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TITLE: Strategies for Policing Innovation (SPI) in Wilmington, Delaware: Targeting Violent Crime

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Executive Summary

The Wilmington (Delaware) Police Department (WPD), along with its research partner the National Police Foundation (NPF), received a Smart Policing Initiative (SPI) grant in 2018, funded by the Bureau of Justice Assistance to implement technology designed to reduce homicides and shootings, and increase the effectiveness of WPD. Prior to receiving SPI funding, WPD had an existing ShotSpotter (SST) gunshot detection system. SPI funding was used to expanded SST coverage and integrate existing CCTV security cameras. The goal of integrating SST and CCTV was to improve the combined systems efficacy for solving homicides and shootings.

This report discusses several different approaches used to understand the impact of SST/CCTV integration. The study period assessed data from June 2014 – July 2021, although data limitations prevent an assessment of the full intervention period (2014-2021). WPD provided data including homicide, shooting, and crime and incident data and arrest clearance data for homicides and shootings. ShotSpotter Inc. provided shots fired alert data captured during the evaluation period. NPF conducted two waves of community surveys to assess community perceptions and confidence in police response. WPD officers were also surveyed – the first wave assessed respondents' thoughts on the current state of technology for gun crime in WPD; the second wave assessed respondents' perceptions of the technology expansion and integration. Finally, NPF conducted focus groups with WPD personnel to gain insight into the use of the technology in responding to, and investigating, homicides and shootings.

Our findings indicate that the SST/CCTV integration did not lead to measurable improvements to public safety. Results from our most robust statistical modeling suggests:

• Overall, crime was lower after the implementation of the integrated SST/CCTV

system although this change was non-significant.

- However, this crime reduction benefit was not found for the crimes most likely to be affected by SST/CCTV. Homicides and shootings *increased* in the postimplementation phase.
- Further, clearance by arrests for homicides and shootings were *lower* during the post-implementation phase.

Together, we found limited, and unconvincing, evidence that SST/CCTV integration reduced crime or lead to better investigative outcomes. Despite the conceptual benefits of faster and more accurate response to firearm discharges, there was little support that these improvements translated to meaningful changes in key public safety outcomes. We must note, however, that despite close collaboration with WPD, data limitations prevented us from testing several key indicators of SST/CCTV performance. Namely, data on actual evidence recovered (e.g., shell casings), as a result of SST alerts, was unavailable. Additionally, there was no systematic information on how the integration of CCTV was used by officers in response to SST alerts.

Despite the limited empirical support found in our analysis, focus groups and surveys of WPD officers suggested respondents believed that the technology was useful in investigating gun crimes. Community surveys found that respondents reported generally positive perceptions about police response.

These results make it difficult to provide broad recommendations about the implementation of an integrated SST/CCTV solution. Despite agency and public support, we found little evidence that the integrated SST/CCTV technology improved key public safety

outcomes. Given the installation and ongoing maintenance costs of these systems, more research is needed to determine if, or how, they can be made more effective.

Introduction

Homicide and violent crime are a serious problem in Wilmington, Delaware. According to the FBI's Uniform Crime Report¹, over the last decade, violent crime in Wilmington occurred at a rate of 1,868 per 100,000 in 2009, and 1,523 per 100,000 in 2019. These numbers are well over the violent crime rates for Delaware (422 per 100,000 in 2019) and cities with similar populations (360 per 100,000)². In 2019, Wilmington's homicide rate was 40 per 100,000, which is more than eight times higher than the average homicide rate of five per 100,000 in jurisdictions with similar populations.

The Bureau of Justice Assistance funded the Wilmington Police Department's (WPD) Smart Policing Initiative (SPI) in 2018 to implement ShotSpotter (SST), an acoustic gunshot detection system (AGD), in high gun crime locations and enhance WPD's ability to respond and investigate related crime. The National Police Foundation (NPF) was funded by the grant to act as the research partner. NPF's role, as the research partner, was to evaluate the technology implementation on outcomes including crime, community perceptions, and officer perceptions.

SST was implemented in Wilmington in May 2013. SST uses a collection of microphones placed around the city to capture sounds, which are routed to a central dispatch. Algorithms determine if the sound was a gunshot along with the location of those shots. This information is reviewed by a SST acoustics analyst before being forwarded to the WPD. SST initially covered three square miles of the city experiencing high gun crime, which was expanded

¹ <u>https://crime-data-explorer.app.cloud.gov/pages/home</u>

² Violent crime rates are calculated using 2019 UCR data for jurisdictions in which the population is no more than 10% different from that of Wilmington.

to five square miles in early 2019. In May 2016, the WPD created a Real Time Crime Center (RTCC) to integrate a command center with technology in patrol cars to provide bi-directional information sharing about suspects and locations, as well as integrating city cameras with monitors at police headquarters.

In 2016, technical limitations of the SST deployment were identified. The WPD 911 communications center received a number of calls for service involving shots fired calls that were not detected as gun shots by SST. The RTCC researched these detection failures and discovered that approximately 77% of the cases were identified by SST but only by one acoustic sensor. In order for an alert to go through to the RTCC, it would have needed to be recognized by three sensors—an inherent requirement of the triangulation necessary for SST technology. SST representatives attributed these identification failures to poor coverage in affected areas and suggested that greater geographic coverage would be required. Along with increased coverage, SST alerts were networked with existing surveillance cameras to ensure that the cameras closest to the alert panned to the angle and location where the shot was triangulated by the acoustic sensors.

In addition to these technology changes, policy changes were made for officers responding to calls for shots fired. Officers arriving to the scene were instructed to engage in a more comprehensive effort to locate the scene and evidence to more precisely collect shell casings and investigate crime guns in the area. Any recovered evidence was entered into the National Integrated Ballistic Information Network (NIBIN) and eTrace (an online system that allows participating agencies to submit firearm traces to the National Tracing Center operated by the Bureau of Alcohol, Tobacco, Firearms, and Explosives).

The proposed evaluation was based on the following hypotheses:

- (1a) When used together, SST and CCTV should support faster response and (1b) facilitate the collection of more, and less degraded, evidence which (1c) can then be entered into NIBIN and eTrace.
- The collection of more, and better-quality evidence, (2a) should allow for faster leads or hits (confirmed linkage of gun crimes through utilization of NIBIN), thus (2b) providing earlier identification of shooters.
- (3) Improved identification of offenders should lead to increases in case clearance by arrests for firearm-related crimes.
- (4) The deterrent effects of SST and surveillance cameras will reduce gun violence and other crimes.
- (5) Lower crime and improved solving of crime should lead to more positive perceptions of the police.

The community survey was administered to assess community perceptions of WPD's response to gun violence. The officer surveys and focus groups served to identify how WPD personnel perceived the impact of the integration on their ability to perform their job.

Literature Review

AGDs are a technological solution that, in theory, improves law enforcement's handling of gun-related crimes by quickly identifying and locating incidents of gunfire (Mazerolle et al., 1998; Watkins et al., 2002). AGDs were introduced in the 1990s alongside several other gun control initiatives in response to the widespread gun violence across the United States. The purpose was to facilitate faster police response time to shooting incidents, which would translate into higher chances of apprehending the perpetrator and increasing likelihood of the victim surviving (Mazerolle et al., 1998). AGDs work by identifying and triangulating acoustic waves produced by gunshots, thus pinpointing the time and location of where the gunfire occurred and sending real time alerts to the police (Watkins et al., 2002). AGDs have primarily been marketed as a tool to identify gun violence in high crime areas (Mares & Blackburn, 2020), though its utility extends to the monitoring of random, or celebratory, gunfire as well (Mazerolle et al., 1998).

Stated benefits of AGD systems are threefold. First, AGDs can alert the police about shots fired that may have otherwise gone unreported. The police have traditionally relied on calls for service to pinpoint areas in which shootings occur, but evidence suggests that gun incidents go unreported for a variety of reasons, including witnesses dispersing, fear of retaliation for contacting the police, or not wanting to become involved in police investigations (Irvin-Erickson et al., 2017). Carr and Doleac (2016) found that only 12.4% of gunfire incidents recorded by AGDs were also reported to the police by the community via a citizen-initiated call for service. However, AGD systems have the potential to alert the police of gunfire incidents without needing to rely on calls for service initiated by community members (Irvin-Erickson et al., 2017).

Second, AGDs provide law enforcement with time and location data that are more precise compared to information that may be provided by traditional calls for service (Carr & Doleac, 2016). Evidence suggests officer response times tend to be quicker for AGDs alerts compared to citizen-initiated calls for service (e.g., Choi et al. 2013; Mares and Blackburn, 2012). Quicker, more precise response may increase the likelihood of apprehending offenders or collecting evidence before a scene is compromised.

Third, AGDs may serve as a crime deterrent if the public is made aware of the presence and efficacy of the systems (Watkins et al., 2002). Mares and Blackburn (2020) noted that the

deterrent effects of AGDs is likely not due to their visibility; acoustic sensors are small and inconspicuously placed. Rather, the benefits of AGD may come from law enforcement monitoring and data-driven presence in targeted areas, combined with rapid and precise response to incidents.

ShotSpotter. SST, an AGD system, has been implemented in 85 cities in the United States (e.g., Buckley, 2009; Sullivan, 2016; Yee, 2020). SST uses acoustic sensors strategically placed in targeted areas to capture the time and audio connected to gunshots (or similar sounds). Data from the sensors is used to triangulate the incident, which are then processed by machine algorithms to classify the event as a gunshot versus other similar loud noises (e.g., a car backfiring or construction noise). After automated classification, a trained SST acoustic analyst located in SST's Incident Review Center confirms that the event is gunfire and appends the alert with critical information, such as the number of shots fired, type of gun, and whether the shooter is on the move. Alerts then go through the law enforcement agency's dispatch center, where a dispatcher deploys officers to the specified location. More recently, alerts can be immediately sent to patrol officers through their mobile device terminals, smartphones, or tablets. SST claims that the process, from capturing the gunshot to alerting the agency, can be completed in 45 seconds (ShotSpotter, 2021).

AGDs are subject to both false negative (i.e., actual gunshots that were not detected) and false positive errors (i.e., alerts that were not actually gunshots), which can negatively impact system accuracy and, in turn, its value for law enforcement agencies (Carr and Doleac, 2016). While SST claims a 97% accuracy rate (ShotSpotter, 2021), only a handful of external, independent studies have examined its accuracy. For example, a field trial conducted in Redwood City (CA) found that SST was able to detect 80% of test shots, with varying degree of

accuracy depending on the type of firearm: shotgun rounds were detected at 90%, pistol rounds at 77%, and assault rifle rounds at 63%. Moreover, SST was able to triangulate 84% of the test shots within a median margin of error of 25 ft, again, with varying degrees depending on the type of firearm: shotgun tests had a triangulation rate of 100% with a median margin of error of 23.5 ft. Pistol tests were triangulated at 85% within a 25 ft margin of error and assault rifles were triangulated 63% of the time within a 27 ft margin of error. Multiple gunshots were more likely to be detected and triangulated than single shots (Mazerolle et al., 2000).

A pilot program of SST in the Las Vegas Metropolitan Police Department found the system was able to detect 92.41% of potential gunfire incidents (Koren, 2018) Overall, findings suggest SST to adequately detect when gunshots do occur (Mazerolle et al., 2000), though detection accuracy is tempered by variables such as number of shots fired, sensor proximity, and type of firearm.

False positive events are more often cited as a shortcoming of SST (Aguilar, 2018; Mazerolle et al., 1998). An assessment of SST data from more than a dozen cities found that police were unable to find evidence of gunshots between 30%-70% of the time (Drange, 2016). Additionally, a recent study conducted by the MacArthur Justice Center at Northwestern University School of Law in collaboration with the Chicago Police Department (CPD) evaluated SST-initiated police deployments from July 1, 2019, through April 14, 2021. They found that out of the 46,743 SST-initiated dispatches, 88.7% did not result in police recording an incident involving a firearm. Moreover, 85.6% of SST alerts did not result in a case report by officers. The authors called into question the value of SST (see also Gonzalez, 2013).

There are considerable drawbacks to a high rate of false positive errors. False positive alerts can result in consistent, yet unfounded, deployment of officers primed to expect armed

perpetrators (Schuba, 2021). If SST sensors are primarily installed in high-crime areas, and those coincide with communities of color (as in Chicago's case; Illinois v. Michael Williams, 2021), the result can be over policing in areas where the distrust between the police and the community is already high (Gunderson, 2021). Indeed, community leaders in Chicago and other places, have expressed disapproval of SST (Schuba, 2021; Foskett, 2021; Shakur, 2020). A high number of false positives can also de-motivate officers to respond efficiently to the incidents (Ratcliffe et al., 2019). The result of false positive errors may therefore be counterproductive to the initial purpose of SST, which was to facilitate faster response times.

Nonetheless, qualitative evidence from officers suggests that AGDs are perceived as being valuable. For example, Chicago's Mayor, Lori Lightfoot, noted that SST was particularly important for enabling police to attend to gunfire incidents in areas where people may be afraid of contacting 911 (Schuba, 2021). Similarly, in an interview with WNYC, Newark (NJ) Police Director Samuel DeMaio stated that the value of SST is not just in the number of guns recovered or the number of perpetrators arrested, but also the immediacy of the response and the decreased reliance on community-sourced calls for services (Gonzalez, 2013).

In a 2012 interview with the New York Times, Sgt. Chris Bolton of the Oakland (CA) Police Department stated that, [before the installation of the system in their most crime-ridden areas], "A patrol officer would receive a gunshot call from the community and you could spend up to 30 minutes driving within, I would say, three to four blocks of that location, just to make sure there isn't a victim in need of assistance, a crime ongoing or any evidence." (Goode, 2012).

Overall, interviews with command staff from three cities (Richmond, CA; Milwaukee, WI; and Denver, CO) found broad support for the use of SST technology and confidence in the accuracy of the system (Lawrence et al., 2018).

ShotSpotter and CCTV. To address the issue of false positives, innovative work by Ratcliffe and colleagues proposed that AGD systems could be more valuable if integrated with closed-circuit television (CCTV) technology, especially since CCTV already exists in many areas for scanning and monitoring crime and disorder (Watkins et al., 2002). In the United States, the last decade has seen steady growth in CCTV use; a large majority of agencies serving populations of 250,000 or more now employ CCTV (Reaves, 2015). The widespread installation of CCTV cameras is backed by evidence indicating its utility for crime reducing some crimes, under some circumstances (Piza et al., 2019).

When integrated with SST technology, CCTV cameras can be programmed to automatically pan and zoom-in toward the areas where SST detects gunfire. Essentially, SST acts as the "ears" and CCTV can serve as "eyes" (Choi et al., 2013). Such combination can, in theory, inform dispatchers about whether an alert does, in fact, correspond with a shooting. Integrating SST and CCTV may also help police with arrests rates and case resolutions, a function for which, as described above, SST alone may be limited (e.g., Choi et al., 2013; Doucette et al., 2021).

Unlike SST, or other AGD systems, CCTV has the ability to record images of the perpetrators, provide evidence of where they fled, if they discarded their weapons, and other pertinent information that can help the advancement and clearance of criminal investigations (Ashby, 2017; Choi et al., 2013). Despite the promise of SST and CCTV integration, research on the effects of the integration on the law enforcement response to gunfire remains limited (Ratcliffe et al., 2019).

In sum, SST has gained momentum as a promising tool for providing police with real time alerts on gunfire, allowing for a quicker and more precise police response. Despite this

rapid adoption, there is limited research suggesting that AGDs are effective—the most promising of which tends to be descriptive and qualitative. Nevertheless, less is known about its potential to aid in crime reduction efforts when paired with CCTV. The present project aimed to address this limitation. Two goals were identified for this implementation in WPD: reduce homicides and shootings city-wide by more effectively responding to and investigating shooting incidents and improve WPD's organizational capacity to respond to gun violence by leveraging integrated technologies.

Current Study

Two goals were identified for this implementation in WPD: reduce homicides and shootings citywide by more effectively responding to and investigating shooting incidents and improve WPD's organizational capacity to respond to gun violence by leveraging integrated technologies. Table 1 presents the objectives and performance measure for the two goals identified in this study. Table 1: Study goals, objectives, and performance measures

GOALS	OBJECTIVES	PERFORMANCE MEASURES
1. Reduce homicides and shootings citywide by more effectively responding to and investigating shooting incidents (Koren, 2018; Ratcliffe et al., 2019)	 Conduct targeted investigative strategies based on enhanced evidence collection Share information from enhanced evidence collection (e.g., suspect, vehicle photos) with the public to generate additional leads and to improve community confidence Make more timely arrests of people involved in firearms violence Improve clearance rates of fatal and non-fatal shootings 	 Fatal shootings (monthly counts) Nonfatal shootings (monthly counts) Clearance rates for shooting incidents Community satisfaction of WPD measured before and after implementation (surveys)
2. Improve WPD's organizational capacity to respond to gun violence by leveraging integrated technologies (Lawrence, 2015; also see discussions on Firefly in Katz et al., 2021)	 Integrate gunshot detection technology with Wilmington's CCTV system Develop revised policy and procedure for WPD's RTCC and investigations personnel to leverage enhanced evidence and assess officer perceptions about the utility of the integration Assess integration results and outputs every 30 days to ensure optimal leveraging of technology to improve investigative processes and outcomes. Provide WPD command staff briefings every quarter on the activities and outcomes of the project to promote further process improvements and leveraging of technology. 	 Number of SST alerts Officer opinions regarding the technology and its potential to improve investigative efforts measured before and after implementation

Methods

This section describes the data and analyses used to evaluate the combined SST/CCTV

implementation. The expansion and integration occurred over a six-month period. We use

February 19, 2020, as the implementation date, as this was when the SST expansion occurred.

The full SST/CCTV integration was not finalized until August 2020.

Data

WPD Crime Data

WPD provided data on (1) overall crime and (2) more detailed information on shootings, and homicides, including information on clearance by arrests. Because homicides and shootings are of particular interest, given their severity and relevance to SST's capabilities, throughout this report, we will describe crime in the aggregate (including aggravated assault, burglary, larceny, murder, rape, and robbery), and more specific analyses on just murders and shootings. Whenever we report on overall crime, that category includes shootings and murders. Additionally, shootings refer to only non-fatal shootings.

Additionally, SST provided information on the number of gunshots detected during the evaluation period. Figure 1 shows the gradual accumulation of homicide and shooting cases, and the accumulation of case clearances logged in the data files for homicides and shootings. The homicide and shooting data extends from 2019 to mid-March 2021.



Note. The horizontal line indicates February 19th, 2020, when SST was expanded.

Figure 2 shows the time series for overall crimes, homicides, shootings, and SST alerts, with the number of events aggregated by month. There was a distinct increase in SST alerts after full system expansion in February of 2020. There also appears to be a noticeable drop in shootings from late 2017 to mid 2019, and a decrease in crimes in starting in 2019.



Figure 2: Time series of overall crimes, homicides, and ShotSpotter alerts, with the number of events aggregated at each month

Note. March 2021 has been excluded from the ShotSpotter panel due to incomplete data. Plots are of raw incident counts, no additional modeling or trend corrections have been applied. Red dash line is a 12-month moving average.

Community Surveys

Community surveys were administered before (wave 1) and after (wave 2) the SST/CCTV integration to assess whether the integration was associated with changes in public opinion of WPD's ability to respond to and clear gun crimes. The survey instrument was from the National Law Enforcement Applied Research & Data Platform (Platform).³ NPF's institutional review board (IRB) reviewed and approved the survey questions and methods for both survey waves. Data collection was administered through Qualtrics. NPF developed a flyer that contained a link and QR code to the survey. WPD led efforts to disseminate the survey, which included conducting outreach through press releases, emails, social media, and directly with civic associations, community leaders, business leaders, and residents.

³ <u>https://www.policefoundation.org/national-law-enforcement-applied-research-data-platform/</u>

The Platform survey consisted of several sections (see Appendix 1 for the wave 1 survey instrument). Section one asked respondents about their perceptions of police effectiveness in their neighborhood. This included how well police responded to crime and gun problems, along with other problems or concerns in the neighborhood. Section two asked about perceptions of police professionalism in their neighborhood, including questions about using excessive force and other misconduct, treating people with bias, and whether police act professionally. Section three asked respondents about concerns in their neighborhood (e.g., concern over being the victim of a violent crime).

The fourth section of the survey explored respondents' confidence in the WPD (i.e., do they have trust and confidence in the department. The fifth sections asked respondents about their willingness to cooperate with the police. This section included questions on whether respondents would work with the police to identify a person who committed a crime, identify places where crime may be occurring, and attend a meeting to discuss crime prevention. The sixth section asked about respondents' view toward the law and compliance with the law and willingness to follow commands from a law enforcement officer. Finally, the survey captured demographics, including gender, age, race, education, and income.

The wave 2 instrument was the same as the pre-intervention with an additional section on police technology (see Appendix 2). This additional section assessed if technologies used by the police, such as security cameras, body-worn cameras, and gunshot detectors, were an invasion of privacy or if they made respondents feel safer.

The wave 1 survey was administered from March 1 through April 30, 2019; wave 2 from December 7, 2020, to January 21, 2021. Due to COVID-19, there were some limitations in command staff and officers handing out flyers to community members during wave 2. Surveys

that contained missing responses for all questions were dropped from the analysis (147 surveys in wave 1, and 55 surveys in wave 2). The final sample size was 254 respondents in wave 1, and 191 respondents in wave 2.

Officer Surveys

Two waves of officer surveys were conducted. The NPF IRB reviewed and approved both survey instruments and data collection methods. Surveys were administered via an online link to Qualtrics. NPF shared this link with WPD command staff, who emailed the link to WPD personnel and mentioned the survey at roll calls.

The wave 1 survey (Appendix 3) contained nine questions. The survey asked respondents whether they were aware of the upcoming SST and CCTV integration, and if so, their thoughts on the technology's impact on responding and working on shootings. Questions also asked respondents about their reliance on current technology and resources of the department when working shooting cases. Additional questions asked the amount of time spent performing various tasks when responding to a shots fired call, such as driving to the scene, talking to the community, and arresting suspects. An open-ended question allowed respondents to offer their thoughts on whether training would be helpful to respond to shots fired calls. The final questions asked the respondents for their rank and length of tenure at WPD.

The wave 2 survey (see Appendix 4) contained 14 questions. The survey asked several questions about the integration of SST and CCTV camera: whether it allowed respondents to arrive to shots fired calls in a timely manner, if the integration has led to increased victim or witness cooperation, and if it has helped to identify and arrest suspect. One question asked whether respondents experienced any challenges using the technology. Additional questions asked whether the respondent received training, and if so, how would they rate the training. Respondents were able to provide open feedback on training received. As in the wave 1 survey,

this survey also asked about the amount of time spent performing various tasks when responding to a shots fired call. Another open-ended question allowed respondents to provide additional feedback on the technology integration. Finally, questions asked for respondents' rank, gender, current assignment, and length of tenure at WPD.

Data collection for wave 1 occurred from March 1 through April 4, 2019. The wave 2 survey was conducted from February 10, 2021, through March 30, 2021. Surveys that contained missing responses for all questions were dropped from the analysis (16 surveys in wave 1; 22 surveys in wave 2). The final sample size was 99 respondents for the wave 1 survey (approximately 31% of sworn personnel in the department) and 144 respondents (approximately 45% of sworn personnel) for the wave 2 survey.

WPD Focus Groups

Focus groups were conducted with WPD personnel. Five one-hour focus groups were held in May 2021 with Detectives, Sergeants, Inspectors and Captains (referred to below as the executive staff group), crime lab staff, and Real Time Crime Center and Criminal Justice Information Center (CJIC) staff (referred to below as the RTCC group) from the WPD⁴. Due to the ongoing public health crisis, these focus groups were held remotely via video conference. Each focus group contained between two and six participants. Focus groups were divided by personnel from each rank or unit (for example, all detectives were interviewed together). All interviews followed a semi-structured interview schedule consisting of predetermined queries to generate discussion among participants (Appendix 5). Each interview was conducted by one facilitator and one note taker. Participants shared their experiences with SST

⁴ We originally had a focus group interview scheduled with patrol officers; however, the participants were called out to an incident just prior to the scheduled time. NPF and WPD were unable to reschedule this focus group.

technology, as well as its integration with CCTV, discussed the technology's usefulness, practical limitations, and provided suggestions for further improvements.

Analytical Strategy

WPD Crime Data

Date information was recorded inconsistently in the clearance files; some records had specific dates events were cleared while others only had information that the case was cleared but with no accompanying date. This meant that we were constrained to a narrow set of analytic options to assess changes in clearance rates. To understand the effect of SST implementation on the probability of a case being cleared, we fit a simple logistic regression, estimating the probability of a case being cleared as a function of case type (homicide & shooting), and whether it occurred before or after SST was fully rolled out (with full integration starting on February 19, 2020)

Data on homicides, shootings, and SST alerts contained more granular information on the dates of events. Because of this, we had more flexibility to pursue analytic approaches that could rule out some of the alternative explanations described above. Changes in the number of homicides and shootings were explored through a series of Bayesian structural time series (BSTS) models. These models estimate the prevalence of these outcomes over time.

Additionally, these models can incorporate additional information attempts to rule out other, potentially competing, effects. Our approach capitalizes on two particularly important opportunities afforded by these models. First, seasonal trends can be included to account for the fact that many crimes show a seasonal component. Visual inspection of outcome measures suggests that this pattern exists in Wilmington data. Appropriate controls over seasonality must be applied to accurately explore the impact of SST/CCTV technology.

Second, data from other, similar, jurisdictions can be included in the model to better differentiate the impact of SST/CCTV integration from broader changes in the trend of crime. Assuming that crime in other places tend to rise and fall similarly, we leverage this information to derive more precise estimates of the expected count of crimes (including homicide and shootings) in Wilmington if SST/CCTV had never been implemented. To accomplish this, we sourced crime data (UCR Part 1 and 2) from cities that were in close geographical proximity, residential population, demographics, household income, unemployment/poverty rates, and crime rates. These efforts yielded datasets detailing aggregate monthly crimes from seven donor cities: Danville, VA; Hampton, VA; Petersburg, VA; Portsmouth, VA; Richmond, VA; Baltimore, MD; and Harrisburg, PA (Figure 3).





Note. Wilmington crime data is represented by the thick black line. Plots are of raw incident counts, no additional modeling or trend corrections have been applied.

The BSTS models identify what relationship, if any, exists between the time series from the donor cities and the observed data for Wilmington in the period leading up to the SST/CCTV deployment. Using that information, alongside the patterns observed for Wilmington in the pre-SST period, we can extrapolate what the data are expected to look like in the post-SST period. The larger the departure from the expected pattern, the more confident we can be that SST had an effect on the count of crime incidents.

One limitation of this approach was addressed. WPD data were available through June 2021 but data for the majority of the donor cities could only be sourced through 2020. Only

Baltimore and Harrisburg provided data beyond the end of 2020 (into May 2021). For each outcome, we fit an additional model using only those two donor cities and extend the analysis through the last full month of data available from the donor cities (May 2021).

For SST alerts, we report simple descriptives of the pattern of alerts over time.

Community Surveys

Table 2 and Table 3 show the distribution of respondents for age and race for both waves combined, along with the population distribution for these categories. The population data were computed from the five-year estimates from the 2018 American Community Survey. Respondents were between the ages of 35 and 74, and overrepresents people who identify as white or as having more than one race. Because of the differences between respondent and population characteristics, we analyze these data using multilevel regression with poststratification. This technique is often used in polling research to adjust for non-representative samples.

One basic insight of MRP is that one can use grouping variables in the multilevel model to share information between the levels of those grouping variables. For instance, although we may have relatively few respondents who are multiracial and between the ages of 25-34, we can use information about how multiracial persons of other ages, and persons aged 25-34 responded to inform what our estimate of this particular demographic slice would be. After modeling the responses in this way, MRP then weights responses based on the population size in each of the demographic slices in the model, where population sizes are typically taken from something like the US Census.

Table 2: Age distribution

Age	Number of Respondents	Percent of Sample	Population Percentage
Missing	24	5.4	-
Under 18	1	0.2	23.2
18 - 24	8	1.8	8.7
25 - 34	55	12.4	17.1
35 - 44	84	18.9	12.9
45 - 54	75	16.9	12.7
55 - 64	103	23.1	12.7
65 - 74	77	17.3	7.6
75 - 84	14	3.1	3.8
85 or older	4	0.9	1.3

Note. Population percentages based on 2018 ACS estimates.

We fit one Bayesian multilevel model to each section of surveys, allowing both the overall level of response, and the difference between waves to vary by race, age, and question number. The model also adjusts for the tendency for respondents to give similar answers across questions. Our primary interest was in the overall change in responses across waves. This modeling setup is analogous to a 1 parameter item response theory (IRT) model (Bürkner, 2019). However, whereas IRT models are typically used to measure the difficulty of items on a test, here we are applying the methods to estimating the tendency to agree or disagree with particular items, and how those response tendencies shift across waves (see Caughey & Washaw, 2015 for a similar approach to analyzing survey data).

Table 3: Race distribution

Race	Number of Respondents	Percent of Sample (%)	Population Percentage (%)
Missing	53	11.9	-
Asian	1	0.2	1.3
Black or African American	90	20.2	58.3
More than 1 race	15	3.4	1.7
Native American	2	0.4	0.2
Other	3	0.7	3.4
White	281	63.1	35.1

Note. Population percentages based on 2018 ACS estimates.

We provide descriptive information for survey questions that were only asked in one wave. In the wave 1 survey, these questions relate to community perceptions on police effectiveness at responding to gun violence in their neighborhood and responding promptly to gunshots. The wave 2 questions focus on community feelings of safety and privacy of body worn cameras, CCTV, and AGD devices.

Officer Surveys

Due to differences in survey items, the two waves of officer surveys were analyzed independently. Survey response options that were Yes/No were recoded as 1 (yes) or 0 (no). Several questions in both waves contained a Likert scale about officers' perceptions about the technology's impact on their work. This four-item scale ranges from 1 (Not at all) to 4 (A great deal). A series of questions asked respondents to estimate the amount of time participants spent performing tasks. The time spent scale ranges from 1 to 4: 1 = Less than 15 minutes; 2 = 15-30 minutes; 3 = 30-60 minutes; and 4 =Over an hour.

Table 4 presents the rank and tenure from respondents both survey waves. Overall, both waves are very similar regarding respondents' rank and tenure. Slightly more investigators completed the wave 1 survey while a higher percentage of patrol officers participated in wave 2.

		Wave 1		Wave 2
Rank	N	Percentage	N	Percentage
Patrol Officer	29	37.2	54	42.2
Sergeant	14	18.0	23	18.0
Detective	20	25.6	29	22.7
Lieutenant	4	5.1	4	3.1
Other	11	14.1	18	14.1
Tenure	N	Percentage	N	Percentage
1 - 5 years	16	20.8	24	21.2
5 - 10 years	14	18.2	18	15.9
10 - 20 years	32	41.6	49	43.4
20 years or more	15	19.5	22	19.4

Table 4: Officer wave 1 and wave 2 sample characteristics

WPD Focus Groups

All focus group notes were coded for key units of information (e.g., SST's app is userfriendly, SST allows for faster first aid provision to victims) and labeled with information about the WPD personnel that provided each statement (e.g., Sergeant, RTCC). Units of information were then organized into overarching themes (e.g., usefulness, challenges, training), and written up into a narrative format with the addition of representative verbatim quotes to provide additional context.

Results

Clearance Rates

Figure 4 shows the estimated probability of a homicide of firearm-related incident being cleared, based on whether it occurred in the time before or after SST/CCTV integration. Two definitions of clearance rates are described: simple clearances reflect the number of cases cleared in the same year that the precipitating event occurred while aggregate clearances include clearances from previous years (e.g., an incident that occurred in 2019 but was cleared by arrest in 2020).

Our analysis suggests relatively large differences in the probability of clearing an incident with an arrest from pre- to post-SST/CCTV integration. However, these differences were **not** in the hypothesized direction; the probability of a clearance decreased after SST/CCTV integration. For instance, the probability of a shooting being cleared in the pre-period is estimated to be .27, 95% confidence interval (CI) = [.36, .17]. In the post-period this decreases to .07, [.12, .02], which is a statistically significant change (p < .01). A similar decline is seen for homicides, which are estimated to have a clearance probability of .36, [.55, .17] in the pre-SST era and .13, [.26, .01] after full SST/CCTV integration, though this trend is not significant at the .05 level (p = .06)





Note. Bands represent 95% confidence intervals.

These results, however, should be interpreted with caution given the nature and timing of the evaluation. The fact that the probability of an incident being cleared is lower in 2020 and 2021 is not terribly surprising, as there has been less time for a case to be cleared. In an ideal scenario, we would control or adjust for this differential risk by conducting other types of analyses. More sophisticated approaches, such as survival analyses, would better control for the differential post-event time. Our ability to use these techniques was hampered by the poor quality of data.

Additionally, because SST's rollout coincided with the onset of the COVID-19 pandemic, we cannot rule out the possibility that the changes we see are attributable to the large changes that have taken place in the months since. Further analysis to rule out other alternative explanations would require more accurate and consistent clearance data, especially around the date of the clearance.

Crimes, Homicides, and Shootings

Figure 5 shows that model estimates corresponded to the observed data very closely in the pre-SST/CCTV integration period. After SST/CCTV integration, the observed monthly crime counts were modestly lower than the model would expect. Summing up the individual data points during the post-SST period, there were a total of 2,868 crimes reported. Had the SST not been rolled out, the model predicted 3,045 crimes. The 95% interval of this prediction is [2,374, 3,734]. The probability of obtaining this effect by chance is p = .35. Given the wide range of predicted changes, this impact would not be considered statistically significant.

Figure 5: Results of fitting a Bayesian structural time series model to crime data



Note. Top panel shows the observed data (black line), the model estimate (dashed line), and the 95% uncertainty intervals (grey band). The vertical dashed line represents the time at which ShotSpotter/CCTV integration was fully achieved (February 2020). The middle panel shows the pointwise difference between the observed data and the model estimate, along with the uncertainty interval. The bottom panel shows the estimated cumulative effect of ShotSpotter.

Table 5 reports the results from each model fit. Models noted as "extended" included the

extra months of data into 2021 (at the cost of losing all but two donor cities).

Table 5: Summary of models fit to crime, homicides, and shootings

Model	Cumulative Count	Model Prediction	Prediction Interval	р
Crime	2,868	3,045	[2,374,3,734]	0.35
Crime, Extended	4,117	3,957	[3,204, 4,863]	0.33
Homicides	26	20	[11, 27]	0.05
Homicides, Extended	37	27	[13, 37]	0.03
Shootings	91	24	[-19, 70]	<.01
Shootings, Extended	118	31	[-42, 123]	0.03

Note. Extended models take advantage of the longer time series of data available for WPD. The tradeoff for using the extended timeline was the loss of all but two donor cites due to time series censoring among the donor agency data. Crime counts includes homicides and shootings.

Of the outcomes tested, homicides and shootings both showed a pattern where the observed counts of events were higher in the post-SST period than would be expected based on the patterns seen in the pre-SST period. Both specifications for shootings, and the extended model for homicides reached the threshold for statistical significance, while the shortened model for homicides had a marginal p value. By contrast, there were slightly fewer crimes than would be expected. However, in neither model specification did this difference reach the threshold for statistical significance.

ShotSpotter Alerts

In the period before full SST/CCTV integration, the median number of monthly SST alerts was 31, with a maximum of 62 (reached in November 2014), and a minimum of 13 (February 2015). After full integration in February 2020, we had full monthly data until February 2021. The median number of SST alerts in this period was 106, with a maximum of 154, (reached in September 2020), and a minimum of 65 (reached during May 2020).

Community Surveys

Figure 6 shows the poststratified estimates for community survey items, by wave. Across all survey sections, only the set of questions asking about neighborhood concerns showed reliable changes across questions between waves. Though all of these questions showed shifts consistent with reduced concerns in wave 2, only questions asking about having a home or car broken into, and asking about being hassled by youths, or others drinking, loitering, or panhandling exhibited changes large enough and consistent enough for robust confidence that community sentiments reflect reduced concerns in these areas. Other questions in this section tended to show similar shifts in concerns, but the results were less definitive.





Note. Points represent the median of the posterior, and error bars represent the 80% (fat) and 95% (thin) uncertainty intervals.

Results from other questions are displayed in Table 6 through Table 11. All estimates are the median and 95% uncertainty intervals from the posterior distribution. Table 6 contains the question block asking respondents how well they believe police are doing at their jobs. Although none of the questions reach statistical significance, posteriors for each question reflect slightly higher values in the wave 2 survey; respondents were modestly more likely to rate police more positively between wave 1 and wave 2.

Торіс	Wave 1	Wave 2	Difference
Fighting crime	1.69 [0.09, 2.94]	1.78 [0.31, 3.18]	0.09 [-0.13, 0.30]
Dealing with problems that concern your neighborhood	1.58 [0.07, 2.94]	1.76 [0.11, 2.98]	0.17 [-0.04, 0.39]
Being visible on the street	1.62 [0.09, 2.96]	1.76 [0.21, 3.06]	0.13 [-0.07, 0.33]
Being available when you need them	1.65 [0.12, 3.00]	1.83 [0.30, 3.15]	0.18 [-0.02, 0.40]
Responding promptly to calls	1.65 [0.18, 3.04]	1.83 [0.28, 3.14]	0.18 [-0.03, 0.40]
Helping victims of crime	1.67 [0.13, 3.00]	1.78 [0.21, 3.07]	0.11 [-0.09, 0.33]
Treating people fairly regardless of who they are	1.68 [0.10, 2.96]	1.78 [0.26, 3.11]	0.10 [-0.11, 0.32]

Table 6: From Very Poor (1) to Very Good (4), how well are police doing at...

Table 7 presents results questions related to police professionalism. None of the differences reached statistical significance. Wave 2 respondents rated negative actions as slightly less common, as reflected in the negative differences between the posteriors. However, wave 2 ratings for whether the police act professionally were lower than the wave 1 responses. The estimated differences across questions were between -0.33 and 0.09 on a 4-point response scale.
Торіс	Wave 1	Wave 2	Difference	
Stop people on the streets/cars without good reason	1.19 [0.18, 2.34]	1.07 [0.08, 2.24]	-0.11 [-0.31, 0.09]	
Use excessive force	1.03 [0.00, 2.17]	0.93 [-0.10, 2.08]	-0.1 [-0.31, 0.09]	
Use offensive language	1.09 [0.15, 2.31]	0.97 [0.02, 2.21]	-0.12 [-0.33, 0.08]	
Break the law of break police rules	1.18 [0.16, 2.33]	1.05 [0.04, 2.23]	-0.12 [-0.32, 0.07]	
Treat people differently depending on race, ethnicity, gender, religion, or immigration status	1.36 [0.39, 2.57]	1.25 [0.27, 2.44]	-0.11 [-0.31, 0.09]	
Act Professionally	2.47 [1.42, 3.58]	2.38 [1.31, 3.5]	-0.09 [-0.29, 0.14]	

Table 7: From Very Uncommon (1) to Very Common (4), how common is it for the police to...

Questions about respondent concerns about crime and disorder in their neighborhood (Table 8) suggested that respondents were slightly less worried about most problems during Wave 2. The magnitude of shift across questions is estimated to be between about -0.31 and 0.07 on a 3-point response scale.

Table 8: From Not at all worried (1) to Very Worried (3), how worried are you about...

Торіс	Wave 1	Wave 2	Difference
Car broken into/stolen	2.18 [1.31, 3.10]	2.02 [1.12, 2.96]	-0.16 [-0.30, -0.01]
Home broken into	2.02 [1.12, 2.93]	1.85 [0.97, 2.81]	-0.16 [-0.31, -0.02]
Assaulted/robbed	2.05 [1.13, 2.95]	1.90 [1.02, 2.85]	-0.14 [-0.30, 0.00]
Being out in your neighborhood at night	2.09 [1.18, 2.99]	1.96 [1.07, 2.88]	-0.13 [-0.29, 0.02]
People selling/using drugs	2.27 [1.39, 3.20]	2.12 [1.24, 3.08]	-0.15 [-0.30, 0.00]
People using/selling guns	2.32 [1.44, 3.26]	2.23 [1.35, 3.18]	-0.10 [-0.24, 0.07]
Hassled by youths or others drinking, loitering, or panhandling	2.19 [1.27, 3.08]	2.02 [1.12, 2.96]	-0.16 [-0.31, -0.02]

Table 9 describes perceptions about police legitimacy and respondents' trust and confidence in the WPD. Respondents showed little change on these items; differences in responses were estimated to be between -0.31 and 0.21 on a 4-point response scale.

Table 9: From Strongly Disagree (1) to Strongly Agree (4), how much do you agree or disagree with the following statements?

Topics	Wave 1	Wave 2	Difference	
Trust PD to make decisions that are good for everyone	2.80 [1.06, 4.02]	2.74 [0.95, 3.95]	-0.06 [-0.26, 0.15]	
Confidence that PD can do its job well	2.85 [1.1, 4.06]	2.79 [0.98, 3.98]	-0.06 [-0.27, 0.14]	
Comfortable calling PD if I needed help	3.15 [1.4, 4.35]	3.15 [1.29, 4.28]	-0.01 [-0.22, 0.21]	
If I complained about an officer, PD would take it seriously	2.75 [1.04, 3.98]	2.65 [0.91, 3.9]	-0.09 [-0.31, 0.11]	

Responses on cooperation with the police (Table 10) also show little difference between wave 1 and 2. Changes between waves for these questions were estimated to be between -0.23 and 0.14 on a three-point response scale.

Table 10: From Very Unlikely (1) to Very Likely (3), how likely would you be to...

Торіс	Wave 1	Wave 2	Difference
Work with police to ID a person who has committed a crime	3.33 [2.16, 4.19]	3.30 [2.12, 4.16]	-0.03 [-0.21, 0.13]
Work with police to ID place where crimes are taking place	3.34 [2.20, 4.23]	3.29 [2.13, 4.17]	-0.04 [-0.22, 0.13]
Attend a meeting of residents to discuss crime prevention	3.27 [2.11, 4.14]	3.21 [2.02, 4.07]	-0.05 [-0.23, 0.12]

Questions on obligations to obey laws (Table 11) shows virtually no difference between waves 1 and 2. Changes in responses to these questions are estimated to be between -0.14 and 0.16 on a four-point response scale.

Table 11: From Strongly Disagree (1) to Strongly Agree (4), how much do you agree or disagree with the following statements?

Торіс	Wave 1	Wave 2	Difference	
I question the laws we are asked to obey	2.40 [2.22, 2.62]	2.42 [2.20, 2.61]	0.01 [-0.12, 0.14]	
When an officer makes a request, you should do what they say even if you disagree	3.11 [2.92, 3.32]	3.11 [2.91, 3.32]	0.00 [-0.14, 0.12]	
I feel an obligation to obey the law	3.54 [3.34, 3.74]	3.57 [3.35, 3.77]	0.03 [-0.10, 0.16]	

Figure 7 displays differences in key metrics between Wave 1 and Wave 2, disaggregated by race, marginalizing across specific questions. Most confidence intervals cross 0, indicating little evidence for robust changes between Wave 1 and 2. The exception was the perceptions of neighborhood concerns expressed by White respondents: they generally perceived fewer neighborhood concerns during Wave 2 compared to Wave 1. At the same time, White respondents also had slightly higher values on police effectiveness, though this effect was marginal. Confidence intervals on estimates for other racial categories indicate data consistent with reduced perceptions of legitimacy, professionalism, and willingness to cooperate between Wave 1 and 2. However, the relatively large confidence intervals indicate that we were not able to precisely detect differences this small for these groups.



Figure 7: Differences between Wave 1 and Wave 2, by race

Some questions were only asked during one phase of the study (Figure 8). Wave 1 included two additional questions on police effectiveness as it relates to gun crime. Wave 2 included questions on community perceptions of gun crime and police technologies. 70% of respondents said police did a good, or a very good, job of responding to gun violence; however, nearly one third of respondents (30%) answered that police did a poor job, or a very poor job, of responding to gun violence in their neighborhood. 83% of respondents indicated that police did a good, or a very good, job at promptly responding to gunshots.



Figure 8: Community survey (wave 1 only) questions on police effectiveness responding to gun crimes

The wave 2 survey included items on whether police technologies make community members feel safer or if they think the technology is an invasion of privacy (Figure 9). When asked if body worn cameras were an invasion of privacy, an overwhelming majority disagreed or strongly disagreed (95%), a rate substantially higher than those reported from previous surveys (Crow et al., 2017; Sousa et al., 2015). Nearly 90% agreed or strongly agreed that cameras made them feel safer. Conversely, when asked whether the cameras were an invasion of privacy, 90% disagreed or strongly disagreed. When asked if sensors used by police to detect gunfire makes respondents feel safer, 85% agreed or strongly agreed. Finally, more than 95% disagreed or strongly disagreed that AGDs were an invasion of privacy.

Figure 9: Community wave 2 survey questions on feelings of safety and privacy of various police technologies



Officer Surveys

Wave 1 Results

Nearly three-fourths of officer respondents indicated that they were aware of the SST/CCTV integration (72% yes, 28% no). Those who answered yes, were asked to what extent they believed the technology would improve their response to gunshots and ability to work shooting cases (Figure 10). Over 75% of respondents believed that the technology would

improve their response to gunshots; over 90% indicated it would improve their ability to

investigate and solve shooting cases.



Figure 10: Officer wave 1 survey results for the ability of technology to improve work

All respondents were asked about their reliance on technology to respond to shots fired, and to work shooting cases. Figure 11 presents the results. Sixty-four percent of respondents indicated that they rely on departmental technology a great deal to respond to shots fired. More than 90% of respondents indicated that current department resources help them work shooting cases.



Figure 11: Officer wave 1 survey responses on current department technology

Respondents answered a series of questions asking how much time they spent performing various tasks for a shots fired call (Figure 12). All respondents spent less than 30 minutes and (97% spent less than 15 minutes) driving to the identified location. About 71% of respondents spent less than 30 minutes conducting surveillance at the shots fired location. More than 80% indicated they spend less than 30 minutes speaking to the complainant. About 70% of respondents spent 30 minutes or more talking to members of the community. Finally, arresting suspects at a shots fired call took greatest amount of time; 49% indicated that this aspect takes over an hour.



Considering a typical shots fired call, how much time do you spend performing each of the following tasks?

Wave 2 Results

The post-implementation officer survey asked respondents a series of questions examining the extent the integration of SST and CCTV cameras impacted their work. (Figure 13). Nearly 80% indicated that the integration had assisted their ability to arrive to a shots fired call in a timely manner. Almost half of respondents (49%) said that the integration did not increase victim or witness cooperation in gun crime investigations. However, respondents were more positive about the technology's assistance in helping them identify suspects, with 72% saying it helped somewhat or a great deal. Respondents were less likely to say that the technology helped them in arresting suspects, with 61% indicating it helped somewhat or a great deal.



Figure 13: Officer wave 2 survey results for integration's impact on work

Respondents were asked about challenges regarding SST/CCTV integration (Figure 14). A majority of respondents indicated they had not at all (34%) or not very much (40%). When asked whether they received training on the implementation, the vast majority (89%) indicated that they had not received training. Of those who did receive training (15 respondents), they rated the training as good (nine respondents) or excellent (six respondents). The 15 respondents who had received the training reflect those who were trained through a "train the trainer" effort, and that training for additional WPD personnel was forthcoming at the time this report was issued.





As in the wave 1 survey, respondents were asked about the time spent performing various tasks related to shots fired calls, with a few added questions for this wave. Figure 15 shows the results. Similar to wave 1, the vast majority of respondents indicated that it took less than 15 or 15-30 minutes to drive to the identified location, although less than 1% indicated it took over 31 minutes. Three-quarters of respondents said it took less than 15 minutes or between 15 to 30 minutes to conduct surveillance of the area. More than 83% spent less than 30 minutes speaking to a complainant, while 78% spent less than 30 minutes speaking to the community. As in wave 1, arresting suspects took up more of respondents' time, with 48% indicating that it took between 31 to 60 minutes or over an hour. More than 85% of respondents spend 30 minutes or less issuing warnings, and more than 61% spent 30 minutes or less on other tasks at shots fired calls.





Considering a typical shots fired call, how much time do you spend in minutes performing each of the following tasks?

Focus Group Findings

The following narrative presents the findings from five focus groups conducted with WPD personnel.

How is ShotSpotter used?

In using SST technology, officers receive shooting alerts with location information directly to their phones (via a mobile application) or to a computer in their patrol cars. Participants from the crime lab also noted that some of the crime scene technicians have access to the application. Patrol officers and supervisors respond to all SST alerts and write a report, even if it turns out to be a false alert. Response to a SST alert by detectives can vary and is on a "case-by-case basis" (e.g., whether there is incoming information on a victim). Sergeants noted

that they take into consideration the type of area flagged; for instance, they prioritize responding to SST notifications more in known high-crime areas, which is often accompanied by multiple SST alerts and citizen calls for service. Sergeants compared this type of alert to a known construction area, providing Interstate 95 construction as an example, in which only one SST notification is received, where false positive alarms are more likely to happen. Officers are still required to respond a write an alert when an alert is received that is likely attributed to construction, but instances where only one alert occurs is a lower response priority than an area with multiple alerts around the same time. WPD detectives explained that, for a "normal shooting," a member of the team typically remains on standby and reviews the footage. It was noted by detectives that some officers can view live footage on their phones, and the inspector/captain group added that the SST app is user friendly. Sergeants noted that, when responding to an alert, a patrol supervisor is also always assigned to the call. Furthermore, sergeants added that a report is written about all SST alerts, including for alerts that cannot be independently corroborated as gunfire.

According to staff from the RTCC, SST alerts are directly sent to their phones, laptops, and camera feed in their office. RTCC staff stated that they check social media platforms to see if there are mentions about the area in which the incident took place to provide additional information to responding officers and the investigation, and the computer aided dispatch system to see if they can find out which officers are in the area.

WPD officers had not received trainings since the department first installed SST seven to eight years ago. WPD executive staff stated that there was an initial overview provided to officers but no follow-ups in the time since. Nevertheless, they believed that officers knew how

to use the SST app. There had been training associated with the integration of SST and CCTV, but COVID-19 had required that training be paused.

ShotSpotter/CCTV Usefulness

Focus group participants provided positive commentary about the usefulness of SST technology. Agency executive staff noted that they "rely heavily on SST in the Criminal Investigations Divisions," while the detectives and sergeants noted that SST had contributed to a "major shift" in investigations that had resulted in more crime scene identifications and leads. One main benefit reported was the increased shell casing recoveries which, according to the crime lab group, in turn had increased the efficiency of investigations. Detectives noted that more shell casing recoveries were helpful when victims were reluctant to engage the investigations. The crime lab group also stated that SST has contributed to their significant increase in firearms recoveries.

Both the sergeant and crime lab staff noted that police response has become more agile with the implementation of SST; sergeants noted that reaction times to shootings could occur within "seconds to minutes." The sergeant group used an illustrative example in which gang members were shooting at each other while driving motor vehicles through the highway and city; they noted that SST aided in tracking the location of the ongoing shootings thereby improving safety for the officers as they approached the moving gunfight. The sergeant group emphasized that information from SST provided a clearer expectations of crime scenes. Officers could, for example locate a scene more quickly and pinpoint evidence more precisely. Moreover, participants perceived the effectiveness of SST increased after the geographic expansion of SST coverage. A sergeant stated, "Once the expansion came, we felt like that we could do our job better now because it's covering a wider area for us." When asked about the integration of SST and CCTV, several sergeants noted that SST and CCTV compliment other forms of intelligence data; detectives noted that even prior to SST integration, CCTV had aided with evidence collection by recording shootings. The executive staff group provided positive narratives about the broader implications of SST, and, to some degree, CCTV technology. They stated that SST facilitates resource allocation by identifying problem areas, and that SST and CCTV together facilitate prosecution by providing supportive video evidence. Further, they noted that because SST allows officers to arrive on the scene much faster, aid for victims can be provided much quicker. Generally, they noted a positive response from community members, specifically from civics associations.

Difficulties Associated with ShotSpotter/CCTV

Participants identified several challenges associated with SST, in general, and SST/CCTV integration. The inspector/captain groups noted that occasionally there is a shooting that gets registered by the SST system but does not get forwarded to officers, and, on the practical side, that officers need multiple screens to monitor SST alerts and view crime scene footage.

The crime lab group noted there was a substantial increase in workload and paperwork for lab technicians.⁵ They explained that all potential hits on firearm casings go through a peer review process, in which three crime lab personnel, including a supervisor, reviews the report to ensure error reduction, however, there is insufficient staff for the level of work that the process requires. A crime lab staff stated, "The challenge is to hold ourselves accountable. We need to make sure our data is correct, but everyone wants everything now, now, now. The busier we get,

⁵ Unfortunately data on firearm and ballistic evidence processing was not available to evaluate trends over time.

the faster people want it. We want to avoid errors increasing exponentially." Moreover, the crime lab focus group believed that the success of SST for evidence collection depended on officers' level of accountability in collecting shell casings and completing paperwork.

The integration of SST and CCTV was perceived as a "work in progress. Notably, participants stated that there were a number of legacy cameras, currently being phased out, that did not have the ability to pan or track incidents. Further, they described situations in which cameras zoom in too closely during active shootings, reducing the amount of contextual information that would be visible (e.g., vehicles, witnesses). There was also a concern that individuals may attempt to disable or destroy cameras (e.g., with paintball guns), but also stated these incidents are identified quickly and that there have been arrests associated with these incidents.

Recommendations from Agency Personnel

There were relatively few recommendations for improvements provided by agency personnel. Executive staff recommended expanding the camera activation radius after a SST notification. They believed that expanding the activation radius in response to an SST notification would have been useful in identifying potential suspects. This group also noted that, to combat the vandalism of the cameras, they need to be more difficult to access, more covert, and associated with stronger penalization for vandalism. The detective group also wished for greater CCTV coverage and speculated on the value of 360-degree camera technology for enhancing the value of the system.

Executive staff encouraged other departments looking to implement SST/CCTV integration to seek where in the community the technology is needed, and obtain community buy-in and support for the technology. They further noted that it is imperative to collect data to evaluate the implementation of SST/CCTV to support funding continuation.

Discussion

Empirical assessment of SST/CCTV integration found mixed results, with most results suggesting that the implementation and integration was not effective at achieving key goals of crime reduction and increased clearance rates. Modeling the trajectories of homicides, shootings, and crime incidents, produced mixed results. Although overall crime was lower than predicted in the post-SST/CCTV period, this change was not significant. Moreover, homicides and shootings increased during the post-implementation time and this change was statistically significant.

Additionally, results suggest that the probability of a homicide or shooting being cleared by arrest was *lower* during the post-SST/CCTV integration. This is directly counter to the hypothesis that the technology should facilitate arrest of suspects and improve clearance rates. Nevertheless, we are cautious to not over interpret the generalizability of these results. The reliability of our results must be tempered by acknowledging the poor quality or limited availability of key data and the unusual circumstance that the COVID-19 public health crisis has created for public safety more generally.

We must also acknowledge that this was not an experimental design or evaluation. Quasiexperimental evaluations of SST are most common, but have limitations. Despite sophisticated approaches to control for broader changes in crime (for example, by 'borrowing' information from similarly situated donor cities) and ongoing trends (such as seasonality), we cannot rule out the possibility that responses to the public health crisis effected results by changing behaviors of officers or the public.

The community survey findings suggest that respondents' concerns about crime decreased between waves 1 and 2; significant reductions were found about having their home or car broken into and being hassled by youths, or drinking, loitering, or panhandling. There

appeared to be some differences by race with most of the overall reductions in concern driven by changes in perceptions of white residents.

Differences between waves 1 and 2 on police performance did not reach statistical significance, although the responses indicated that wave 2 respondents tended to rate the police higher. Respondents in wave 2 were less likely to say that negative police behaviors were common, although the median response was lower for whether police act professionally than in Wave 1. Regarding police legitimacy and working with the police on crime issues, respondents showed lower level of agreement on questions in Wave 2, although the findings did not reach the significant level. The final questions of obligation to obey showed virtually no differences in responses between the waves.

We can only speculate as to why this pattern emerged between Wave 1 and Wave 2. Considerable social and political strife emerged during the intervening period between the two waves of surveys. This may explain why we saw some movement on the perceptions of neighborhood problems. Other measures, such as general perceptions of police effectiveness, may be more durable and less influenced by current events. Nevertheless, it is at least somewhat encouraging for WPD that these public perceptions was relatively unchanged despite larger public demonstration of anti-police sentiment ongoing around the same time of the surveys.

It is also plausible that the small sample size contributed to the non-significant result. However, even if sufficient surveys had been conducted to identify these differences as significant, they were practically small and it is difficult to call these changes meaningful. More broadly, considerable social and political events occurred in the time between wave 1 and wave 2 administration. It is impossible to know how these external factors affected survey results.

The single wave questions about gun crime and police technologies found that respondents felt positively about how police in their neighborhood responded to gun crimes. Respondents also reported positive feeling regarding police technologies, including CCTV and SST. There were relatively little privacy concerns about the use of this technology.

Officer surveys found largely positive views about technology and the SST/CCTV integration. The pre-intervention survey found that the majority of respondents viewed technology favorably and believed it would contribute to their ability to respond and work shots fired calls. Respondents also utilized existing technology resources at a high level prior to the expansion.

Wave 2 questions focused on respondents' view of the SST/CCTV integration. The majority responded positively about the ability of the expansion to arrive on scene in a timely manner. There was broad agreement that the technology was helpful in identifying and arresting suspects. However, most respondents did not believe that the technology led to increased victim or witness cooperation. Focus groups with WPD personnel indicated positive feedback regarding the expansion of SST and the integration with CCTV. Participants indicated that the technology was easy to use, and believed it contributed to an increase in recovery of shell casings and firearms. Some implementation challenges involved technology issues, such as older cameras that do not pan, cameras that zoom in too much at a scene. Overall, the officer surveys and WPD focus group indicate that WPD personnel are largely positive about the integration and its impact on their job.

About half of agency respondents suggested that SST/CCTV did not increase victim or witness cooperation in gun crime investigations. In response to shots fired calls, about 80% of officers indicated that they spent less than 30 minutes speaking to a complainant or community

members. This raises questions about the veracity of the claim that SST will improve community cooperation by overcoming the barrier of calling the police in response to shots fired. Even with the automated SST notification of shots fired, officers will have limited investigative options without cooperation from community members. Additional work is needed to understand how to facilitate effective police-community response to SST notifications.

More confoundingly, it is difficult to reconcile the lack of measurable impact on outcomes with the generally positive perception by officers. For patrol officers, it may be that SST simply increases the number of high priority calls to which they respond. Improvements in the ability to responder faster, and more accurately, may lead to a perception that the technology is effective (see Lum et al., 2017). In other words, these officers may be focusing on outputs (e.g., faster police response) rather than outcomes (e.g., reducing firearm violence). Given the often tentative relationship between police technologies and the ability to prevent and solve crime (Garicano & Heaton, 2010; Lum et al., 2017), it is perhaps unsurprising that we are unable to identify an impact on key outcomes of interest.

Limitations

There were a number of limitations in the evaluation of SST/CCTV integration. First, due to delays and technological challenges, the integration did not occur fully until summer of 2020. While we had several years of pre-implementation crime data from WPD, the post-intervention period provided just over a year of data. More time would be helpful in assessing the impacts of the integration, particularly given that COVID-19 coincided with the post-implementation period.

Second, much of the data that would have been useful for assessing the impact of the SST/CCTV integration was unavailable or of poor quality. WPD was unable to provide full calls

for service data with response times, information on shell casing, gun recoveries, or NIBIN hits, information on witness identifications, or the number of gun incidents captured on camera. A technical software limitation restricted the ability of the WPD to provide a full enumeration of calls for service data with response times. As part of this study, this limitation was identified and addressed with the software vendor, and the agency now has additional capabilities to extract data from the State-based platforms utilized to record calls for service. Nevertheless, this correction was not retroactive and we were unable to capitalize on this technical fix.

Even when available, some of the data were limited and prevented fully exploring the impact of the system. For example, clearance data from several years was unavailable, and information on days to arrests information was inconsistent. Some cases provided specific information on date the incident was cleared by arrests while others just indicated that an arrest had been made.

Although the community survey was two waves the questions were not all directly related to community perceptions of the SST implementation and CCTV expansion. Using the already established Platform survey instrument did not allow us to change these questions, although these surveys do provide useful information to WPD about the perceptions and feelings of community members towards police in their neighborhoods. Additionally, the gun-related and technology-related questions were only asked in one wave each, so we are unable to compare the changes in these questions over time.

Conclusion

Our findings indicate that the SST/CCTV integration did not lead to results that were consistent with hypothesized impacts. In summary, results from our most robust statistical modeling suggests:

- Overall, crime was lower during the post SST/CCTV implementation period although this change was non-significant.
- However, the crime reduction benefits did not hold for the crimes most likely to be affected by SST/CCTV. Homicides and shootings *increased* in the postimplementation phase.
- Further, clearance by arrests for homicides and shootings were actually *lower* during the post-implementation phase.

Taken together, we found limited, and unconvincing, evidence that SST/CCTV integration reduced crime or lead to better investigative outcomes. Despite the conceptual benefits of faster and more accurate response to firearm discharges, there was little support that these improvements translated to meaningful changes in key public safety outcomes. We note that despite close collaboration with WPD, data limitations prevented us from testing several key aspects of the conceptual model that would link SST/CCTV to improved public safety outcomes. Namely, data on actual evidence recovery, as a result of SST alerts, was unavailable. Information on response times, and changes to response times, were also limited. Additionally, there was no information on how the integration of CCTV was used by officers in response to SST alerts.

We theorize several reasons for the lack of measurable impact generated by the SST/CCTV integration:

• Consistent with much earlier research, police response times do not matter for the

likelihood of apprehending a suspect on scene. If true, this would undermine the proposed mechanism whereby SST improves immediate case closures via arrests generated by patrol officers.

- Faster, and more precise, response to shots fired does not lead to the better, or more comprehensive, collection of evidence. Unfortunately, the lack of available documentation prevented testing whether SST alerts lead to better evidence collection.
- The additional shots fired events identified by SST, that would otherwise not have been reported by community members, may not be generally actionable by law enforcement. We note that officers still reported challenges in engaging community members for shots fired calls. Without additional evidence or witnesses, these events have limited investigative avenues.

Unfortunately, we are unable to disentangle these potential competing theories for why SST/CCTV integration appears ineffective. Nevertheless, they do identify a path for future research and data collection. In particular, more detailed and comprehensive data are needed across a variety of proposed proximal and distal outcomes. Information from a variety of systems, including SST, records management systems, and laboratory information systems must be unified to produce a more comprehensive view of how SST may impact agency operations and key public safety outcomes.

The community survey questions were too general to directly assess nuanced public sentiment towards the deployment of integrated SST/CCTV. Results from a limited number of questions suggested that survey respondents generally supported the technology and did not feel that it was an invasion of privacy. Officer surveys and focus groups indicate that WPD personnel

also found the expansion and integration useful. Participants believe the SST/CCTV integration helped them do their job and be more effective.

It is difficult to reconcile these desperate findings: there was little empirical evidence that SST/CCTV integration reduced firearm-related violence or improved case closure rates. The lack of findings here are consistent with research that has been conducted in other places. Nevertheless, there was generally positive feedback from the public and agency representatives. Law enforcement perceptions can be highly sensitive to case studies and high-profile examples of success. These individual successes, however, can be difficult to measure in aggregate. This suggests that researchers must work more closely with agency representatives to understand the mechanisms through which SST/CCTV should work. This must be supported by additional data collection that is sufficiently detailed to facilitate sensitive analyses needed to detect these changes.

Finally, we note that the implementation of SST is very likely to increase agency workload. This is most likely to be felt by patrol officers in the response to SST alerts and attempting to locate evidence and witnesses once on scene. It is unclear how this additional workload impacts officer activity if the response to SST alerts is displacing other kinds of proactive policing activity. Hot spots policing, for example, has been found to be one of the most consistently effective police patrol strategies for preventing crime. Future work exploring how to integrate SST alerts and hot spots policing strategies may prove useful for optimizing the crime prevention potential of patrol officer resources.

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Appendix 1: Wave 1 Community Survey



Platform Survey: Community Survey

We would like to ask your opinions about the police department that serves your community and the police in general. The survey is confidential; your individual responses will not be revealed to your agency, or any other agency or organization.

Performance of Officers in Your Neighborhood

1. **Police Effectiveness** – We would like you to think about the police who work in the neighborhood where you live.

How well are they doing...

	Very	Good	Poor	Very	Do Not
	Good Job	Job	Job	Poor Job	Know
Fighting Crime					
Responding to gun violence specifically?					
Dealing with problems that concern your					
neighborhood					
Being visible on the street					
Being available when you need them					
Responding promptly to call for assistance					
Responding promptly to gunshots					
Helping victims of crime					
Treating people fairly regardless of who					
they are					

2. **Police Professionalism** – Still thinking about the police who work in the neighborhood where you live, please rate how common the following types of police actions are.

How common is it for the police to...

	Very	Somewhat	Somewhat	Very	Do Not
	Uncommon	Uncommon	Common	Common	Know
Stop people on the streets or in cars without good reason					

Use excessive force			
Use offensive language			
Break the law of break			
police rules			
Treat people differently			
depending on race,			
ethnicity, gender			
identification, religion, or			
immigration status			
Act professionally			

Neighborhood Concerns

3. How worried are you about...

	Very worried	Somewhat worried	Not at all worried
Having your car broken into or stolen			
Having your home broken into			
Being assaulted or robbed			
Being out in your neighborhood at night			
People selling or using drugs			
People using or selling guns			
Being hassled by youths or others drinking, loitering, or panhandling			

Confidence in the Police Department (Legitimacy)

4. Please indicate how much you agree or disagree with the following statements.

	Strongly Agree	Agree	Disagree	Strongly Disagree
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I trust my police department to make decisions that are good for everyone in my city		
I have confidence that my police department can do its job well		
I would feel comfortable calling the police department if I needed help		
I believe that if I complained about an officer to my police department, that the agency would take it seriously		

Willingness to Cooperate with the Police and Community

5. How likely would you be to...

	Very Likely	Likely	Unlikely	Very Unlikely
Work with the police to identify a person who has committed a crime in your neighborhood				
Work with the police to identify place for example – houses, businesses, parks, where crimes are taking place				
Attend a meeting of residents in your neighborhood to discuss crime prevention				

Citizen Views Toward the Law and Compliance (Legal Cynicism)

6. Please indicate how much you agree or disagree with the following statements.

	Strongly Agree	Agree	Disagree	Strongly Disagree
--	-------------------	-------	----------	----------------------

I sometimes question the laws we are asked to obey		
When a police officer makes a request, you should do what they say even if you disagree with it		
I feel an obligation to obey the law		

Demographics

Finally, we would like some personal and household information so that we can better understand how different groups feel about the police. Your personal information is confidential. Only group information will be reported.

7. What is your gender

□ Male

□ Female

8. Please enter your age

- \Box Under 18
- □ 18-24
- □ 25-34
- □ 45-54
- □ 55-64
- □ 65-74
- □ 75-84

\square 85 or older

- 9. What race do you consider yourself to be?
 - □ White
 - \Box Black or African American
 - □ Hispanic or Latinx
 - \Box Asian
 - \Box Native American
 - \Box Some other racial or ethnic group
 - □ Mixed (e.g. White-African American, Hispanic-African American)
- 10. What is the last grade you completed in school?
 - \Box Some grade school
 - \Box Some high school
 - \Box Graduated high school
 - \Box Technical/Vocational
 - \Box Some college
 - □ Graduate college/Bachelors/BA
 - □ Graduate/Professional/PhD/JD/MA,etc.
- 11. What was the total combined income for all the people in your household, before taxes, for the past year? (Your specific response will be kept completely confidential.)
 - \Box Less than \$25,000

- □ \$25,001 to less than \$50,000
- □ \$50,001 to less than \$75,000
- □ \$75,001 to less than \$100,000
- □ Over \$100,000
- 12. Is there anything you would like to share about your local agency and/or its officers, good or bad? (All responses are confidential)

Appendix 2: Wave 2 Community Survey



Platform Survey: Community Survey

We would like to ask your opinions about the police department that serves your community and the police in general. The survey is confidential; your individual responses will not be revealed to your agency, or any other agency or organization.

Performance of Officers in Your Neighborhood

1. **Police Effectiveness** – We would like you to think about the police who work in the neighborhood where you live.

How well are they doing...

	Very Good Job	Good Job	Poor Job	Very Poor Job	Do Not Know
	Good Job	300	300	1001300	KIIUW
Fighting Crime					
Dealing with problems that concern your					
neighborhood					
Being visible on the street					
Being available when you need them					
Responding promptly to call for					
assistance					
Helping victims of crime					
Treating people fairly regardless of who					
they are					

2. **Police Professionalism** – Still thinking about the police who work in the neighborhood where you live, please rate how common the following types of police actions are.

How common is it for the police to...

Very	Somewhat	Somewhat	Very	Do Not
Uncommon	Uncommon	Common	Common	Know

Stop people on the streets or			
in cars without good reason			
Use excessive force			
Use offensive language			
Break the law of break			
police rules			
Treat people differently			
depending on race,			
ethnicity, gender			
identification, religion, or			
immigration status			
Act professionally			

Neighborhood Concerns

3. How worried are you about...

	Very worried	Somewhat worried	Not at all worried
Having your car broken into or stolen			
Having your home broken into			
Being assaulted or robbed			
Being out in your neighborhood at night			
People selling or using drugs			
People using or selling guns			
Being hassled by youths or others drinking, loitering, or panhandling			

Confidence in the Police Department (Legitimacy)

4. Please indicate how much you agree or disagree with the following statements.

Strongly Agree	Agree	Disagree	Strongly Disagree
-------------------	-------	----------	----------------------
I trust my police department to make decisions that are good for everyone in my city			
--	--	--	
I have confidence that my police department can do its job well			
I would feel comfortable calling the police department if I needed help			
I believe that if I complained about an officer to my police department, that the agency would take it seriously			

Willingness to Cooperate with the Police and Community

5. How likely would you be to...

	Very Likely	Likely	Unlikely	Very Unlikely
Work with the police to identify a person who has committed a crime in your neighborhood				
Work with the police to identify place for example – houses, businesses, parks, where crimes are taking place				
Attend a meeting of residents in your neighborhood to discuss crime prevention				

Citizen Views Toward the Law and Compliance (Legal Cynicism)

6. Please indicate how much you agree or disagree with the following statements.

	Strongly Agree	Agree	Disagree	Strongly Disagree
I sometimes question the laws we are asked to obey				
When a police officer makes a request, you should do what they say even if you disagree with it				
I feel an obligation to obey the law				

Community Members' Feelings of Safety and Privacy of Various Technologies

	Strongly agree	Agree	Disagree	Strongly disagree
Security cameras				
used in public spaces				
by the police are an				
invasion of privacy				
Cameras worn by				
police officers are an				
invasion of privacy				
Security cameras				
used in public spaces				
by police make me				
feel safer				
The use of sensors by				
police to detect				
gunfire makes me				
feel safer				
The use of sensors by				
police to detect				
gunfire is an invasion				
of my privacy				

7. Please indicate how much you agree or disagree with the following statements.

Demographics

Finally, we would like some personal and household information so that we can better understand how different groups feel about the police. Your personal information is confidential. Only group information will be reported.

8. What is your gender

□ Male

- □ Female
- 9. Please enter your age
 - □ Under 18
 - □ 18-24
 - □ 25-34

- □ 45-54
- □ 55-64
- □ 65-74
- □ 75-84
- \square 85 or older
- 10. What race do you consider yourself to be?
 - \square White
 - □ Black or African American
 - □ Hispanic or Latinx
 - \Box Asian
 - \Box Native American
 - \Box Some other racial or ethnic group
 - D Mixed (e.g. White-African American, Hispanic-African American)

11. What is the last grade you completed in school?

- \Box Some grade school
- \Box Some high school
- □ Graduated high school
- \Box Technical/Vocational
- \Box Some college
- □ Graduate college/Bachelors/BA
- Graduate/Professional/PhD/JD/MA,etc.
- 12. What was the total combined income for all the people in your household, before taxes, for the past

year? (Your specific response will be kept completely confidential.)

- □ Less than \$25,000
- □ \$25,001 to less than \$50,000
- □ \$50,001 to less than \$75,000
- □ \$75,001 to less than \$100,000
- □ Over \$100,000
- 13. Is there anything you would like to share about your local agency and/or its officers, good or bad?

(All responses are confidential)

Appendix 3: Wave 1 Officer Survey

Officer Survey: Pre-implementation

- 1. Are you aware of the upcoming technological integration of ShotSpotter with the existing CCTV cameras in Wilmington?
 - a. Yes
 - b. No
- 2. (If yes): To what extent do you think this technology will improve your ability to respond to gunshots rapidly?
 - a. A great deal
 - b. Somewhat
 - c. Not very much
 - d. Not at all
 - e. Unsure
- 3. (If yes): To what extent do you think this technology will improve your ability to work shooting cases, make arrests, and assist prosecutors of shooting incidents?
 - a. A great deal
 - b. Somewhat
 - c. Not very much
 - d. Not at all
 - e. Unsure
- 4. Currently, how much do you rely on the technological resources of the department to respond to shots fired calls in a timely manner?
 - a. A great deal
 - b. Somewhat
 - c. Not very much
 - d. Not at all
- 5. Currently, how much do you think the resources of the department help you work shooting cases?
 - a. A great deal
 - b. Somewhat
 - c. Not very much
 - d. Not at all
- 6. Considering a typical shots fired call, how much time do you spend performing each of the following tasks? (Answer options: Less than 15 minutes, 15-30 minutes, 30-60 minutes, over an hour, and unsure)
 - a. Driving to identified location
 - b. Conducting additional surveillance of the area
 - c. Talking to a complainant
 - d. Talking to community residents
 - e. Arresting suspect(s)

- 7. Are there any types of training or technology could be provided to help you respond to shots fired calls? Please describe: ______
- 8. What is your rank? _____
- 9. How long have you been working for WPD? _____

Appendix 4: Wave 2 Officer Survey

Officer Survey: Post-implementation

- 1. To what extent has the integration of ShotSpotter with CCTV cameras assisted your ability in arriving to shots fired calls in a timely manner?
 - a. A great deal
 - b. Somewhat
 - c. Not very much
 - d. Not at all
 - e. Unsure
- 2. To what extent has this integration led to increased witness or victim cooperation in gun crimes?
 - a. A great deal
 - b. Somewhat
 - c. Not very much
 - d. Not at all
 - e. Unsure
- 3. To what extent has this technology assisted you in identifying suspects?
 - a. A great deal
 - b. Somewhat
 - c. Not very much
 - d. Not at all
 - e. Unsure
- 4. To what extent has this technology assisted you in arresting suspects?
 - a. A great deal
 - b. Somewhat
 - c. Not very much
 - d. Not at all
 - e. Unsure
- 5. Did you experience any implementation challenges with this technology?
 - a. A great deal
 - b. Somewhat
 - c. Not very much
 - d. Not at all
 - e. Unsure
- 6. Did you undergo specific training for this technology?
 - a. Yes
 - b. No
- 7. (If yes): How would you rate the training you received to use the technology?
 - a. Excellent
 - b. Good
 - c. Average

- d. Poor
- e. Terrible
- 8. (If yes): Are there any comments you can provide that would improve the training you received?
- 9. Considering a typical shots fired call, how much time do you spend performing each of the following tasks? (Answer options: Less than 15 minutes, 15-30 minutes, 30-60 minutes, over an hour, and unsure)
 - a. Time spent in minutes driving to identified location
 - b. Time spent in minutes conducting additional surveillance of the area
 - c. Time spent in minutes talking to a complainant
 - d. Time spent in minutes talking to community residents
 - e. Time spent in minutes arresting suspects
 - f. Time spent in minutes issuing warning
 - g. Time spent in minutes doing other tasks
- 10. Any general comments you would like to provide regarding this technology integration?
- 11. Rank:_____
- 12. Gender: _____
- 13. Current assignment:
- 14. How long have you been working for WPD? _____

Appendix 5: Wilmington Police Department Focus Group Questions

PATROL OFFICER QUESTIONS

Are you aware of any formal written protocol developed by WPD for use of ShotSpotter (SST) with integrated closed-circuit television (CCTV) technology as it relates to patrol officers in your District?

Have you attended any training or been provided with official guidance about the integrated SST/CCTV software? Have you received informal information shared by others about the integration of software?

How do you receive integrated SST/CCTV notifications? Do you also receive non-integrated SST notifications? If so, how do these differ?

Describe the response process for when you receive an integrated SST/CCTV alert:

- Describe the procedures that you take on-scene during response. Are there differences in how you typically process a shots-fired call?
- How frequently do you respond to false alerts?
- What is the internal process for reporting a false alert?
- While you are responding, what steps do you take if you are notified that it was a false alert?
- o Does your response process for integrated alerts differ from SST only alerts?

Has the integrated SST/CCTV technology affected the time you spend on scene looking for shell casings? How? Does this differ from the SST only alerts?

Since the full SST/CCTV expansion in July/August, has the technology improved your work in the field or made it more challenging? How has this integration differed from the SST only alerts? Describe.

What have been the most successful elements of the integration of SST/CCTV? Do you have any success stories to share?

What would you do to improve the use of SST/CCTV integration by you and your fellow officers at the Wilmington Police Department?

Do you have any additional thoughts overall on the SST/CCTV integration?

SERGEANT QUESTIONS

What are key challenges in this department related to firearms? Do you think the SST/CCTV integration helps address these challenges?

Are you required to respond to all SST/CCTV alerts? Does this differ from the typical response policy for shots fired calls? Does it differ from SST only alerts?

How do you receive SST/CCTV integration notifications? Do you receive SST only alerts?

Describe the response process for when you receive an integrated SST/CCTV alert. Does this differ from your response process to SST only alerts?

Describe the procedures that you take on-scene during SST/CCTV response. Are there differences in how you typically process a shots-fired call versus a SST/CCTV alert? How about differences in SST only alerts?

How do you determine if an alert is false? How frequently do you respond to potential false alerts?

What is the internal process for reporting a false alert? What steps do you take if—while you are responding—you are notified that it was a false alert?

Do you think the technology has helped you supervise and process shots-fired scenes?

Do you think the technology has helped the officers you supervise do their job?

Has the SST/CCTV integration affected the time you spend on scene looking for/processing shell casings? Does this differ from the SST only alerts?

What have been the most successful elements of using SST/CCTV integration? Do you have any success stories to share?

What would you do to improve SST/CCTV integration in the department?

Do you have any additional thoughts overall on SST/CCTV technology?

DETECTIVE QUESTIONS

What are key challenges in this department related to firearms? Do you think the SST/CCTV integration helps address these challenges?

Are you aware of any formal written protocols developed by WPD for the use SST/CCTV as it relates to patrol officers in your District?

Have you attended any training or been provided with official guidance about the SST/CCTV software? Have you received informal information shared by others about the integration of software?

How do you use SST/CCTV technology in your role as an investigator? Does this differ from how you use SST only technology in your investigative role?

How do you learn about SST/CCTV notifications if it relates to your case? Does this differ from SST only notifications?

For what types of investigations do you typically use SST/CCTV technology?

Does SST/CCTV integration help make linkages between suspects or firearms? Any differences between using the integration technology versus the SST only alerts?

Has SST/CCTV technology made your job easier or more challenging? How has this integration differed from the SST only alerts?

What have been the most successful elements of using SST/CCTV? Do you have any success stories to share?

What would you do to improve SST/CCTV integration in the department?

Do you have any additional thoughts overall on SST/CCTV technology?

INSPECTOR/CAPTAIN QUESTIONS

What are key challenges in this department related to firearms? Do you think SST/CCTV integration helps address these challenges?

Describe the strategies for deciding the locations for SST/CCTV technology deployment. How are these different from SST only locations?

What have been the most successful elements of using SST/CCTV technology? Do you have any success stories to share?

What have been the most challenging elements of using SST/CCTV technology? Do you have any lessons learned stories to share?

What would you do to improve SST/CCTV technology in the department?

Do you have plans to increase the SST/CCTV coverage area? Why/why not?

Do you have any additional thoughts overall on SST/CCTV technology?

CRIME LAB QUESTIONS

Describe how firearms/casings are processed. Any differences with processing evidence from SST/CCTV alerts? What about SST only alerts?

Do you think SST/CCTV integration has increased/decreased your workload? Is the workload from SST only alerts similar?

Do you think SST/CCTV integration has produced new challenges?

Do you think SST/CCTV integration has increased the number of hits for firearms? Is this different from SST only alerts?

Do you have any additional thoughts overall on SST/CCTV technology?

REAL TIME CRIME CENTER QUESTIONS

Describe how SST/CCTV integration alerts are received in the RTCC. How is this different from SST only alerts? How is this different from previous procedures?

What does your role require when you receive SST/CCTV alerts? Is your role different when receiving SST only alerts?

Do you think SST/CCTV integration has increased/decreased your workload?

What have been the most successful elements of using SST/CCTV technology? Do you have any success stories to share?

What have been the most challenging elements of using SST/CCTV technology? Do you have any lessons learned stories to share?

Do you have any additional thoughts overall on SST/CCTV technology?