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Rajiv Shah [a] & Jeremy Braithwaite [b]

[a] University of Illinois at Chicago, Bloomington, IL, USA

[b] Department of Criminology, Law, & Society, University of California, Irvine, CA, USA

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RESEARCH ARTICLE

Spread too thin: analyzing the effectiveness of the Chicago camera network on crime

Rajiv Shah[a]* and Jeremy Braithwaite[b]

[a]*University of Illinois at Chicago, Bloomington, IL, USA;* [b]*Department of Criminology, Law, & Society, University of California, Irvine, CA, USA*

The use of surveillance cameras is growing tremendously in the USA. In this paper, researchers evaluate two studies that analyzed the effectiveness of Chicago's camera network in reducing crime. Chicago has one of the largest urban surveillance networks, with over a 1000 cameras. The analysis found the initial crime level of an area where a camera was placed had a significant effect. In areas with high crime, cameras were very effective in reducing crime. In other areas, the cameras had little effect in reducing crime. This exploratory research suggests fewer cameras in crime hotspots are much more effective than a wide diffuse camera dragnet.

Keywords: video surveillance; crime analysis; hotspot; CCTV

Introduction

Before 9/11, there were only a handful of police departments using surveillance cameras (Nieto, Johnston-Dodds, & Simmons, 2002). Since 9/11, the use of cameras has expanded to 100s of cities. Cities such as New York and Chicago created large networks with access to 1000s of cameras. This emergent technology is used by law enforcement to combat crime. Compared to patrolling by foot or police car, surveillance cameras make it possible to oversee larger spaces with the same amount of personnel (Koskela, 2000). In this paper, researchers analyze the effectiveness of a large-scale camera network in Chicago.

The Chicago Police Department (CPD) began using surveillance cameras as a police tactic in the summer of 2003 (Theodore, Martin, & Hollon, 2006). Over the next few years, the CPD kept progressively adding cameras with a goal of 2250 cameras (Shachtman, 2005). As the CPD builds its network, the city is building an even larger network. The Office of Emergency Management & Communications in Chicago has linked together approximately 15,000 cameras (Bulkeley, 2009). Chicago's Mayor Daley has famously said that by 2016, 'we'll have [cameras on] almost every block' (Spielman, 2006).

The Chicago camera network is relatively unique, because of its size. The network uses over a 1000 cameras across 200 square miles as a crime-fighting tool. This paper examines the impact of Chicago's camera network on crime. The results of Chicago's camera network will reverberate around the world, as many policy-makers and policing officials are carefully watching what happens in Chicago. While anecdotes abound about the effectiveness of large-scale camera networks, there is little empirical evidence,

*Corresponding author. Email: rajiv.shah@alumni.illinois.edu

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particularly within the USA on whether surveillance cameras prevent crime. This study begins to fill a large gap in our understanding of surveillance cameras systems on crime.

The paper focuses on evaluating the effectiveness of Chicago's camera network on crime. Nevertheless, it is important to recognize that camera networks also raise a number of other issues that are outside the scope of this paper, including concerns over their abuse (Nestel, 2006), privacy issues (Bloss, 2009; Slobogin, 2007), as well as the larger impact of a surveillance state on its citizens (Monahan, 2010).

Literature review

The modern history of surveillance cameras networks in the USA begins with the 1994 Violent Crime Control and Law Enforcement Act, which allocated federal funding for state and local law enforcement crime prevention programs (Violent Crime Control and Law Enforcement Act, 1994). Within three years, there were at least 13 American cities (predominantly on the east coast) that had implemented video surveillance (Nieto, 1997). The operations varied from city to city in terms of the type of surveillance (i.e. active monitoring vs. passive monitoring from mobile units), hours of surveillance (i.e. 24-h monitoring vs. 'split' shifts) and rationale for use.

This section briefly reviews the extant research on the effectiveness of surveillance cameras on crime. The leading site for research is the UK, because of the emphasis on the use of cameras to prevent crime. For example, British Home Office spent approximately a $1 billion dollars between 1995 and 2005 on surveillance cameras (Norris, 2009). As an example, there are over 10,000 police cameras just for the city of London (Davenport, 2007).

There are two significant analyses on the effectiveness of surveillance cameras on crime emerging from the UK. The first is by Welsh and Farrington, who performed a meta-analysis of 22 studies of cameras (2002). Their analysis of all the studies found that cameras had a very small impact on crime. The most effective use of cameras was in enclosed parking lots. In five studies on enclosed parking lots, they found reductions in vehicle crimes, however in all five studies there were also other interventions such as improved lighting, fencing, notices about closed circuit television (CCTV), and increased security personnel. As a result, it is not clear how much of the impact derives solely from the cameras.

A second study comes from the Home Office in 2005. Gill and Spriggs performed a meta-analysis of 14 studies and found that cameras had not reduced crime overall (2005). However, their findings suggested that cameras impact different kinds of crime different. So while premeditated, or more planned offenses, such as vandalism, burglary, and vehicle crime decreased, other more spontaneous offenses such as violence against a person or public order offenses did not decrease.

There are only a handful of studies evaluating surveillance cameras in the USA. A study of San Francisco's 68 cameras found cameras had a small impact on property crimes, but no impact on violent crimes (King, Mulligan, & Raphael, 2008). A study of two areas in Los Angeles with a total of 20 cameras failed to find a statistically significant impact on crime (Cameron, Kolodinski, May, & Williams, 2008). A study in Philadelphia found a general benefit to the cameras, however, in half the sites there appeared to be no benefit from the cameras (Ratcliffe, Taniguchi, & Taylor, 2009). Finally, a study of a private complex in New York found cameras moderately effective in reducing minor crimes or displacing them (Greenberg & Roush, 2009).

Ratcliffe summarizes the consensus on the effectiveness of cameras in five points (Ratcliffe, 2006) First, cameras are more effective at reducing property crimes than violent crimes. Second, surveillance cameras are most effective in small, well-defined areas (such as parking garage). Third, the context of each area and how the system is used are important. Fourth, it is difficult to find statistically significant reductions in crime due to cameras. Fifth, cameras can also serve an important role for investigations after a crime has been committed.

Two dominant justifications for cameras have emerged in the USA. The first is for police investigations where cameras are used to solve crimes after they occurred. This is known as the investigative function of cameras. For example, after several recent high-profile terrorists' cases, police circulated surveillance footage of terrorists. Whether the cameras are instrumental in solving the case is an area of debate. Critics have pointed out that surveillance footage is typically not the key factor in solving the crime (Warrick, Finn, & Nakashima, 2010). Consider how in the London underground terrorist bombings in 2005, CCTV was not the reason why the terrorists were identified. Nevertheless, cameras can assist as an investigative aid for the police.

The second justification for cameras is reducing or preventing crime. A theoretical explanation emerges from situational crime prevention, where a rational criminal is likely to avoid committing a crime in the presence of cameras because of the perceived risk of capture. For example, overt camera configurations – those that are in view of the public and often accompanied by signs indicating the area is under surveillance – can be an effective method of situational crime prevention (Ratcliffe, 2006). All other things being equal, the presence of cameras would lead a rational burglar to avoid the area. Another anthropomorphic explanation for how cameras reduce crime is the concept of cameras as a 'force multiplier' (Buchanan, 2003). In this view, cameras are analogized as eyes, which allow the same number of police officers to monitor a large area.

The city of Chicago claims cameras have reduced crime. Specifically, cameras reduced serious index crimes by 17% in the monitored areas (CPD, 2007). Overall, the police claimed a drop of 30% in crime in the 234 areas where cameras were located (Johnson, 2006). The cameras were also touted as a significant factor in reducing homicides 25% between 2003 and 2004 (Ruethling, 2005). As a result, the Chicago experience has provided the imprimatur of effectiveness for large-scale camera networks. Other cities such as Baltimore and New York use the Chicago experience to justify additional cameras.

There is concern that the city has exaggerated the effectiveness of the camera network. After all, if the city's claims are true, then the effect of cameras in Chicago differs markedly from other studies. Additionally, prominent scholars in Chicago have pointed to the role of recognized gang units and changes in demographics as two factors that weigh larger than surveillance cameras in reducing crime (Lemmer, Bensinger, & Lurigio, 2008; Skogan, 2007). More recent research by La Vigne, Lowry, Dwyer, and Markman (2011) revealed that surveillance cameras yielded the greatest impact when active monitoring and real-time intervention was implemented. Researchers found that this was critical not only for apprehension of offenders engaged in criminal activity, but also for investigative and prosecutorial purposes. Researchers also concluded that, regardless of active or passive monitoring, the importance of training must also be emphasized. Most important was the finding that locations identified as hotspots of criminal activity were not necessarily sites chosen at points of camera installation. Researchers found that a number of logistical considerations are in operation when determining camera placement, such as proximity to power sources and physical obstructions. This latter finding suggests that current camera networks may not be situated in areas they are intended to have the most

impact. Lost in this debate is a true statistical analysis of the effectiveness of the cameras. This lack of analysis led us to study Chicago's camera network.

Methodology

The data

The data for this article was obtained through a Freedom of Information Act (FOIA) request to the CPD. The CPD was not initially forthcoming, so the authors contacted the Illinois American Civil Liberties Union (ACLU) for assistance. With the Illinois ACLU's efforts, the CPD eventually relented and released their reports on the effectiveness of the cameras. The documents from the CPD contain two studies on the effectiveness of the cameras. In both studies, the cameras are spread throughout the city. While there are a few clusters of cameras, there are many other cameras that are isolated. The diffusion and high volume of cameras in the present studies distinguishes this research from prior research efforts (Brown, 1995; Griffith, 2003; Sarno, Hough, & Balos, 1999; Squires, 2003). Given the relative scarcity of literature on surveillance technology effectiveness, we approach this research as exploratory in nature, and therefore limit our analysis to one major urban locale (see generally: Cameron et al., 2008; Waples & Gill, 2006). Although we acknowledge that the effectiveness of surveillance technology in one city likely would not generalize to other US cities, it also should be noted that cities have employ different approaches to the setup and monitoring of networks in effort to balance public security with individual privacy (see La Vigne et al., 2011). These approaches are also likely to be highly correlated with camera effectiveness.

The first study (referred to as 'Northwestern study') was conducted by students of Northwestern University. The study and the data were not released to the public. The data-set consisted of 71 locations where cameras were installed between 2003 and 2005. The data provided raw numbers for the following crimes: fire-related incidents, gang incidents, domestic-related incidents, and motor vehicle thefts. This study examined the crime counts at four specific time periods: Week A (one week prior to the camera's installation), Week B (one week immediately following the camera's installation), Week Y (one week prior to the camera's removal), and Week Z (one week immediately following the camera's removal. Additionally, the data included crime figures for a wide range of radii, ranging from 50 to 500 m from the center of the camera's location. Figure 1 shows the distribution of cameras across Chicago from the Northwestern study.

The second data-set (CPD Police observation devices [POD] study) was an internal CPD study of 111 camera locations between 2003 and 2006. The second data-set was larger and more suited for analyzing the impact of the cameras on crime than the Northwestern study. Detailed information on the type of crime captured by the cameras was not specific in this study, except that the recorded crimes excluded narcotic-related incidents. Also, this study only examined two time periods, labeled primary and secondary periods. The primary period was not the time in which the cameras were initially installed, but rather was a similar 180-day time period for the previous year as the comparison time period. By selecting the same 180-day period, this would account for seasonal differences (e.g. Christmas crimes, etc.). The secondary period examined crime counts 180 days following the POD installation. Finally, the crimes recorded by the cameras were captured at a radius of 330 feet from the camera's installation point. Given the scope of area coverage captured by the cameras in the latter study (roughly 100 m), this was matched with the 100 m radii data recorded in the Northwestern study.

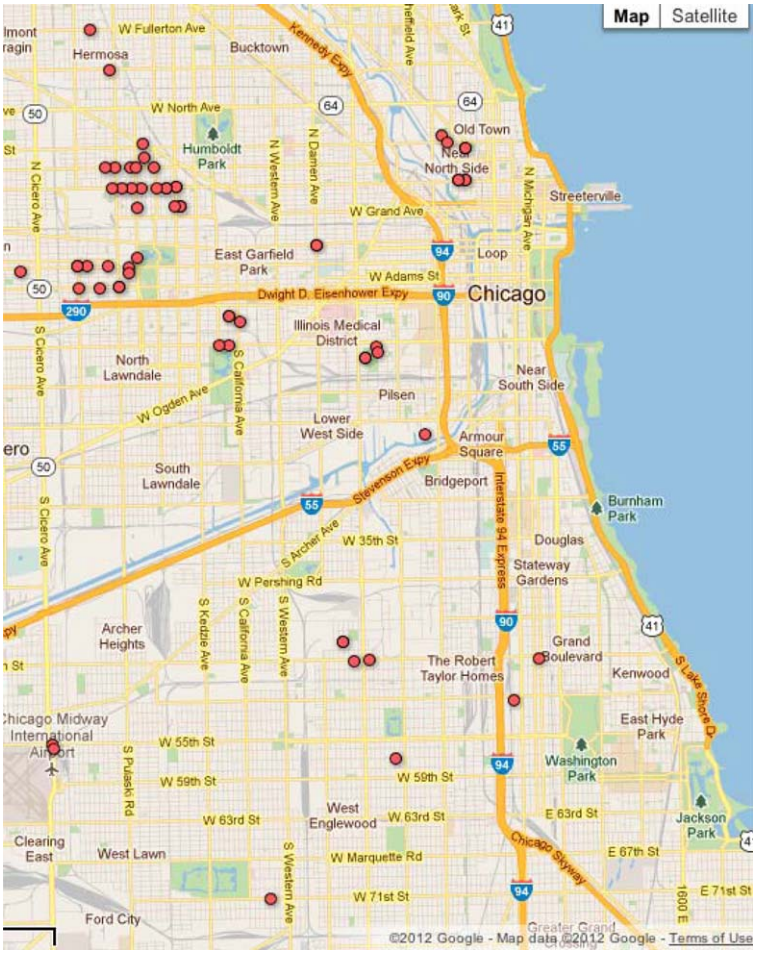

Figure 1. Cameras in the Northwestern study. Source: Google Maps.

Procedure

The data were organized using a statistical software program. Due to the limited nature of the data-sets, the most appropriate procedure for determining the significance in change between pre- and post-installation periods was to utilize bivariate measures of association, specifically repeated measure and independent sample *t*-tests. Given that the interval data in both studies display a normal distribution curve, this test is most appropriate in evaluating the effect of cameras. With regard to the CPD study, the initial recording period and the secondary recording period were the test variables. In the Northwestern study, researchers utilized a combination of test variables: Week A paired with Week Y, as well as Week A paired with Week Z.

Results

In examining the 71 locations in Chicago from the Northwestern study, researchers find an average reduction of 6.83 crimes – a 30.89% decrease – from a time period spanning one week pre-installation through one week pre-removal. This decrease yielded statistical

significance, t (70) = 4.067, $p < .05$). When examining 111 camera locations in Chicago from the CPD POD study, researchers again find a statistically significant crime reduction, which spans a six-month data collection period, t (110) = 2.979, $p = 0.004$. This reduction was approximately 7.0 crimes (a 14% decrease). Based on the evidence here, it appears that *collectively*, the cameras in both studies display a positive effect on crime rates, as measured by crime reduction.

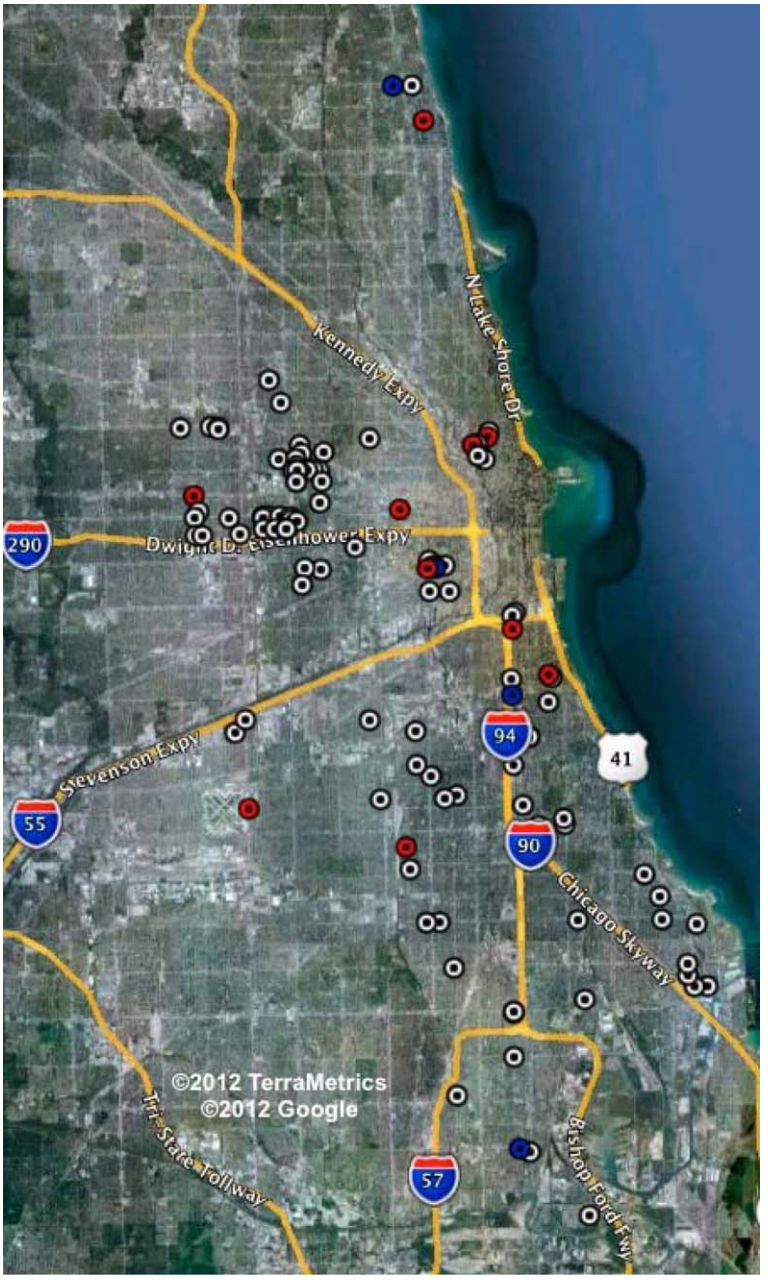

Figure 2. CPD cameras based on initial crime level. Source: Google Maps.

To better understand the crime reductions, the researchers considered if the initial crime level of an area was a factor in the effectiveness of a camera. After all, with the city deploying 100s to 1000s of cameras, there is a large variation in the crime level of the areas. The areas were categorized as low, medium, and high crime areas, based on where the initial crime counts fell on a normal distribution curve. A map of these areas is shown in Figure 2 based on the CPD data. The high areas are red, medium areas are white, and the low areas are blue.

Running the same significance tests on the low, medium, and high crime areas individually, researchers arrived at some interesting, consistent conclusions for both studies. In both studies, areas classified as low crime areas actually experienced an *increase* in the number of crimes during the respective time periods of each study. Although these increases did not reach statistical significance, they are noteworthy. In both studies, areas classified as medium crime areas experienced decreases in crime. In the CPD POD study, this decrease (approximately 4.0 crimes) only approached significance, $t\ (92) = 1.719$, $p = .089$; in the Northwestern study, this reduction (approximately 3.85 crimes) reached significance, $t\ (52) = 2.732$, $p < .05$.

In both studies, high crime area PODs appear to provide the greatest 'return' (i.e. the greatest reduction in crime). In the CPD POD study, camera locations experienced a mean decrease of 25.55 crimes in the 180-day period. This difference was significant, $t\ (10) = 3.429$, $p = .006$. This indicates that POD cameras are particularly effective in areas that experienced a high volume of crime prior to camera installation. In effort to determine the impact of high crime areas in the data-set, researchers re-analyzed the data, but eliminating high-crime PODs from the analysis, leaving only low-level and medium-level crime areas. Although only 11 out of 111 pods were excluded from analysis, researchers find that the decrease in crime is no longer significant, $t\ (96) = 1.594$, $p = .114$. As mentioned earlier, a decrease of approximately 7.0 crimes was evident when calculating change for all 111 pods, collectively. However, this decrease lowers to approximately 3.58 crimes when extracting the 11 high crime areas from analysis (about a 49% difference).

The robustness of high crime areas is quite evident in the CPD data. The overall decrease in crime levels loses significance when the high crime locations are extracted from analysis. When the same procedure is conducted with the Northwestern data, the decrease in crime levels is marginalized; however, they still retain statistical significance. The decrease in crimes from Week A to Week Y (which was only a decrease of 3.849 crimes in medium crime areas) was 31.778 crimes, which was statistically significant, $t\ (8) = 4.656$, $p < .05$. Also noteworthy, a decrease of 30.00 crimes between Week A and Week Z (i.e. one week pre-installation through one week post-removal) was also evident, which approached significance, $t\ (3) = 2.722$, $p = .072$.

Discussion

The results of both studies show that crime decreased with the presence of cameras. However, the decrease cannot and should not be attributed to the camera network. Both of these studies are methodologically flawed for determining the effect of the cameras on crime. A carefully designed study would incorporate an adjacent area, to account for displacement, and a control area, to account for other variables (Short & Ditton, 1998). Without considering an adjacent area, the analysis cannot account for displacement or the tendency of crime to move just beyond the reach of the cameras.

Despite the methodological limitations, one significant insight is that the relative amount of crime in an area is related to the effectiveness of the cameras. The cameras

are more effective in areas with more crime. In areas with less crime, the cameras have much less impact. A simple illustration of this is shown in Figure 3 using the CPD study data. The figure shows that the mean change in crime for the low crime area was an increase of 99%, in the medium areas crime went down 11%, and in the high crime areas crime went down 30%. A figure for the Northwestern study data would look similar. The Northwestern study also shows a mean increase of 9% in low crime areas, a drop of 21% in medium crime areas, and a drop of 64% in high crime areas. The import here is not the precise change in each area, but the general trend and stark contrast of the high crime area is similar for both groups of data.

The implication is that cameras are most effective in high crime areas. Diffusing a large number of cameras throughout a city does not appear to be effective in reducing crime. Instead, the targeted use of a smaller number of cameras in high crime areas is much more effective. This finding is significant and has immediate impact for how cameras should be used. It fills a gap in research by showing that a large number of diffuse cameras is not effective. While other policing studies have focused on small focused areas or hotspots, this research points to use cameras in a hotspot method.

Although the limited data in this study do not provide a definite explanation as to why cameras in high crime areas are more effective, researchers offer three possible explanations for this phenomenon.

First, high crime areas where cameras are installed are likely to have increased police presence. The CPD is and should be targeting areas with high crime. As a result, the crime drop could be partly attributed to increased police presence. After all, the CPD is known to use hotspot policing, which focuses on areas of high crime intensity. Hotspot policing is increasingly important in problem-oriented policing, as crime prevention practitioners and police managers focus their resources on areas in most dire conditions (Ratcliffe, 2004; Zahm, 2007).

The results of the present study reflect such a modality of policing. If the high crime areas defined in this study are locations the police have classified as hotspots, then the sharp decrease in crime is not due solely to surveillance networks. Furthermore, our finding that low and medium crime areas (with high crime area cameras excluded from analysis) do not result in a significant decrease in crime levels also reiterates the notion that the policing strategies of these areas may also be the key variable in crime fluctuations.

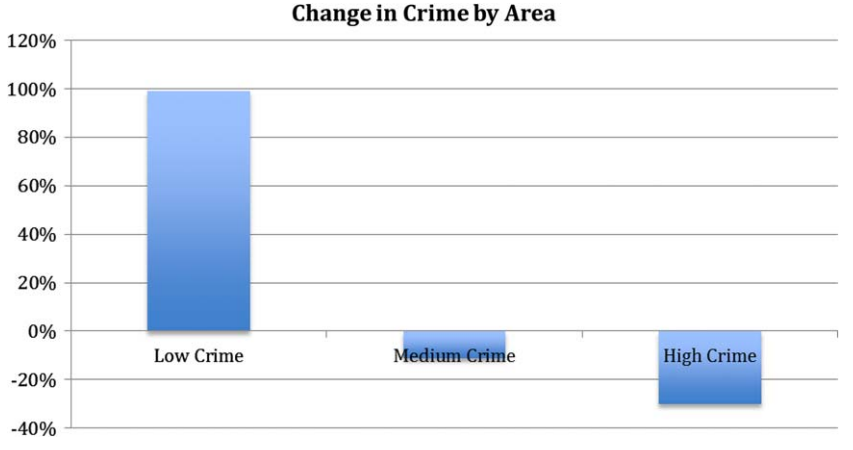

Figure 3. The effectiveness of cameras based on initial crime level (CPD POD data).

We term the effect of cameras in high crime areas as the catalyst effect of cameras. The act of placing cameras in a high crime area pushes the police to focus their efforts in these areas, thus reducing crime. It will take further research that includes controls for other policing efforts in order to isolate the catalyst effect of cameras.

Second, cameras in high crime areas are much more likely to be carefully monitored at all times. The city has 100s of cameras, but only a handful of camera operators. It seems likely that camera operators are more likely to watch an area with almost daily crime compared to an area with one reported crime a week. Researchers believe the lack of live monitoring impacts the deterrence effect of a camera. Once a rational criminal realizes that a camera is not monitored, the consequence is that they are less likely to be captured committing a crime. Anecdotal reports by police support the idea that criminals quickly realize whether cameras are being watched and adjust their behavior correspondingly. Chicago and other cities are trying to solve this problem using automated surveillance systems or smart camera systems (Kinzer, 2004).

Third, the drop in crime in high crime areas could be partly attributed to regression to the mean. This phenomenon occurs when variables that are extreme on a first measurement, may tend to be closer to a mean on a later measurement. In this case, areas that have very little or very high crime initially, may tend to average out when measured again. This suggests a second measurement would find crime higher in low crime areas and lower in high crime areas (Rocconi & Ethington, 2009).

Besides the quantitative data on hand, our familiarity with the Chicago cameras also leads us to point out a few other qualitative findings. These two anecdotes help illustrate the promise and limits of the cameras. The first is the mugging of William Kelly.

William Kelly was mugged and beaten to the ground in front of his Gold Coast/Streeterville residence. He noticed some blue light cameras and was hoping they could help identify his attackers. It took two weeks before he was given access to review the tape. The tape proved ineffective, because the camera was too far away and not at the correct angle to capture his attackers. This led Bill Kelly to characterize the camera system as wasteful. After all, from what he saw, the camera system was not terribly useful.

Chicago Board of Education President Michael Scott was found dead with an apparent shot in the head [2010 #46]. Scott was a high-profile figure and also involved in a legal case before a federal grand jury investigating allegations of politically influenced admissions to top schools. While it appeared as a suicide, the police continued as a death investigation. The first thing the police sought was the recording from the cameras near where he was found. Those cameras were found to be not working.

The police then begin to recreate Scott's final moments, a 20-min drive through the city, by putting together footage from a succession of surveillance cameras. This is laborious and highly technical process, but allowed the police an unprecedented perspective. The results didn't capture Scott's final moments, but it helped convince police his death was a suicide. The video showed that he wasn't followed, wasn't following anyone, and was alone.

These examples should provide a flavor of how the cameras are used. Cameras have limitations, they are only as good as their technology and the person watching the camera. As William Kelly found out, just because there is a camera nearby isn't enough. Nevertheless, a camera network and technical tools can allow unprecedented use of the cameras for investigative purposes as illustrated by the Michael Scott case.

Limitations

The authors acknowledge the methodologically flaws of both studies for determining the effect of the cameras on crime. The studies only look at locations where cameras are installed. They don't include control locations, where cameras are not present. The lack of any controls means the analysis cannot examine the impact of other variables, such as increased police presence, larger sociological shifts, and environmental changes. It is important to carefully inspect these trends, as the conventional wisdom among environmental criminologists is that social trends have been the primary influence in Chicago's recent crime drop (Skogan, 2007).

The design of both studies is fundamentally weak in that researchers are only able to examine pre-and post-installation crime comparisons, allowing for relatively meager statistical applications. Earlier work by Mazerolle et al. utilized an ARIMA time series analysis of data derived from interpretation of video footage of CCTVs combined with police incident data (Mazerolle, Hurley, & Chamlin, 2002). In addition, police calls for service data were examined. However, noteworthy strengths of the current research design involve the time periods of study and the volume of cameras analyzed. While prior work has been plagued by poor camera organization and time periods of analysis (Brown, 1995; Squires, 2003), the present data-sets reflect 71 and 111 camera locations, covering six months to three years of crimes, respectively.

Conclusions

Cities around the world are embracing technology as a tool for crime prevention efforts in the first decade of the twenty-first century. Chicago is one of many cities in the USA that is deploying surveillance camera networks using over a 100 cameras. While millions are spent deploying these systems, our understanding of the effectiveness of these systems for deterring crime is nonexistent. This study is a beginning for understanding the effectiveness of the surveillance cameras and their utility for police. However, there is clearly need for much more empirical evaluation to fully understand the effectiveness of the cameras.

On the surface, our exploratory study showed cameras had a significant crime reduction. Further parsing of these results showed a stark difference, in both studies, between high crime and low crime areas. Cameras in high crime neighborhoods were associated with large reductions in crime, while other areas showed little change in overall crime. This phenomenon is termed the catalyst effect of cameras. The impact of a few cameras in high crime areas suggests using cameras in a focused targeted manner, instead of large diffuse networks of cameras. Up until this point, nearly all discussion of surveillance camera networks have focused upon minimal, diffused cameras that do not cluster or congregate in any particular point. Extending Ratcliffe's suggestions, police managers and city officials should consider crime analysis (i.e. hotspots) when using cameras (2004).

This focus on targeting camera networks for specific areas is based in empirical data. Until now, most of the policies were based on anecdotal evidence of how camera networks should operate. As we saw in Chicago, this led to an ineffective use of cameras by trying to cover a wide an area as possible.

The next step is for empirical work that is carefully designed to examine multiple areas with cameras while having control groups and measuring displacement. With a careful design, it is possible to account for sociological shifts, environmental changes, and other policing efforts, that will better isolate the effects of the cameras. Such research would provide police with better evidence on which surveillance applications are most

valuable and cost-effective to the city. Furthermore, it is imperative to recognize that such technologies have a high potential for further expansion and refinement. As we move toward more advanced technological applications in everyday police work, it is crucial that researchers, practitioners, and industry identify, evaluate and prioritize these applications in effort to gage maximum effectiveness in crime reduction.

Notes on contributors

Rajiv Shah is an adjunct assistant professor in the Department of Communication at the University of Illinois at Chicago. He received his PhD from the Institute of Communications Research at the University of Illinois at Urbana-Champaign. Prior to that he earned a JD from the University of Illinois at Urbana-Champaign and a BS in Electrical Engineering from the University of Nebraska-Lincoln. His research seeks to understand the relationship between the design of information technologies and society. He has published in leading journals in communications, law, and computer science. A recent interest is the emergence of smart camera systems and Chicago's surveillance camera network.

Jeremy Braithwaite is a doctoral student in the Department of Criminology, Law, and Society at the University of California, Irvine. He also works for Social Solutions International, Inc. as an evaluation specialist. His research interests include: special populations of sexual offenders, ecological and structural factors in violent crime, and evaluative research. His recent articles have appeared in the *Journal of Victims and Offenders, Journal of Knowledge and Best Practices in Juvenile Justice and Psychology*, and the *Journal of Alcohol and Drug Education*.

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