the automatic comparison is faster than manual license plate checks (Willis, Koper, and Lum, 2018); the technology can also perform scans at high speeds or in dark conditions, something police officers are unable to do on their own with any accuracy (Ozer 2010; Merola and Lum 2014; Willis, Koper, and Lum 2018).

However, research on LPRs that met the inclusion criteria is limited. From the 98 articles included in this review, only seven focused on the use of LPRs, and only one focused on the effectiveness of LPR technology. The other studies provide frameworks and considerations for use of LPRs or examined the factors that related to public support for them. As shown in table 8, five of the articles (71 percent) were quantitative in nature; similarly, five of the articles (71 percent) had been peer reviewed.

When considering LPR effectiveness, one can consider the performance of the technology or crime reduction outcomes. LPR measures that are relevant to overall performance of the technology include capture efficacy, read accuracy, matching effectiveness, and capture/read factors (Roberts and Casanova 2012). Measures of effectiveness may include the number, nature, and results of license plate matches (e.g., vehicles recovered); the number and outcomes of investigations for which LPRs or LPR data have been used; and

Table 8. Summary of LPRs article characteristics (n=7)

	n	%
Research approach		
Mixed methods	1	14
Quantitative	5	71
Qualitative	1	14
Literature type		
Grey literature	2	29
Peer review	5	71
Evaluation type		
Outcome evaluation	7	100

whether crime was reduced in areas where LPRs were deployed (Koper, Lum, and Willis 2014). The limited number of studies on LPRs still leaves tests of these measures of effectiveness wanting. While Roberts and Casanova (2012) did theorize measurement tools, of the articles in this review, only Ozer (2010) and Koper et al. (2022) empirically measured effectiveness of LPRs in crime reduction. Ozer (2010) proposes that, although costly, technological innovations like LPRs can help police departments smartly enforce the law, optimally allocate scarce resources, and maximize crime prevention; the efficacy and effectiveness of LPR technology make it a worthy investment. Given how rapidly technology changes, the field would benefit from more recent studies on the use of LPRs.

In addition, police departments have expanded the use of LPRs beyond their traditional intent and are applying them in innovative ways (Willis, Koper, and Lum 2018). Merola and Lum (2014) and Merola et al. (2014) introduced a “continuum of LPR uses” that provides a way to understand both the extent of the uses and the legal and logistical considerations related to adopting and deploying LPRs, including using LPRs for identifying cars of interest, connecting the data with secondary data sources, data mining, data storage, and using the data for predictive analysis.

As with other technologies, the studies mentioned in this section lack generalizability; the number of LPRs an agency has access to, whether the LPRs are mobile or stationary, and the size of the jurisdiction have a large impact on how the agency is using LPRs. Koper, Lum, and Willis (2014) discussed how the user’s familiarity with the technology greatly also affected its strategic use and efficacy. When the individual officer’s application of the technology is inconsistent, it calls into question the reliability of the results stemming from user bias and error. Similar to other location-dependent technologies, there is still much research that can be done into the decision-making regarding where LPRs are deployed.

Social media and websites

Social media (such as X [formerly Twitter] and Facebook) and other websites (such as a police department’s website) have the potential to transform police organizations’ communication and enhance police-community relationships by creating effective virtual police-citizen interfaces (Beshears 2017; Hu, Rodgers, and Lovrich 2018; Rosenbaum et al. 2011; Cheng 2021). For instance, social media and websites can allow police organizations to increase their communication and information transmissions and reach out to speak with community members who may be unable or unwilling to show up at public meetings (Rosenbaum et al. 2011). Social media and websites can also be a relatively low-cost way to communicate (Beshears 2017) and, when used effectively, can potentially expand the problem-solving dialogue between police and community. Furthermore, social media and websites can allow police agencies to be more transparent and accountable to the communities they serve (Rosenbaum et al. 2011).

Sacramento County (CA) Sheriff’s Department



As seen in table 9, there are relatively few articles that looked at the use of social media and websites. Overall, we found the current studies to be primarily theoretical, though three of the five articles (60 percent) did use some type of quantitative approach. Most of them were peer reviewed (80 percent, n=4), and two contained evaluations of both outcome and process (40 percent) while the remaining three did not include evaluations (60 percent).

Table 9. Summary of social media and websites article characteristics (n=5)

	n	%
Research approach		
Quantitative	3	60
Qualitative	2	40
Literature type		
Grey literature	1	20
Peer review	4	80
Evaluation type		
Outcome and process	2	40
Other	3	60

The articles in this category discussed how law enforcement agencies can use social media and websites to push out, pull in, and interact with their community constituents in broad ways.

The articles in this category discussed how law enforcement agencies can use social media and websites to push out, pull in, and interact with their community constituents in broad ways. For instance, there is evidence indicating that social media can help improve and strengthen community-police relationships and in turn increase departments' ability to solve crime (Beshears 2017). This can also be true for websites, though this is impacted by how the agencies use them. This is illustrated by Rosenbaum et al. (2011), who found that agencies with websites were more inclined to use websites to "push out" information rather than "pull in" information from community members. The study concluded that departments with a stronger emphasis on community policing were more likely to have a website than departments that give less attention to the community policing model. These fall into the broader ways in which law enforcement agencies use social media found by Hu, Rodgers, and Lovrich (2018), which include "crime-fighter," "traditional cop," "public-relations facilitator," or some mix or balance of these.

As mentioned earlier, the breadth of social media research and how it can be used to law enforcements' advantage is quite small. The review found only five studies to consider, all of which are quite narrow. Cheng (2021) examined only a single police department's Twitter usage. Two studies—Hu, Rodgers, and Lovrich (2018) and Rosenbaum et al. (2011)—had quite a large sample of agencies but were limited in the media they were studying. Hu, Rodgers, and Lovrich had a sample of 7,153 posts from 14 police departments, but looked only to Facebook for data. While Rosenbaum et al. did have a large sampling size of law enforcement agencies, the extent of research on social media usage in community policing that met the inclusion criteria is quite small, and results might not be generalizable to all U.S. agencies.

Mobile phones and computers

Radio communications are a mainstay technology for police agencies across the nation. As many law enforcement agencies transition from radio communication to mobile broadband networks to improve their internal and external communications, it is important that police agencies understand this technology and its impact. “Broadband” refers “to the (relatively wide) bandwidth characteristics of the wireless transmission and its corresponding ability to support multiple users and/or transport [large] quantities of data” from remote terminals, such as in-car computers and mobile phones (Carter, Grommon, and Frantz 2014, 2). Wireless-enabled radios and computers use over-the-air programming (OTAP) to process tasks that previously required police officers to return to the station house to establish physical connection between mobile radios and computers.

Despite the centrality of this communication for police agencies, there is relatively little research on recent developments around this integral police technology. As shown in table 10, both of the articles reviewed (100 percent, n=2) on mobile phones and computers (broadband communication) were mixed methods, and both of the articles (100 percent, n=2) included an outcome evaluation of the technology. The articles were evenly split between peer reviewed (50 percent, n=1) and grey literature (50 percent, n=1).

In reviewing the articles for this technology, the team found only two that actually examined the impact of wireless mobile broadband on police operations. One of these was Carter and Grommon (2017), which evaluated the impact of mobile broadband on end users’ perceptions of transitioning from cellular-based communications to a dedicated wireless mobile broadband network. This study found that wireless broadband technology enhanced officers’ perceptions of their ability to do their job. The officers surveyed reported improvements in information flow and quality, increased feelings of confidence and safety, and enhanced and more efficient report writing. Specifically, police personnel

Table 10. Summary of mobile phone and computer article characteristics (n=2)

	n	%
Research approach		
Mixed methods	2	100
Literature type		
Grey literature	1	50
Peer review	1	50
Evaluation type		
Outcome evaluation	2	100

considered their reports to be higher in both quality and accuracy. Patrol personnel reported more confidence and feelings of safety during law enforcement encounters in which they used broadband systems to glean information. The perceived and actual improvements in information flow and quality appeared central to these perceptions. Officers in this study also reported that “signal strength and coverage issues in some patrol areas continued to be problematic and influenced how they were able to complete certain tasks” (859). This study also demonstrated that there was “a perceived increase in workload responsibilities associated with report writing by patrol officers (859),” including an increased amount of information reported in the field due to additional data entry fields and increased supervisory accountability to review and approve all the reports and additional data being collected.

A prior study by Carter, Grommon, and Frantz (2014) attempted to determine the efficacy of wireless broadband technology on police operations by examining (1) the implementation fidelity³ and (2) the implementation impact on police officers. This study found that the adoption of wireless broadband was associated with greater access to information, better flow of information, and an improvement in reports. As wireless broadband technology allows for reports to be automatically uploaded into the department’s record management system from the field, reports have more data fields than before, which can improve the quality of information captured and shared internally both within the department and externally among partner agencies. Police personnel included in the study agreed that the information in their reports was more accurate after implementing wireless broadband, which meant their reports were of higher quality supporting the idea that broadband can lead to improvements in report writing. Improvements in information sharing as a result of wireless broadband implementation were considered to be beneficial.

These two studies were limited by their retrospective study design. The departments included in the research had existing mobile broadband technology prior to the study, leading to possible misattribution of changes in the workflow to broadband when other mobile technology was confounding the results (Carter, Grommon, and Frantz 2014). Furthermore, participants in these studies had varying levels of familiarity with the technology itself, which could have impacted the survey responses (Carter and Grommon 2017).

3. In this study (Carter, Grommon, and Frantz 2014), *implementation fidelity* refers to the degree to which the wireless broadband technology was implemented in accordance with initial expectations.

Gunshot detection

With the advent of gunshot detection technology in the 1990s (Choi, Librett, and Collins 2014), law enforcement agencies can efficiently identify and locate shots fired. Typically, police rely upon community members to report shots fired, and in some cases police directly observe gunshots. Gunshot detection technology like ShotSpotter changes this reliance and gives law enforcement another way to consistently get information about gunshots.

This technology relies on sensors to triangulate and alert police dispatch or to trigger other alert systems that gunshots have been detected in a specific area. Developers, vendors, and law enforcement promote gunshot detection as a technology that can consistently and rapidly inform police about gun-related crimes and thus facilitate the police's ability to resolve gun-involved crimes more effectively and with greater accuracy than gun-involved crimes only made aware to police through calls for service. Because of its focus on sound rather than images, gunshot detection is also less invasive than other surveillance systems, such as CCTV.

Despite gunshot detection's utility, there was only one article discussing it (see table 11) in this literature review that met the inclusion criteria. Choi, Librett, and Collins (2014) performed a quasi-experimental study to examine the impact of gunshot detection technology, namely the ShotSpotter system, on the police's effectiveness to identify, investigate, and prosecute gun-involved cases. Their findings suggest that the implementation of ShotSpotter increased police effectiveness in two of the three categories they observed, including improved response times and time to dispatch (though not case resolutions). However, the authors also noted that gunshot detection cannot guarantee complete accuracy when locating shots fired and thus cannot be the only method officers use. An additional drawback includes the high costs associated with the implementation of the system. As a result, they suggest linking technologies in more deliberate ways, such as combining gunshot detection and CCTV. This combination could lead to more effective outcomes, as cameras can be synchronized with sensors to visually track shots fired in areas where the sound of gunshots was detected.

Table 11. Summary of gunshot detection article characteristics (n=1)

	n	%
Research approach		
Mixed methods	2	100
Quantitative	1	100
Literature type		
Peer reviewed	1	100
Evaluation type		
Outcome evaluation	1	100



Trends in Findings

The team observed that each of the final 98 articles provided unique insights to implementing a particular technology. Nevertheless, they found broader themes across the articles with respect to identifying technology needs and implementation considerations as well as achieving intended benefits. The aggregate of these articles was therefore capable of illustrating the range of processes that agencies have used (for better or for worse) to implement new technology or enhance existing technology. The team summarizes each of these themes in this section, providing lessons learned and promising practices for agencies at any stage of the implementation process.

Identifying a need for technology

A key theme that emerged in the literature review was a focus on the factors law enforcement agencies consider when identifying the need to implement a new technology. Overall, approaches to identifying a need for technology can be proactive or reactive. Proactive approaches include identifying a need, deficit, or challenge and finding a technology to help fill that need. For example, agencies with a goal of increasing community engagement may use social media or websites to increase communication with the public. Reactive approaches tend to be responses to negative events or to mandatory policy around technology use, such as BWC policies. Across proactive and reactive approaches in the articles reviewed, the team identified five overarching needs that tended to be the driving forces for implementing new technology in law enforcement: (1) increased accountability and transparency, (2) improved quality of investigations, (3) increased efficiencies in personnel and financial resources, (4) increased effectiveness of existing technologies through integration, and (5) improved communication and relationship with the community. These categories are not mutually exclusive; implementation of some technologies can improve outcomes across multiple areas.

Accountability and transparency

The most common theme around identifying a need for technology in this review was the need to improve accountability and transparency (see, for example, Caplan, Kennedy, and Miller 2011; Johnston 2013; Miller and Toliver 2014; Jennings, Lynch, and Fridell 2015; Koen 2016; Heumann, Kavin, and Chugh 2018; Nowacki and Willits 2018; Sousa, Miethe, and Sakayama 2018; Hendrix et al. 2018; Pang and Pavlou 2019). In the articles touching upon this theme, BWCs were the most common technology being implemented or evaluated to address the issues. In part, this frequency may be due to increasing calls for technologies that can improve accountability and transparency by community advocates concerned about use of force and racial bias—BWCs being one of the most common types of these technologies (Jennings, Lynch, and Fridell 2015; Heumann, Kavin, and Chugh 2018).

With regard to internal accountability, some studies (Miller and Toliver 2014; Katz, Kurtenbach, et al. 2015; Ariel 2016; Nowacki and Willits 2018) have found that agencies implemented BWCs out of a desire to increase compliance with their own departmental policies. This finding is also reflected in another study (Stinson 2018), which found that the greater the perception that BWCs will improve officer performance, the more likely leadership would support the implementation of BWCs. Alternatively, the desire

Across proactive and reactive approaches in the articles reviewed, the team identified five overarching needs that tended to be the driving forces for implementing new technology in law enforcement.

for new technology can also arise from lower-ranked personnel. For instance, studies (Miller and Toliver 2014; Jennings, Lynch, and Fridell 2015; Hickman 2017) have found that patrol officers support adopting BWCs to protect themselves from (possibly unfounded) community complaints.

Improve quality of investigations

The second-most cited reason for the implementation of new technology is that law enforcement leaders are interested in improving the quality of policing practices (see, for example, La Vigne and Lowry 2011). Agencies may seek out new technology like cameras, drones, or LPRs to provide actionable intelligence for investigations by generating leads or video evidence of crimes (La Vigne and Lowry 2011). For instance, several studies (Roberts and Casanova 2012; Merola and Lum 2014; Merola et al. 2014) have noted that LPRs increase efficiency in an area that would otherwise require manual work, giving agencies the ability to read license plates at high speeds and at night and being able to link individuals quickly using vehicle records and other connected databases. Also related to improved investigations, Koper, Vovak, and Cowell (2019) and Flippin, Katz, and King (2022) looked at Crime Gun Intelligence Centers (CGIC), which allow for the comparison of ballistics evidence through a nationwide database, thereby helping investigators of crimes involving firearms identify when those firearms have been used in other crimes across the country. In both studies, the authors noted that CGICs are particularly helpful in improving the investigation and clearance rates of gun crimes (Flippin, Katz, and King 2022) and nonfatal shootings (Koper, Vovak, and Cowell 2019).

Effective use of resources

Departments may also implement technology in an effort to make more effective use of limited agency resources (see, for example, Rosenbaum et al. 2011; Choi, Librett, and Collins et al. 2014; Koper, Lum, and Willis 2014). This possibility is especially true of technologies that automate certain police duties, which can reduce costs and improve efficiencies. Technological improvements related to crime analysis can also help departments effectively deploy personnel to hot spots in their jurisdictions (Elmes and Roedl 2012; Caplan, Kennedy, and Miller 2011; Kennedy, Caplan, and Piza 2011). Other studies (Choi, Librett, and Collins 2014; Koper, Lum, and Willis 2014) examined the integration

of multiple technologies as an innovation in and of itself that can yield more effective outcomes, such as integrating gunshot detection and camera technologies. Finally, technology that facilitates communication, like websites and social media, can enhance intelligence gathering, problem solving, and public confidence in the police—all for a reduced price compared to other, more labor-intensive efforts such as in-person report taking (see, for example, Rosenbaum et al. 2011; Beshears 2017).

Community trust

Articles in the review also highlighted technology's ability to facilitate communication with the public, primarily through social media and agency websites, and new opportunities for information exchange between police and the public (e.g., one-way pushing out of information and two-way exchange of information). For instance, several articles (see, for example, Rosenbaum et al. 2011; Koper, Lum, and Willis 2014; Beshears 2017; Cheng 2021) discussed how websites and social media give police and the community another way to communicate and connect, which may lead to strengthened partnerships and overall enhanced perceptions of legitimacy. In addition, the literature available on BWCs (Katz, Choate, et al. 2015; Ariel, Farrar, and Sutherland 2015; Jennings, Lynch, and Fridell 2015; Braga et al. 2017; Hedberg, Katz, and Choat 2017; Braga et al. 2018; Heumann, Kavin, and Chugh 2018) showed fewer community complaints after implementation than before. However, while Crow et al. (2017) looked at BWCs as a tool for improving community perceptions of police, non-White respondents did not rate their positive perceptions of the technology as highly as White respondents. Therefore, BWCs (as well as other monitoring technologies) are not in and of themselves a panacea for building community trust; other efforts must be employed in tandem (La Vigne and Lowry 2011; Sousa and Madensen 2016; Heen, Lieberman, and Miethe 2018, Hendrix et al. 2018).

Expectations for technology's ability to address identified needs

Several studies collected for this review noted that, when identifying the need for technology, law enforcement agencies should also calibrate their expectations around what the new technology can reasonably accomplish. For example, research (Yokum, Ravishankar, and Coppock 2017) finds that the introduction of BWCs alone, particularly in large cities, cannot effect widespread change in policing practices or community behavior. Lack of clear links between technological progress and effectiveness in policing may limit the appeal of certain technologies. Relatedly, technical, legal, and financial issues may limit the potential impact of policing technology (Koper, Lum, and Willis 2014; Willis, Koper, and Lum 2018; Wy, Gaub, and Koen 2022). Research (Willis, Koper, and Lum 2018) suggests that agencies view technology as a practice rather than a tool, and as such, implementation and utility of the technology will vary by person and circumstance. In line with this idea, technology is more likely to meet the desired purpose if officers receive training and direction on how to use the technology in their daily work. In part, we discuss these issues in the next section of this review.

Considerations for implementation

When implementing any new technology, an agency should undertake careful planning to ensure that the technology is well resourced, has community and agency buy-in, and is supported through strong policies and training. In addition, even the most carefully planned technology can ultimately lack organizational utility when fidelity to the implementation plan is not maintained. In this section, we discuss implementation trends reflected in the collected literature, noting how each impacted the focus and findings of the articles we reviewed.

Resources

One of the primary elements for implementing new technology is ensuring that the program is adequately resourced. At the most basic level, agencies must be able to devote funds to purchase the physical technology hardware and software, which at times may not be available (see La Vigne and Lowry 2011). For instance, research on the implementation of BWCs (Heumann, Kavin, and Chugh 2018) found cost to be a key barrier in implementation. However, in a cost-benefit analysis of BWCs, Braga et al. (2017) measured the costs and benefits of officers wearing BWCs for a year and found that agencies whose officers used BWCs saved about \$4,006 per officer. When applying the CBA estimate to the department's 1,400 patrol officers, BWCs would save the department between \$4.1 and \$4.4 million annually (Braga et al. 2017). BWCs generated savings for departments as they were able to resolve complaints at a faster rate. Furthermore, costs may be front-loaded (see, for example, Choi, Librett, and Collins 2014, in the context of ShotSpotter) or may vary by month (see Ozer 2010, in the context of ALPRs). In addition, ongoing operating and maintenance costs (including associated personnel) must be considered. This analysis should be done methodically, as things like personnel hours should be concentrated where they are going to be most impactful (see Shah and Braithwaite 2013). For instance, La Vigne and Lowry (2011) found that while still cameras installed at the exits of commuter parking lots were meant to deter offenders, only one-third of cameras were operational because of budgetary constraints, and the need to manually download footage from each camera led to lowered use of the cameras overall. Combined, these issues may represent a real hindrance to the implementation process and may ultimately lead to the program's failure.

In addition to purchase costs for new equipment, agencies must also be aware of the costs associated with system infrastructure, integration, and technological capacity. If systems do have the necessary infrastructure, technologies that promise to improve productivity may inadvertently lead to increased workloads and decreased productivity. For instance, depending on an agency's current infrastructure, implementation of technology may lead to increased burden, workload, and responsibilities in reporting requirements via an increased number of data entry fields (Carter, Grommon, and Frantz 2014; Koper, Lum, and Willis 2014; Carter and Grommon 2017).

In addition to purchase costs for new equipment, agencies must also be aware of the costs associated with system infrastructure, integration, and technological capacity.

Community buy-in

Several of the articles reviewed touched upon the importance of community buy-in as a contributor to a technology program's overall success. One potential barrier to community buy-in of technology is community members' privacy concerns, as the public may not be supportive of technologies without proper assurances that their information will be protected. For instance, studies on BWCs (see, for example, Boivin et al. 2017; Crow et al. 2017) find that when people are concerned about privacy (i.e., how footage will be stored and used), they are less likely to support the department's use of BWCs. Trust in the new technology may further be impacted by the community's overall trust in the department in general. While community members must decide for themselves whether the potential security benefits outweigh privacy concerns, "trust in the police may provide a kind of social capital that might be the difference" in their decision (Merola and Lum 2014).

As one potential way to achieve community buy-in, Sousa and Madensen (2016) discussed a four-dimensional approach that enhanced public trust in a mounted crime surveillance camera in a high-crime area of Las Vegas. They found that community buy-in was achieved when the department was able to demonstrate the intervention was (1) reasonable (in line with community desires), (2) disarming (visible cameras, privacy sacrifices offset by increases in safety), (3) focused (limited camera range), and (4) consistent (reflective of deterrence purpose). In their review, they found that the Las Vegas Metropolitan Police Department worked with the community to address any concerns with these dimensions.

Similarly, community members may have concerns with aerial surveillance in the form of UASs. While law enforcement agencies and criminological researchers seem to agree that the use of UASs is beneficial for crime investigation and prevention, local community members are concerned about how the use of UASs impacts privacy rights and, in turn, agencies are concerned about how the use of UASs impacts communities' perception of law enforcement. In fact, such privacy concerns are so prevalent that they were the focus of most of the articles regarding UASs in the collected literature (Schwartz 2017; Heen, Lieberman, and Miethe 2018; Marte et al. 2018).

Fittingly, actively engaging the community on new technologies can also be accomplished using current technology, particularly websites and social media platforms. Such community outreach mechanisms should be designed to support communication and problem-solving discussions among residents, rather than simply acting as a tool for providing one-way information.

In addition to privacy concerns, departments may have to contend with community belief that the use of the technology will reinforce biased perspectives. Community members may hold this belief about police agencies' use of crime prediction technology and hot spot policing—a belief supported by relevant literature in this review. For instance, Lum and Isaac (2016) discussed the potential circular bias in hot spot policing in the sense that initially biased data will lead to biased algorithms, leading to biased hot spot identification and thereby reinforcing biased crime data (in addition to incurring other damaging social costs).

Agencies can mitigate these concerns about implementing new technology in several ways. One is by incorporating strict privacy safeguards through policy and community outreach. For instance, in their review of BWCs, Heumann, Kavin, and Chugh (2018) discuss several policy considerations regarding privacy, including victims' and bystanders' ability to request the camera be turned off, retention schedules, redaction, and subject or event characteristics that may present unique privacy concerns. Policy should also reflect current legal opinions related to Fourth Amendment rights against unreasonable searches and seizures, particularly for technologies such as drones and CCTV cameras that allow law enforcement to see further than is possible with the naked eye. For instance, Valdovinos, Specht, and Zeunik (2016) discussed various court decisions pertaining to the reasonable expectation of privacy and noted that such reasonable expectation may be limited by location.

To help law enforcement agencies develop policies and procedures that increase community support, both the International Association of Chiefs of Police (IACP) and the Office of Community Oriented Policing Services (COPS Office) released written reports (IACP 2015; BJA 2014) containing recommendations related to community relations. As with BWCs, community concern over the use of UASs frequently notes the Fourth Amendment right against unreasonable searches and seizures (Valdovinos, Specht, and Zeunik 2016). The U.S. Supreme Court has addressed the right to reasonable expectation of privacy in a number of cases, though it notes that this expectation may be limited by location (*Katz v. United States*; *United States v. Jones*; *United States v. Knotts*). By having robust discussions with the community beforehand, law enforcement can allow community members' voices to be heard while also coming to a shared understanding of legal restraints.

Officer and leadership buy-in

Also critical for the successful implementation of technology is buy-in from street-level officers, supervisors, and command staff (see Katz, Choate, et al. 2015; Headley, Guerette, and Shariati 2017; Hickman 2017; Heumann, Kavin, and Chugh 2018). As technology does not impact crime and operational statistics by itself, strong practices, oversight, and management approaches are needed to elicit the greatest degree of organizational utility from the technology. As a first step, buy-in at the leadership level is critical because executive support has been shown to improve the overall implementation and effectiveness of new technologies. For example, in his review of BWCs, Stinson (2018) found a correlation between agency leaders' intention to use technology and their perception that others believe that BWCs are important. Hickman (2017) had also found that agency leadership should make a concerted effort to engage officers about the implementation of BWCs, including explaining the benefits and addressing concerns.

Similarly, the culture and practices of an agency may impact the success of implementing a new technology (Koper, Lum, and Willis 2014). Executives will therefore need to ensure they are taking the necessary steps to make officers comfortable with new technologies such as BWCs. As an example of these efforts, several articles reviewed (see, for example, Heumann, Kavin, and Chugh 2018; Headley, Guerette, and Shariati 2017; Koen 2016; Katz, Choate, et al. 2015) commented on officers' perceptions that BWCs would be used as a disciplinary tool. For instance, Heumann, Kavin, and Chugh (2018) found that officers expressed concerns that incorrect use of BWCs could be one more thing they could be disciplined for, despite also believing that use of BWCs was in their best interest and would have a positive impact on policing.

Overall, many studies concluded that departments and officers generally support new technology, particularly after having some experience with it. For instance, Snyder, Crow, and Smykla (2019) found more positive views of BWCs among all officers post-implementation than pre-implementation, and that the change in perceptions was particularly salient for supervisors. Consistent with this observation is other research (see Heumann, Kavin, and Chugh 2018) indicating that officers consider use of BWCs to be in their best interest. Heumann, Kavin, and Chugh (2018) also found that officers in departments that already had in-car camera programs generally regarded BWCs as the next logical technological step. Therefore, as department members become more and more acquainted with different technology, they will be more supportive of it as well as other technology introduced in the future.

Developing or updating policies and training

Incorporating any new technology also most often means developing or updating policies and training accordingly. As part of these updates, organizations need to ensure that policies and training specify how to use the technology as well as provide clarity on what benefits the technology is supposed to deliver. Policies must be developed and enforced

to ensure data quality, system security, compliance with applicable laws and regulations, and recognition of civilian privacy concerns (for example, see Roberts and Casanova 2012, as it relates to ALPRs).

In part, these elements should be informed by a robust pilot test program, incorporating staff input and evaluating initial findings to observe the impact the technology is having across the department. This approach may be guided by the diffusion of innovation theory (see Hu, Rodgers, and Lovrich 2018), which holds that new ideas and technology pass through clear phases of implementation, including a period of trial and error and adaptive adjustment that leads (in time) to routinization.

Agencies will also want to consult publicly available resources for how other agencies have structured their policies. For instance, a BWC toolkit is presently available through the Bureau of Justice Assistance (BJA 2024) as a resource for agencies seeking to develop or revise their BWC policies. By providing the most up-to-date information, the toolkit provides agencies the means to develop policies that are in line with current best practices and relevant to their needs. The toolkit also provides a repository of information on additional topics, including research, training, and implementation resources. In addition, for agencies participating in the federal BWC Training and Technical Assistance (TTA) program,⁴ a TTA team provides support with the implementation process, including policy review. As part of this process, scorecards are used to assess the comprehensiveness of an agency's BWC policy, ensuring that at least 17 issues across 11 different categories (e.g., video activation, video deactivation, and data transfer and download) are addressed while also identifying areas for improvement.

Maintaining fidelity to implementation

Finally, several articles (see, for example, Koper, Lum, and Willis 2014) discussed the need for an agency to maintain fidelity to its initial implementation plan. When implementing any new technology, agencies must adhere conscientiously to their strategies and goals for implementing and using the technology as well ensure the technology advances their overall strategies and goals.

Once technology implementation is initiated, agencies should verify that officers are using the technology as intended so they can conduct a true assessment of the technology's effectiveness. This assessment can be accomplished via ongoing review and auditing to "help enforce proper use of the system and reassure the public that their privacy interests are being recognized and respected" (Roberts and Casanova 2012, 2). As part of the assessment, agencies should incorporate reliable and valid measures of success (Koper, Lum, and Willis 2014). Agencies should also manage expectations for how the data may be interpreted. For instance, Choi et al. (2014) reviewed ShotSpotter, noting that it was difficult to determine whether the system reduced crime because the "tally of acknowledged crime [could] increase dramatically" as a result of implementing the technology.

4. BJA has funded BWC TTA since 2015 to help local communities implement their BWC Policy and Implementation Program (PIP) initiatives. Learn more at "Body-Worn Camera Training & Technical Assistance," Bureau of Justice Assistance, accessed May 7, 2024, <https://www.bwctta.com/>.

Benefits of technology

Once properly implemented, agencies will want to explore the full range of benefits that technology can offer. Often, these benefits can go beyond the conventional use of a technology through innovative thought spurred by organizational needs. This section discusses specific benefits that modern technologies can lead to, including uses in crime prevention, investigations, accountability, and community relations. Specific benefits of particular technologies are also included in the search results.

Crime prevention

One of the benefits agencies should look for in any new technology is greater aid in preventing crime than the department's current approaches. For instance, many agencies employ some type of crime data review process, such as CompStat, to look at area-based trends to maximize deployment efficiency and hold supervisors accountable. However, such approaches are reactive and do not account for the evolving nature of crime. For instance, Caplan, Kennedy, and Miller (2011) found risk terrain modeling showed greater ability to identify future crime (shootings) than did retrospective processes (i.e., hot spot policing). Caplan, Kennedy, and Miller (2011), incorporate concepts of Routine Activities Theory (Cohen and Felson 1979), which posits that crime results when three things exist together: (1) a motivated offender, (2) an attractive target, and (3) the absence of capable guardianship. Using this theory as a framework, Caplan, Kennedy, and Miller (2011) argue that because crime is not static and Routine Activities Theory provides for opportunity-based crime, predicting future crime by measuring such opportunity would be more beneficial than backward-looking processes alone. This argument was also made by Kennedy, Caplan, and Piza (2011), who noted that "risk can, in fact, cluster and that the nature of these clusters can better inform plans for police response" (357).

Crime reduction benefits have also been found in the context of CCTV systems. For example, both Piza et al. (2015) and La Vigne et al. (2011) found crime control benefits in CCTV camera systems. However, both studies concluded that the benefits were found primarily when someone was actively monitoring the CCTV systems and that crime reduction benefits largely disappeared without such monitoring. These findings further reinforce the need for a strong, evidence-based implementation plan as discussed in the prior section.

Therefore, any assessment of crime reduction efforts should also consider the impact of the BWCs themselves on the outcomes of focus.

Furthermore, agencies should be aware that technological tools can lead to additional benefits that may be unexpected but—once identified—should nevertheless be developed as part of the ongoing evaluation and auditing process discussed earlier. For instance, several articles (Braga et al. 2018; Bushaw 2017; Katz, Choate, et al. 2015) examined the influence of BWC implementation on officer productivity, often measured by the number of arrests officers make. Most of these articles found an increase in arrests (though Headley, Guerette, and Shariati [2017] found a reduction in arrests compared to the control group). Therefore, any assessment of crime reduction efforts should also consider the impact of the BWCs themselves on the outcomes of focus.

Improving investigations and case clearance

Another area of technology benefits comes from the improved ability to conduct investigations, gather evidence, and clear cases. In part, this improvement is the result of enhanced evidence collection capabilities of video and camera technology. This enhancement is perhaps most salient with respect to BWCs, which can supplement an officer's written report with visual evidence of the scene, subjects, and officer actions. For instance, studies (see Katz, Choate, et al. 2015; Katz, Kurtenbach, et al. 2015) found that the use of BWCs was associated with improved quality of domestic violence investigations as well as improved case processing and prosecution outcomes. Related to this finding, domestic violence cases involving BWC footage as evidence were more likely to be initiated, have charges filed, and result in a guilty plea or verdict than cases in which BWC evidence was not presented or available.

Similarly, LPRs often provide clear visual evidence and allow police to realize new investigative abilities, such as reading license plates on cars at high speeds or at night. LPR systems further improve investigative capabilities by facilitating rapid response to crimes, allowing license plate data to be quickly and easily linked to specific people through motor vehicle records and other existing data sources, as well as providing an ability to corroborate exonerating alibis (see Ozer 2010; Roberts and Casanova 2012; Merola and Lum 2014; Willis, Koper, and Lum 2018).

Law enforcement agencies can also use UASs to gather video and photographic evidence. For instance, several articles (Anania et al. 2019; Heen, Lieberman, and Miethe 2018; Marte et al. 2018) discussed how UASs can gather pictures or videos in areas of interest and provide real-time video feed of public spaces. Law enforcement agencies can also use UASs for crime scene photography, search and rescue, crowd management, and crime identification. Traditionally, law enforcement agencies have used airplanes or helicopters to assist in these types of activities, though since 2016, an increasing number of law enforcement agencies have begun including UASs in their investigative and crime prevention work (Heen, Lieberman, and Miethe 2018). Furthermore, UASs (when compared to traditional police-operated aircraft) provide increased access to certain locations (i.e., crime scenes vulnerable to contamination or damage) at decreased costs (Heen, Lieberman, and Miethe 2018; Marte et al. 2018), as the cost of purchasing, operating, and

maintaining UASs is much lower than that of using traditional police aircraft (Schwartz 2017). Such saving for investigative technology is included in the overall “Considerations for Implementation” section of this review.

In addition to evidentiary functions, agencies should weigh the benefits of technology with respect to improving police reports’ comprehensiveness and accuracy, which could lead to greater case clearance. For instance, several studies (Jennings, Lynch, and Fridell 2015; Headley, Guerette, and Shariati 2017) found that officers who used BWCs were able to write better reports because the camera footage helped them reduce their errors and improved their recollection. Other studies discussed how reporting may be enhanced through timely access to information. For instance, one review (Carter and Grommon 2017) of an agency’s implementation of a dedicated wireless mobile broadband system said it allows for “the various forms of communications and IT used in police settings [to be] unified into a single system” (847). The review found that, as a result of the new system, officers reported having more timely access to information, greater information flow, and increased quality and timeliness of reports. The study authors also suggested that such findings could ultimately improve investigations and clearances (though they did not evaluate those elements as part of the review).

However, some authors (see Bushaw 2017; Heumann, Kavin, and Chugh 2018) also noted that no universal standards exist regarding viewing video prior to writing reports, including standards related to the number of times video can be reviewed and the types of incidents where review should be able to occur. For instance, critics have argued (Heumann, Kavin, and Chugh 2018) that the viewing of footage can lead officers to remove suspects’ potentially exculpatory evidence from police reports while also bolstering what might otherwise be weak police testimonies at trial. Agencies should therefore consider review practices that are reflective of their organizations’ values as well as of their communities’ expectations.

Increased accountability and transparency

The literature reviewed for this study also included several pieces evaluating how particular technology can enhance oversight systems and processes, thereby leading to greater accountability and transparency within police agencies. While these pieces were nearly universally related to BWCs and though the BWC findings are presented here, agencies should also consider how other technologies may enhance accountability and transparency within their agency.

Articles focusing on the use of BWCs generally focused on several primary outcomes: complaints from community members, use of force, and OISs. For instance, several articles discussed BWCs’ relationship with community member complaints, finding overall reductions in complaints (though Barela [2017] did not find any reductions). One example of this finding is Braga et al. (2018), who conducted a randomized controlled trial of use of BWCs in Las Vegas, Nevada. With respect to community member complaints, the authors found a “30.2 percent reduction in the percentage of treatment officers relative

to control officers who generated at least one citizen complaint” (533)⁵. This observation was similar to White, Gaub, and Todak (2018), who found that “the percentage of officers with a complaint in each group declined by 50 percent and 78 percent (Control and Treatment, respectively) (1),” though the authors also note that because complaints were rare, statistical power was not achieved. In part, it is possible that this rarity may be due to officers self-regulating their behavior and increasing their compliance with departmental policies (see Heumann, Kavin, and Chugh 2018; Hickman 2017; Katz, Choate, et al. 2015). However, there is mixed evidence that officers are affecting results in this way. For instance, in their qualitative study, Heumann, Kavin, and Chugh (2018) found that some officers did not feel BWCs changed their behavior at all. Other officers, however, felt differently, with one officer saying having a BWC “brings you back to when you got out of the academy and you dot every i and cross every t” (Heumann, Kavin, and Chugh 2018, 599). In contrast, a quantitative assessment of New York City Police Department officers (Hickman 2017) found disagreement that BWCs would change their behavior, though there was overall support for BWCs among officers, largely as a protective factor against false complaints.

In addition, of the articles related to impact on use of force, most found that BWCs were associated with reductions in the use of force—though two of these (Perkowski 2019; Peterson et al. 2018) did not find evidence of reductions. For instance, in the same review that found reductions in complaints, Braga et al. (2018) found a 36.9 percent reduction in use of force after BWCs were introduced, compared with a 3.8 percent increase in the control group. This disparity was also reflected in Ariel, Farrar, and Sutherland (2015), who found officers in the control group used force twice as often as officers in the experimental group who had been assigned BWCs. In the same vein, Ariel, Farrar, and Sutherland (2015) found “a reduction in the total number of incidents in experimental conditions compared to control-conditions” (525). In addition to overall use of force, several articles (Alotaibi 2019; Kim 2019) examined BWCs’ relationship with OISs. For instance, using publicly available data, Kim (2019) found an overall 61 percent reduction in subject fatalities post-BWC implementation across many agencies. Alternatively, Pang and Pavlau (2016) did not find reductions using a similar technology, indicating an area where additional

When considering how to use technology to improve community relationships, agencies should also consider that underlying community characteristics may impact their views of the technology in general.

5. Braga et al. (2018) use *citizen* to refer to community members, which may include non-U.S. citizens.

research may be necessary. There is also some evidence that reductions in use of force (as well as in community complaints) are not short-term benefits but that sustained effects can be seen at least four years after implementation (see Sutherland et al. 2017). This too will require additional research, as most articles did not measure long-term impacts.

Improved community relations

As a final benefit, several articles also discussed technology's potential for improving relationships with the community. For some technologies, an improved relationship is the explicit goal. For example, Rosenbaum et al. (2011) examined agency use of the internet, noting that it allowed agencies to "democratize" how community members shape the organization. In addition, the authors found that police departments with websites were "more inclined to . . . 'push out' information rather than 'pull in' information from the community" (Rosenbaum et al. 2011, 39). Similarly, Keith (2015) found significant relationships between e-technology⁶ and collaborative partnerships when controlling for other factors. There was an even stronger relationship when e-technology was combined with measures of orientation toward community policing.

Improved relationships between the police and the community may be an important side effect of the main purpose of other technologies. For instance, White, Todak, and Gaub (2017) found that community members who were aware of an officer wearing a BWC were more likely to report "enhanced perceptions of procedural justice" (699), and the authors comment that BWCs may therefore facilitate increased legitimacy in the eyes of the public. As noted in the prior section, the use of BWCs has also been associated with reductions in use of force, reductions in complaints, increased compliance with departmental policies, and self-reported improvements in the quality of officers' service. Naturally, these improvements may also improve overall perceptions of legitimacy and relationships with the community.

When considering how to use technology to improve community relationships, agencies should also consider that underlying community characteristics may impact their views of the technology in general. For instance, most of the current literature related to UASs focused on local community perceptions and what characteristics make different communities more likely to support the use of UASs. Several studies (Anania et al. 2019; Heen, Lieberman, and Miethe 2018; Marte et al. 2018) found that neighborhood racial compositions, political leanings, and attitudes toward the police impacted individual perceptions of police use of UASs. As one example, Sakiyama (2017) noted that "the more individuals perceive police as a threatening social group, the more likely that people are to have negative attitudes toward police and be less receptive to police UAS use" (83). Other studies have noted that perceptions surrounding police use of UAVs or UASs is more contextualized. For example, Marte et al. (2018, 67) noted that there were seven factors that predicted an individual's privacy concerns relating to the use of UASs—(1) importance of privacy, (2) attitude toward UASs, (3) perceptions of whether police are corrupt, (4) feeling

6. Keith (2015) defines e-technology, or e-government technology, as "internet-based technology used by government or public entities through technology platforms such as websites, emails, and social media to collaborate with private citizens and groups."

of safety in the neighborhood, (5) number of children, (6) ethnicity, and (7) support for police activity in the neighborhood. Similar differences were seen in the BWC literature even though overall support for BWCs is relatively high (Sousa, Miethe, and Sakiyama 2015). For instance, Crow et al. (2017) found that respondents with favorable views of police performance, respondents who reported interacting with the police “sometimes” or “often,” and respondents who expressed less privacy concern related to BWCs were all more likely to have favorable views of BWCs. With the understanding that subject characteristics may influence perceptions of new technologies, departments should ensure they are providing targeted public education in ways that will be most effective.

However, as with any police effort, benefits should not be seen solely as the result of the technology’s existence in the department. Ultimately, the way an agency plans for and implements the technology (discussed in prior sections) will determine whether the implementation has any impact on community perceptions. In addition to this planning and implementation, police officers’ everyday behavior may be more likely than their departments’ technology to influence community member perceptions of the police, as many community members may not even be aware of departmental technology—for example, White, Gaub, and Todak (2018) noted in their research that only 28 percent of community members were cognizant that an officer they had encountered was wearing a BWC. This note is similar to findings from McClure et al. (2017), who found that 43 percent of subjects did not remember whether the officer had been wearing a BWC. Of those who stated they did remember, only half actually remembered correctly. Based on this observation, the authors concluded that “community members’ satisfaction with police was more positively influenced by officers’ procedurally just practices than by the presence of a body-worn camera” (1).

Conclusion

There is little doubt that technology will continue to evolve and improve and that law enforcement agencies will continue to use technology to support their operations. This guide has demonstrated that, regardless of the specific technology being implemented, there remain common factors in the overall process by which it is implemented in an agency. There must be an identified need for the technology, either as a tool for enhancing accountability, improving the quality of investigations, maximizing resources, improving community trust, or some other organizational strategic goal. Upon implementation, organizations will also need to ensure that the technology is adequately resourced, has received community and employee buy-in, and is supported by strong policies and training and that fidelity to the overall implementation plan is maintained. Finally, the agency will want to measure the benefits of the technology, first as to whether it has addressed the identified need but then to measure collateral effects, including community relations.

Despite what we know, there is still much to be learned about how law enforcement agencies use technology. Of primary importance is resolving the substantial gaps in clear standards for employing different types of technology. Certainly, privacy concerns for community members should be at the forefront of any new technology implementation efforts, and the criminal justice system should take steps to ensure that individuals are not being frivolously monitored. However, there are no consistent practices across agencies as to where such a line exists; therefore, departments should be in ongoing communication with community representatives regarding how the technology is being used. Other standards related to the use of technology include, for example, how the technology is used for reporting and evidentiary purposes. For instance, extant literature discusses variations in the practice of having officers review BWC video prior to completing reports. There is no current consensus on this practice and, given concurrent public interest in this area, future research should look further into the potential benefit and detriment of different approaches.

However, there are no consistent practices across agencies as to where such a line exists; therefore, departments should be in ongoing communication with community representatives regarding how the technology is being used.

There are also some limitations in the systematic review that may have restricted the scope of information available for our review. For instance, papers lacking significant findings may have been overlooked for publication, thereby creating a bias in the information available for review. In addition, based on the inclusion criteria, some technologies had few associated articles while others had far more. For example, 53 percent of collected articles were on the topic of BWCs while only one article discussed gunshot detection equipment (as seen in table 2 on page 8). The limited number of articles covering the remaining technology categories makes the conclusions less generalizable; most conclusions may apply more specifically to BWCs. Furthermore, not all technology implementation is carried out with equal rigor and fidelity. For instance, user bias, lack of familiarity, and inconsistent application of the technology were common issues that impacted how technologies were used, thereby limiting standardization across studies.

This guide has provided a status of technologies currently being employed by law enforcement across the nation, including commonly identified needs for technology, implementing the technology, and reaping the full benefits of the technology. Furthermore, this guide discusses modern technologies being used in law enforcement agencies, describing the functions of the technology and specific considerations for employing it. As technology within the law enforcement field becomes more common and more innovative, this guide should assist agencies large and small in taking the necessary steps to ensure the success of their efforts.

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About the COPS Office

The **Office of Community Oriented Policing Services (COPS Office)** is the component of the U.S. Department of Justice responsible for advancing the practice of community policing by the nation's state, local, territorial, and tribal law enforcement agencies through information and grant resources.

Community policing begins with a commitment to building trust and mutual respect between police and communities. It supports public safety by encouraging all stakeholders to work together to address our nation's crime challenges. When law enforcement and communities collaborate, they more effectively address underlying issues, change negative behavioral patterns, and allocate resources.

Rather than simply responding to crime, community policing focuses on preventing it through strategic problem-solving approaches based on collaboration. The COPS Office awards grants to hire community policing officers and support the development and testing of innovative policing strategies. COPS Office funding also provides training and technical assistance to community members and local government leaders, as well as all levels of law enforcement.

Since 1994, the COPS Office has been appropriated more than \$20 billion to add community policing officers to the nation's streets, enhance crime fighting technology, support crime prevention initiatives, and provide training and technical assistance to help advance community policing. Other achievements include the following:

- To date, the COPS Office has funded the hiring of approximately 138,000 additional officers by more than 13,000 of the nation's 18,000 law enforcement agencies in both small and large jurisdictions.
- More than 800,000 law enforcement personnel, community members, and government leaders have been trained through COPS Office-funded training organizations and the COPS Training Portal.
- More than 1,000 agencies have received customized advice and peer-led technical assistance through the COPS Office Collaborative Reform Initiative Technical Assistance Center.
- To date, the COPS Office has distributed more than nine million topic-specific publications, training curricula, white papers, and resource CDs and flash drives.

The COPS Office also sponsors conferences, roundtables, and other forums focused on issues critical to law enforcement. COPS Office information resources, covering a wide range of community policing topics such as school and campus safety, violent crime, and officer safety and wellness, can be downloaded via the COPS Office's home page, <https://cops.usdoj.gov>.

In this series, CNA studies the use of emerging technologies by law enforcement agencies. Case studies examine the Chula Vista (California) Police Department’s program of using unmanned aerial vehicles (UAV), more commonly known as drones; the Fairfax County (Virginia) Department of Public Safety Communications Next Generation 911–equipped communications center; the Las Vegas (Nevada) Metropolitan Police Department’s Fusion Watch center and its cameras and monitoring equipment; the Pinal County, Arizona, Attorney’s Office’s new digital case management software for its adult diversion program; the Sacramento (California) Police Department’s virtual reality training program; and the St. Louis County (Missouri) Police Department’s body-worn and dashboard-mounted camera programs. This implementation guide includes a comprehensive literature review and discussion of various technology types and their real and potential uses by law enforcement agencies around the country.



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