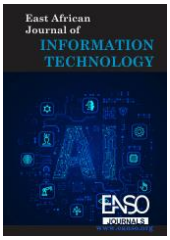

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Original Article

Impact of CCTV on Police Operations Outcomes in Nairobi City County, Kenya

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ABSTRACT

The widespread adoption of Closed-Circuit Television (CCTV) systems in major cities globally aims to improve policing outcomes. However, despite Nairobi's CCTV system being operational since mid-2015, its specific impact remained unclear. This study investigated how CCTV influenced five key police operation outcomes: crime reduction, response times, road safety, officer safety, and cost reduction. Drawing from Rational Choice Theory and Routine Activity Theory, the study employed a convergent mixed-method design combining a cross-sectional survey with a phenomenological design. Participants included 403 police officers from the CCTV command centre and various police stations across the county, selected via cluster and purposive sampling. Data collection utilised questionnaires, key informant interviews and focus group discussions. Quantitative analysis employed binary logistic regression, while qualitative data underwent thematic analysis. The findings revealed that CCTV has significantly reduced crime, enhanced road safety and officer safety, and lowered operational costs. However, response times saw minimal improvement due to limited CCTV coverage and coordination challenges between officers. The study recommends expanding coverage, strengthening collaboration among officers, and publicising the system's successes to maximise CCTV's potential.

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INTRODUCTION

Safe communities depend on effective police operations. These operations encompass numerous tasks officers perform in the field, from proactive community engagement and patrols to reactive incident response and investigations (Hess et al., 2013). The multifaceted nature of these tasks, coupled with the ever-changing crime landscape, presents significant challenges for officers (National Institute of Justice, n.d.). Therefore, equipping officers with the appropriate tools and training is crucial to ensure their effectiveness and safety during operations (Adams, 2001).

An increasingly utilised tool in contemporary police operations is CCTV. These surveillance systems have become integral to urban policing worldwide, particularly in response to rising security threats like terrorism (Rahman, 2017; Thomas et al., 2021). Their increased adoption is driven by numerous perceived benefits. It is believed to enable quicker response times to incidents, improve situational awareness for officers on the ground and provide invaluable footage for post-incident analysis and investigations (Ratcliffe, 2006, 2011). Additionally, CCTV is seen as a potential deterrent to decrease crime rates and the fear of crime, potentially leading to reduced crime management costs (Piza, 2018).

However, the success of CCTV in achieving these goals is contested (Tylor, 2010). While some studies show a correlation between CCTV deployment and reductions in crime (particularly property crimes) and fear of crime, especially in well-policed areas with dense camera networks (Piza et al., 205, 2019; Ashby, 2017), the impact seems highly contextual. Research by Cho and Park (2017), Munyo and Rossi (2019), and Lai et al. (2018) highlight the complexities of CCTV's impact, demonstrating variable outcomes influenced by various contextual factors. This underscores the need for further research across diverse settings to understand these contextual influences better.

This study aimed to address this gap by focusing on the police-operated CCTV system launched in Nairobi City County in mid-2015. This system aimed to improve incident detection, response coordination, and criminal investigations (National Police Service [NPS], 2016a, 2019). While initial reports indicated a decrease in crime, later data revealed a concerning rise (13% in 2016, 50% in 2017) (NPS, 2016b, 2020). This discrepancy raises a critical question: Is the system aiding police efforts, or is its effectiveness declining with rising crime rates? This study investigated this question by analysing CCTV's impact on five key police operation outcomes: crime reduction, response times, road safety, officer safety, and cost savings.

LITERATURE REVIEW

Theoretical Review

This study integrated insights from Rational Choice Theory (RCT) and Routine Activity Theory (RAT) to explore the impact of CCTV on police operational outcomes. RCT, developed by Cornish and Clarke (1986), suggests criminals weigh risks and rewards before acting (Felson, 2017). According to Willis et al. (2017), CCTV influences offenders' decisions by increasing the perceived risk of detection and arrest, potentially reducing crimes in surveilled areas. Thus, RCT supports its use in policing to reduce crime and traffic violations, potentially leading to lower fear of crime and operational costs.

On the other hand, RAT, developed by Cohen and Felson in 1979, emphasises that a crime requires a convergence of a motivated offender, a suitable target, and the absence of a capable guardian (Felson, 2017). Empirical evidence suggests that CCTV disrupts this convergence in two ways. First, its presence acts as a virtual guardian, directly deterring criminals (Reynald, 2011; van Sintemaartensdijk et al., 2021). Second, it empowers human guardians, like police officers, by providing real-time situational awareness and enabling faster responses (Hollis-Peel et al., 2011; Reynald, 2019). This study leveraged these mechanisms to explain how CCTV can act as a

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guardian, deterring crime and attacks on officers, ultimately leading to potential reductions in crime, traffic violations, operations costs and enhanced officer safety.

Empirical Review

This section examines existing literature on CCTV's influence on five key police operation outcomes: crime reduction, response times, road safety, officer safety, and operational costs.

CCTV and Crime Reduction

The research on CCTV's effectiveness in crime reduction presents conflicting findings. While some studies find positive effects, others report minimal impact or even potential drawbacks. For example, King et al. (2008) observed a slight, statistically insignificant decrease in property crime rates in San Francisco following CCTV implementation. Conversely, La Vigne et al. (2011a) documented significant reductions in robberies and assaults across Baltimore and Chicago after CCTV introduction.

Mounting evidence suggests that active monitoring, where live feeds are continuously monitored with immediate intervention upon incident detection, may be crucial for CCTV's effectiveness. Piza et al. (2015) found a decrease in violent and social disorder crimes in Newark, New Jersey when CCTV was actively monitored and combined with police patrols. Similar positive outcomes were reported by Munyo and Rossi (2019) in Montevideo, attributing a 20% crime reduction to active monitoring.

However, the impact of CCTV on crime rates appears to be contextual. Gerell (2016, 2021) reported mixed results in Sweden. While CCTV reduced violent crime in deprived neighbourhoods in Gothenburg, it did not significantly affect property crimes (Gerell, 2021). Additionally, actively monitored CCTV did not reduce assaults in high-risk Malmo areas (Gerell, 2016). Similarly, Lai et al. (2018) found an overall decrease in Taipei's crime rates after CCTV installation, but burglaries increased.

In a comprehensive meta-analysis, Piza et al. (2019) synthesised data from over 80 studies across eight European countries and the United States of America (US), indicating a significant reduction in crime in schemes with active monitoring, particularly when complemented by police patrols. Collectively, these studies suggest that the impact of CCTV on crime is highly contextual, depending on factors like monitoring methods, camera density, location specifics, and the targeted crime type. However, its influence on crime within Nairobi County remained uncertain, necessitating further investigation, as pursued in this study.

CCTV and Response Times

Despite police organisations heavily investing in CCTV to improve incident detection and response, research suggests a disconnect between this goal and the observed outcomes. Studies indicate that CCTV implementation may not significantly impact perceived or actual police response times. Gill and Spriggs (2005) studied 14 CCTV schemes in the United Kingdom (UK) and found that public perception of police response speed remained unchanged after installation. Similarly, Piza et al. (2017) argue that delays in response times are primarily due to resource mobilisation issues, such as officer availability and patrol car allocation, rather than a lack of awareness about incidents. This suggests that while CCTV can enhance situational awareness, it may not be a sufficient solution for improving police response times.

CCTV and Road Safety

CCTV plays an instrumental role in traffic management, offering a range of functionalities that can potentially improve road safety. These functionalities include monitoring traffic patterns, identifying congestion hotspots, detecting traffic violations, facilitating emergency response, aiding in accident investigation, and informing the development of preventive strategies (Abdel-Aty et al., 2022; Eggarsasi & Sa'diyah, 2018). By collecting such data, police aim to promote safe driving by discouraging dangerous behaviour and

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smoothing traffic flow, ultimately reducing accidents.

However, research on CCTV's impact on overall road safety remains inconclusive. While studies like Conche and Tight's (2006) investigation in Great Britain highlight the value of CCTV in accident reconstruction and informing preventive strategies, others point out limitations. For instance, Grabowski and Czyzewski's (2020) modelling in Poland indicates that CCTV effectiveness can be compromised by varying weather conditions. These contrasting findings underscore the need for further research to comprehensively understand the impact of CCTV usage on road safety across diverse contexts like Nairobi County.

CCTV and Officer Safety

The impact of CCTV on officer safety remains a topic of debate with limited and mixed findings. Some studies suggest potential benefits. Goold (2004) highlights CCTV's role in suspect identification and de-escalation, which could improve officer safety during encounters. However, this benefit might be countered by the risk of targeted attacks by criminals who can exploit CCTV to track officer movements (Goold, 2004). Supporting this concern, Levesley and Martin (2005) found that only 37% of officers in their UK study felt CCTV enhanced their safety. Conversely, La Vigne et al. (2011b) emphasise the value of CCTV in coordinating responses. They argue that real-time updates on the scene, including potential threats captured by CCTV, can improve situational awareness and ultimately enhance officer safety.

CCTV and Cost of Police Operations

The research on CCTV's cost-effectiveness presents a mixed picture. Studies typically compare CCTV installation and operational costs with the monetary value of achieved outcomes, primarily crime reduction or the cost of alternative strategies like alarms and improved lighting (Welsh et al., 2015; Matczak et al., 2023). Several studies highlight limitations to CCTV's cost-effectiveness. Gill and Spring's (2005) assessment of 14 CCTV schemes in the UK revealed limited cost benefits due to minimal impact on crime rates and high setup and maintenance expenses. Similarly, Piza et al. (2016) found that pairing active CCTV monitoring with directed patrols in Newark was only cost-effective for police organisations with existing infrastructure. La Vigne et al. (2011b) further emphasise escalating costs associated with large storage capacities or integrating CCTV with other technologies.

However, some studies report positive results. Munyo and Rossi's (2019) research in Montevideo found that actively monitored police CCTV significantly reduced crime management costs, with an estimated saving of around $830 per crime. Similarly, simulations by Lawson et al. (2018) suggest CCTV can be cost-effective, particularly when focused on high-crime areas. However, they acknowledge that improved lighting may be a more cost-effective approach in some scenarios. These contrasting findings highlight the need for a nuanced approach when evaluating CCTV's cost-effectiveness. Factors like existing infrastructure, deployment strategy, and crime type all play a role in determining the actual cost-benefit ratio of CCTV implementation.

METHODOLOGY

Research Design

The study utilised a convergent mixed-methods design, combining a cross-sectional survey to collect statistical data on CCTV usage with a phenomenological approach to capture officers' lived experiences. This dual approach aimed to mitigate the limitations of relying exclusively on quantitative or qualitative methods.

Study Site

The study was conducted in Nairobi City County, Kenya, chosen for its extensive, police-operated CCTV system. Nairobi is Kenya's most populous county, with a well-developed road network and the highest crime rate. The government installed CCTV in 2015 to aid police efforts. At the time of the study, the county had 11 police administrative

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areas, each overseen by a sub-county police commander.

Participants and Data

The study engaged 403 participants. Among them were 347 police officers from various stations and the CCTV control centre who diligently completed and submitted questionnaires, yielding a high response rate of 92.8% from the original cluster sample of 374. Additionally, 29 officers were purposively selected for in-depth discussions: 24 participated in focus group discussions (FGDs), and five served as key informants (KIF). The study utilised three methods to gather data after obtaining the necessary approvals. First, a structured questionnaire gathered quantitative data, establishing strong internal consistency through pilot testing (Cronbach's alpha > .80 for all subscales, surpassing reliability standards – Taber, 2018). Second was an FGD guide to glean qualitative insights (experiences and opinions), and the third was a semi-structured interview guide for deeper exploration with key informants. Quantitative data were analysed using binary logistic regression, while thematic analysis was applied to qualitative data from FGDs and interviews.

Variables

The study investigated the relationship between CCTV use (independent variable) and police operational outcomes (dependent variables). CCTV use was assessed through three components: monitoring public spaces, coordinating incident responses, and investigating crimes. Officers rated these on a 1(very little extent [VLE]) to 5 (very great extent [VGE]) Likert scale. Police operation outcomes were also assessed on a similar scale, focusing on five areas: crime reduction, faster response times, improved road safety, officer safety, and cost savings. These ratings were dichotomised to facilitate regression analysis, with scores 1-3 indicating no significant impact, while scores 4-5 indicating a clear positive impact. Finally, the study regressed the composite CCTV use score against the dichotomised values of each outcome variable to assess their relationship.

RESULTS AND DISCUSSIONS

This section examines the impact of CCTV use on five key police operation outcomes: crime reduction, response times, road safety, officer safety, and cost savings. Each outcome is examined in a dedicated subsection, with data tables and participant quotes supporting the findings. Importantly, all independent variables passed multicollinearity tests, ensuring the validity of the regression analysis. Additionally, the regression model passed diagnostic tests for goodness-of-fit (Hosmer-Lemeshow test [HL]) and overall model strength (Nagelkerke R-squared), further strengthening the analysis.

Influence of CCTV on Crime Rates

Table 1 summarises results from a multiple binary logistic regression model on crime reduction. Predictor variables are CCTV use for monitoring (CCTV_MON), coordinating responses (CCTV_RES), and investigating crimes (CCTV_INV). It presents regression coefficients (B), standard errors (SE), Wald statistics (Wald), degrees of freedom (df), p-values, odds ratios (Exp (B)), and associated confidence intervals (CI) for each predictor based on 347 cases.

Table 1 indicates a statistically significant positive association (p = .000, b = .713) between the use of CCTV for monitoring public spaces (CCTV_MON) and crime reduction. This suggests that increased CCTV monitoring has a deterrent effect, leading to a decrease in criminal activity. However, the relationship between CCTV uses for coordinating incident responses (CCTV_RES) exhibited a positive but non-significant relationship with crime reduction (p = .183, b = .256). This finding implies that while CCTV coordination may offer some ancillary benefit, it lacks a robust statistical connection to crime reduction, possibly due to its reactive nature. The finding supports King et al. (2008), who observed no significant change in crime rates when CCTV was primarily used for reactive response.

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Table 1: Logistic regression results for crime reduction

Variables	B	SE	Wald	Df	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
CCTV_MON	.713*	.197	13.137	1	.000	2.040	1.387	2.999
CCTV_RES	.256	.192	1.776	1	.183	1.292	.887	1.882
CCTV_INV	.608*	.198	9.419	1	.002	1.837	1.246	2.709
(Constant)	-5.561	.811	47.032	1	.000	.004		
No. of Observations (N) = 347								
Overall Percentage = 70.0%								
Nagelkerke R^2 = .251								
Omnibus Tests of Model Coefficients: χ^2 = 71.392, df = 3, Sig. = .000								
HL Test: χ^2 = 4.887, df = 8, Sig. = .770								

** p < .01*

Source: Field Data

In contrast, the relationship between the use of CCTV for crime investigation (CCTV_INV) and crime reduction was both positive and statistically significant (p = .002, b = .608) (Table 1). This finding suggests that increased investigation using CCTV evidence is linked to a more substantial decrease in criminal activity, supporting La Vigne et al. (2011b), who reported a similar positive impact in Baltimore and Chicago.

Qualitative data corroborated quantitative findings, indicating decreased crime, particularly bank robberies, carjackings, and vehicle thefts in CCTV-covered areas. Participants attributed this decline to the increased perception of being caught. They believed CCTV enhanced police monitoring, incident coordination and investigative capabilities. Supporting this perception, a key informant (KIF04) highlighted the collaborative efforts between patrol officers and the command centre, emphasising the difficulty for criminals in utilising vehicles to escape after committing crimes. The informant elaborated that police use of CCTV cameras, intelligence, and other vehicle tracking technologies effectively deterred potential offenders. These observations resonate with RCT, which suggests criminals are less likely to offend if they perceive a high risk of detection. Official data from the NPS (2020) corroborates this finding, showing a notable decrease in carjacking and bank robbery incidents in Nairobi County since CCTV's introduction in 2015. Reported robberies mirrored this trend, dropping from 430 in 2019 to 360 in 2020 (a 16.3% decrease), further declining to 352 cases in 2021 (NPS, 2020, 2021). These reductions align with prior research. For instance, Priks (2015) found a 60% drop in Stockholm subway robberies after CCTV installation, and Gill and Spriggs (2005) reported a 7-75% decrease in vehicle thefts within UK CCTV zones.

During one of the FGDs, PTB07, a police detective, underscored the deterrent effect further, stating, "The recent swift arrest of a youth who stabbed another happened after the command centre replayed the scene recording... Do you think people who witnessed this will dare to mess in front of these cameras?" This prompt arrest vividly illustrates the deterrent impact of CCTV's rapid response, corroborating findings from research by van Sintemaartensdijk et al. (2021) and RAT's principle, suggesting that criminals perceive surveilled areas as less conducive to criminal activity.

Despite evidence of CCTV's role in crime reduction, the study uncovered a missed opportunity to leverage its success. A patrol officer participating in an FGD highlighted this:

> *"These cameras have prevented numerous incidents, including terrorist activities. However, their benefits often go unnoticed because the public isn't always aware of the incidents they've helped resolve"* (PTC03).

This lack of public awareness, the study suggests, could create a barrier to trust and potentially

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hinder cooperation in reporting crimes and identifying suspects captured on camera.

Limited CCTV coverage emerged as another limitation. Participants highlighted the challenges it posed for police monitoring, response coordination and investigations across the county, leading to higher crime rates in non-covered areas. A "tactical displacement effect" was also described, where criminals exploited coverage gaps as "safe havens." An FGD participant (PTC06) articulated this: "Some miscreants, especially pickpockets, phone thieves and those riding motorcycles, commit crimes in areas with cameras and vanish to areas without, making it difficult for us [police] to track and arrest them because cameras cannot capture their movements in areas without cameras." This finding corroborates research by Lv et al. (2014) and Isnard (2001), suggesting minimal CCTV impact on opportunistic thefts in crowded areas. Criminals perceive such areas as offering low detection risk and easy escape. These observations further support the RCT's proposition that criminals are emboldened to offend in low-risk environments and the RAT's assertion that guardians like CCTV are ineffective when unable to surveil targets adequately.

Influence of CCTV on Police Response Time

Table 2 presents the regression analysis of response time with CCTV monitoring, response coordination, and crime investigation as predictors.

Table 2: Logistic regression results for response time

Variables	B	SE	Wald	Df	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
CCTV_MON	.901*	.210	18.402	1	.000	2.463	1.632	3.718
CCTV_RES	.734	.210	12.223	1	.183	2.083	1.381	3.144
CCTV_INV	.113	.209	.292	1	.589	1.120	.743	1.688
(Constant)	-5.526	.885	47.032	1	.000	.004		
No. of Observations (N) = 347								
Overall Percentage = 76.7%								
Nagelkerke R^2 = .306								
Omnibus Tests of Model Coefficients: χ^2 = 84.019, df = 3, Sig. = .000								
HL Test: χ^2 = 4.425, df = 8, Sig. = .817								

** $p < .01$*

Source: Field Data

Table 2 reveals CCTV monitoring directly improves police response times (b = .901, p = .000). However, using CCTV for coordination (b = .734, $p > .05$) and investigating crimes (b = .113, p = .589) shows no significant impact (weak/insignificant correlations). This weak impact likely reflects the reactive nature of these tasks and potentially limited proactive CCTV use. The results from the FGDs and key informant interviews were varied. Some participants felt CCTV improved response times, noting that officers at the command centre could monitor public spaces in real-time, allowing them to quickly alert colleagues on the ground to respond swiftly to CCTV-detected incidents. A key informant (KIF01) stated, "The command centre uses radios to report suspicious activity detected on CCTV to nearby officers, allowing them to respond quickly."

On the other hand, some participants felt that response time had not improved, attributing it to a strained relationship between officers monitoring CCTV and those on operational duties. An FGD participant (PTB01) patrolling the streets added, "The cameras are good, but I don't think they're being used correctly. I've seen crimes happen under CCTV with no response." A command centre participant countered this view: "We can spot wanted vehicles or criminals, but taking action requires cooperation from officers on patrol. We're accused of not contacting them, but we do. Sometimes they don't respond or even let

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go of suspects" (PTA04). These findings align with research suggesting the relationship between CCTV users significantly impacts response times (Keval, 2009; Levesley & Martin, 2005). They also support RAT's claim that uncooperative "guardians" are ineffective (Reynald et al., 2010, 2018).

Participants who reported no overall improvement in crime rates also noted a pattern in CCTV usage. They observed that police primarily used CCTV to coordinate responses for major incidents, road clearances, or traffic jams, as explained by a focus group participant (PTB04): "Cameras are rarely used unless it's serious or initiated by commanders." This finding suggests a focus on resource management. By focusing on critical situations, the police might have been aiming for maximum impact with limited resources, aligning with the concept of maximising benefits with resource constraints, as highlighted in RCT.

Despite coordination challenges and selective use, the study revealed a positive aspect. CCTV enabled police to discover and respond to some incidents even before public reports, suggesting some proactive crime prevention. This finding aligns with research by Piza et al. (2017) and Ratcliffe (2006), who highlight CCTV's potential to improve response times.

Influence of CCTV on Road Safety

Table 3 shows all CCTV uses (monitoring, investigation, response) are linked to improved road safety, with monitoring having the most substantial effect. This finding makes sense as monitoring deters violations proactively, unlike reactive response and investigation.

Table 3: Logistic regression results for road safety

Variables	B	SE	Wald	Df	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
CCTV_MON	.622*	.198	9.913	1	.002	1.862	1.265	2.743
CCTV_RES	.528*	.197	7.225	1	.007	1.696	1.154	2.493
CCTV_INV	.612*	.203	9.043	1	.003	1.844	1.237	2.747
(Constant)	-6.209	.858	52.402	1	.000	.002		
No. of Observations (N) = 347								
Overall Percentage = 69.7%								
Nagelkerke R^2 = .295								
Omnibus Tests of Model Coefficients: χ^2 = 83.313, df = 3, Sig. = .000								
HL Test: χ^2 = 5.159, df = 8, Sig. = .740								
* $p < .01$								

Source: Field Data

Focus groups and interviews revealed a notable decrease in traffic violations and accidents within Nairobi's CCTV zones. Participants attributed this to improved detection, faster police response and increased adherence to traffic rules due to CCTV deterrence. A traffic officer participating in an FGD highlighted the importance of CCTV footage for accident reconstruction and assigning blame:

> *Footage from the command centre helps us pinpoint accident times, parties involved, and the sequence of events. These details are essential for reconstructing the accident, identifying the at-fault driver (particularly in situations with conflicting accounts), and preventing future accidents. The footage is also valuable documentation to support insurance claims* (PTC07).

Similarly, a key informant emphasised how CCTV aids in catching traffic violators and reducing accidents:

> *"They [CCTV cameras] help us a lot catch traffic violators and respond faster to congestion, hazards and accidents. Drivers are more cautious now, knowing they can be recorded, followed, arrested, and prosecuted for traffic violations. All these have led to fewer accidents"* (KIF02).

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These findings suggest CCTV can be a valuable tool for improving road safety. It assists the police in assessing accident causes, holding parties accountable and developing strategies to reduce future incidents.

The observed avoidance of violations under CCTV surveillance supports RCT's idea that the certainty of punishment deters crime. The decrease in traffic violations also corresponds with police crime data, showing a significant drop in Nairobi County from 53 in 2019 to 6 in 2020 (NPS, 2020, 2021). While other factors, such as changes in traffic volume, may have contributed during this period, the substantial reduction suggests the considerable impact of CCTV. This study's findings corroborate prior research (Alghnam et al., 2018), showing CCTV evidence in traffic cases improves road safety by deterring violations and aiding accident investigations (Conche & Tights, 2006).

Effect of CCTV on Police Officer Safety

Analysis of *Table 4* reveals a significant link ($p < 0.01$) between using CCTV for monitoring, response and investigation and improved officer safety during operations. This likely happens because CCTV empowers officers with better situational awareness, allowing for more proactive, prepared and efficient responses to potentially dangerous situations, ultimately enhancing their safety.

Key informants and FGD participants confirmed that CCTV significantly enhanced officer safety in monitored areas. Operators could warn officers about suspicious activity or individuals, enabling them to take necessary precautions. A traffic officer (PTC01) participating in an FGD highlighted this collaborative approach: "Controlling traffic can be risky, but CCTV helps. The controller warns us about what's happening so we can be cautious. Plus, footage helps investigate incidents, including anything that might happen to you." A key informant (KIF04) echoed this sentiment, stating that the control centre reports suspicious characters and vehicles to officers on the ground, allowing them to approach situations cautiously.

Table 4: Logistic regression results for road safety

Variables	B	SE	Wald	Df	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
CCTV_MON	.678*	.202	11.253	1	.001	1.970	1.326	2.928
CCTV_RES	.547*	.203	7.273	1	.007	1.728	1.161	2.570
CCTV_INV	.575*	.208	7.605	1	.006	1.777	1.181	2.674
(Constant)	-6.791	.876	60.160	1	.000	.001		
No. of Observations (N) = 347								
Overall Percentage = 70.3%								
Nagelkerke R^2 = .305								
Omnibus Tests of Model Coefficients: χ^2 = 8.513, df = 8, Sig. = .385								
HL Test: χ^2 = 90.187, df = 8, Sig. = .740								
* $p < .01$								

Source: Field Data

CCTV also enhanced officer safety through improved incident response. Commanders could assess situations remotely using footage, allowing for targeted deployment of resources. This reduced the risk of officers entering dangerous situations unprepared. For instance, real-time updates on incidents, suspect movements, and threats can help officers make informed decisions and coordinate rescues. A key informant (KIF02) emphasised the value of CCTV in tracking criminals: "The cameras are handy when tracking criminals, especially dangerous ones. Officers at the control centre monitor their movements and alert pursuing officers if the suspects are hiding, armed, or disguised." An FGD participant highlighted the cruciality of this real-time information: "These cameras are incredible! They

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helped in the rescue of a female traffic officer abducted by a matatu crew" (PTC03).

Participants also felt CCTV deterred attacks on officers due to the fear of being caught on camera, aligning with RCT's idea that criminals avoid high-detection areas. An FGD participant (PTC03) stated: "Patrols are much safer now. Attacks on officers were common before the cameras were installed but are rare today." However, police crime data shows conflicting trends. In 2020, 11 officers were killed on duty, up from 6 in 2019, and by 2021, the number more than doubled to 23 (NPS, 2020, 2021). This discrepancy might indicate CCTV's impact was localised or has faded over time. Alternatively, the increase in officer deaths could be due to other factors, such as a rise in overall violent crime or changes in criminal tactics.

Despite this discrepancy, the study's findings support past research. Ways and Pearson (2018) and Carli (2008) found that CCTV improves officer safety in risky situations. Similarly, Pang and Pavlou (2019) showed that using technology in policing allows for safer criminal pursuits and arrests. Additionally, La Vigne et al. (2011a) observed that officers feel safer when live feeds are monitored and they receive real-time updates.

Impact of CCTV on Operational Costs

Table 5 shows that while CCTV monitoring significantly reduces police operation costs (p = .003), using it for incident response coordination has no significant impact (p > .05). Notably, CCTV use in investigations shows the strongest association with cost reduction (p = .002). This finding suggests focusing CCTV on investigations may yield the most significant financial benefit.

The qualitative findings confirmed the cost-reduction benefits of CCTV monitoring. Participants highlighted how CCTV enhances police resource efficiency by freeing officers to focus on high-crime areas. A FGD participant said: "The cameras act as extra eyes for the police, helping identify crime hotspots and deploying officers. Even when officers are elsewhere, cameras maintain vigilance in monitored areas" (PTC05). Participants noted CCTV reduced the need for direct supervision due to its constant monitoring, potentially improving officer accountability. A key informant (KIF03) explained: "CCTV has allowed for remote supervision, reducing supervisor travel and vehicle wear-and-tear. It has also reduced misconduct as officers caught on camera have faced disciplinary action." These findings support Harris and Harris's (2009) and Levesley and Martin's (2005) assertions that CCTV can supplement police presence and potentially lower policing costs.

Participants also highlighted CCTV's role in expediting investigations. A key informant remarked, "CCTV has sped up investigations. Cases with footage are quicker to solve and often need fewer investigators. Time is money!" (KIF05, 2021). This finding supports Morgan and Dowling (2019) and Ashby (2017) on CCTV's role in efficient investigations.

Table 5: Logistic regression results for police operations costs

Variables	B	SE	Wald	Df	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
CCTV_MON	.578*	.198	8.557	1	.003	1.783	1.210	2.627
CCTV_RES	.181	.193	.878	1	.349	1.198	.821	1.750
CCTV_INV	.634*	.202	9.846	1	.002	1.884	1.268	2.799
(Constant)	-5.503	.795	47.869	1	.000	.004		
No. of Observations (N) = 347								
Overall Percentage = 68.9%								
Nagelkerke R^2 = .208								
Omnibus Tests of Model Coefficients: χ^2 = 58.861, df = 3, Sig. = .000								
HL Test: χ^2 = 4.500, df = 8, Sig. = .809								
* p < .01								

Source: Field Data

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While the statistical analysis did not show cost reductions from CCTV responses, qualitative data suggested potential benefits. Key informants (KIF04) and an FGD participant (PTB03) noted faster response times for some incidents and more targeted resource allocation due to CCTV's ability to confirm and locate incidents. This finding suggests CCTV efficiently directs resources to genuine incidents, supported by Isnard's (2001) observation. Studies by Lawson et al. (2018) and Piza et al. (2016) also validate CCTV's cost-effectiveness in targeted responses. Despite these findings, the limited CCTV coverage might explain the lack of significant impact on cost reduction across the county.

CONCLUSIONS AND RECOMMENDATIONS

The study finds that the police-operated CCTV system in Nairobi City County has shown promise in reducing crimes within its coverage area, particularly bank robberies, carjacking and motor vehicle thefts. It has also improved road safety and officer safety and lowered operational costs. However, the system's impact on response times has not significantly improved, partly due to limited coverage, poor coordination between officers on the ground and those at the CCTV control centre, and criminals adapting their tactics. Based on these findings, the study concludes that CCTV can substantially improve police operational outcomes, particularly with adequate coverage and effective user collaboration. The study suggests several steps to maximise the effectiveness of CCTV. It recommends expanding CCTV coverage to enhance police monitoring of public areas and improve response and investigation capabilities. It also recommends regular meetings between operational officers and those at the command centre to enhance incident coordination and response times. Moreover, the study recommends publicising successful CCTV uses through community policing forums and various media channels to deter crime and traffic violations and highlight the system’s value.

Despite its contributions, the study has limitations. It relied exclusively on police data and concentrated on police-operated CCTV. Future research should address this by incorporating public perspectives on CCTV effectiveness, exploring the impact of non-police-operated CCTV systems, investigating the generalizability of findings across different locations and times, and examining additional police operation outcomes beyond the five studied here.

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