



DESIGN AND DEVELOPMENT OF A CCTV SYSTEM FOR MITIGATING BLIND SPOTS IN BANKING FACILITIES

Aldy Rinaldy Fadzilah^{1*}, Taofik Muhammad², Alfadl Habibie³

Universitas Muhammadiyah Tasikmalaya, Indonesia

Correspondence Email: Aldyrinaldyfadzilah6@gmail.com

ABSTRACT

This study aims to develop a Closed-Circuit Television (CCTV) system to reduce surveillance blind spots and improve security coverage at the BRI Cempaka Mas Branch Office, Jakarta. A qualitative descriptive approach was employed using direct observation, semi-structured interviews, documentation, and literature review. The study focused on identifying blind spots, evaluating camera positions and viewing angles, assessing network infrastructure, and determining the requirements for CCTV system improvement. System development included the installation of additional cameras, camera repositioning, network cable organization, IP configuration, PoE optimization, NVR configuration, and system testing. The results showed that the CCTV system capacity increased from 16 to 24 cameras, while five previously identified blind spot areas were eliminated. Surveillance coverage increased from approximately 80% to 100%. Connectivity testing demonstrated a 100% connection success rate for all 24 cameras, with no packet loss or IP conflicts. The NVR successfully supported live monitoring, recording, playback, motion detection, and multi-screen functions. These findings demonstrate that combining camera expansion with strategic repositioning and network infrastructure improvements can substantially enhance CCTV effectiveness and monitoring reliability in banking facilities. The study provides a practical reference for systematic CCTV development based on coverage analysis and operational requirements.

Keywords: CCTV system; blind spots; surveillance coverage; banking security; IP camera

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I. INTRODUCTION

The advancement of information technology has encouraged the adoption of technology-based security systems across various sectors, including banking. As institutions managing public funds, information, and financial transactions, banks require effective surveillance to protect assets, customers, employees, and operational continuity. Closed-Circuit Television (CCTV) is an essential security technology that supports continuous monitoring, incident documentation, and investigation through increasingly integrated camera networks.

CCTV effectiveness depends not only on the number of cameras but also on their configuration and placement. Improper placement can create blind spots, where areas are inadequately monitored. Han et al. (2019) emphasized the importance of camera location, orientation, viewing distance, and field of view in achieving optimal coverage, while Heyns (2021) demonstrated that optimizing camera locations and viewing angles can improve coverage while reducing camera requirements. Thus, blind-spot identification and reduction are critical aspects of CCTV development.

In multi-camera environments, interconnected coverage is also essential for continuous surveillance. Nikodem et al. (2020) demonstrated that multi-camera systems can support object tracking across wider areas through distributed processing, while He et al. (2020) showed that multi-camera networks can construct continuous object trajectories despite occlusion. These findings highlight the importance of considering coverage continuity across cameras rather than individual camera coverage alone. At the BRI Cempaka Mas Branch Office, Jakarta, CCTV is an integral component of operational security. However, several areas may remain inadequately monitored due to limitations in camera viewing angles, positioning, room configuration, and coverage. Therefore, CCTV development requires systematic blind-spot identification, coverage analysis, camera-position evaluation, and determination of additional or adjusted devices (Han et al., 2019; Heyns, 2021).

Accordingly, this study focuses on preparing CCTV system development to address blind spots at the BRI Cempaka Mas Branch Office, Jakarta. The preparation includes identifying inadequately monitored areas, analyzing camera coverage, evaluating camera positions and orientations, and determining development requirements. The study is expected to provide an effective and efficient CCTV development recommendation for improving surveillance coverage in strategic banking areas.

II. LITERATURE REVIEW

Closed-Circuit Television (CCTV) is a visual surveillance system used to capture, transmit, store, and display video for security and monitoring purposes. Contemporary surveillance systems have evolved from conventional camera monitoring toward integrated platforms incorporating network communication, video processing, storage, and intelligent analytics (Tsakanikas & Dagiuklas, 2017; Elharrouss et al., 2021). IP-based surveillance also introduces network-related security and performance considerations because cameras are connected through computer networks and may support distributed monitoring (Kalbo et al., 2020). In banking environments, CCTV can therefore serve as an important component of physical security by supporting continuous monitoring, incident documentation, and subsequent investigation. Banking security encompasses the protection of physical assets, information, human resources, and operational activities from internal and external threats. Within this framework, CCTV effectiveness is closely associated with the adequacy of surveillance coverage. Inadequate camera placement may leave areas insufficiently monitored, creating potential blind spots. Camera placement is consequently treated as an optimization problem involving camera position, orientation, coverage requirements, and installation constraints (Altahir et al., 2022; Gaylon et al., 2022). Optimization-based approaches seek to maximize monitored areas while minimizing unnecessary cameras, redundant coverage, or installation costs.

CCTV system development requires the integration of cameras, processing and storage

devices, communication networks, and monitoring applications. Modern video surveillance architectures incorporate different types of devices, network structures, processing mechanisms, and storage components to support reliable monitoring and video analysis (Tsakanikas & Dagiuklas, 2017; Elharrouss et al., 2021). Because IP-based CCTV systems rely on network connectivity, their performance and security must also be considered during system development (Kalbo et al., 2020). Accordingly, the present study involves additional cameras, camera-position optimization, IP configuration, network testing, and storage optimization to improve surveillance coverage.

Blind spots may arise from inappropriate camera positions or orientations, insufficient camera numbers, restricted field of view, physical obstructions, and inadequate consideration of the spatial characteristics of the monitored environment. Recent studies demonstrate that camera placement can be improved through optimization methods that incorporate risk maps, spatial characteristics, and coverage requirements (Altahir et al., 2022; Gaylon et al., 2022). Such approaches provide a basis for identifying locations requiring additional cameras or repositioning existing cameras. In this study, these principles are applied to improve surveillance coverage and reduce blind spots at the BRI Cempaka Mas Branch Office, Jakarta.

Furthermore, video analytics based on Artificial Intelligence (AI) and computer vision enables automated analysis of surveillance video, including motion detection, object detection, recognition, tracking, and abnormal-event identification (Tsakanikas & Dagiuklas, 2017; Elharrouss et al., 2021). Intelligent surveillance systems can also detect intrusions, fire, loitering, and other abnormal activities, thereby reducing dependence on continuous manual observation (Kim et al., 2021). Large-scale surveillance increasingly requires distributed and efficient processing of video data, while privacy and computational efficiency must also be considered (Tu et al., 2021). Therefore, effective CCTV development should combine adequate physical coverage, optimized camera placement, reliable network

infrastructure, and intelligent video analytics to enhance the effectiveness and efficiency of security monitoring.

III. RESEARCH METHODS

This study employed a qualitative descriptive approach to analyze the preparation of CCTV system development for reducing blind spots at the BRI Cempaka Mas Branch Office, Jakarta. Data were collected through direct observation, semi-structured interviews, documentation, and literature review, focusing on CCTV infrastructure, camera positioning, surveillance coverage, and supporting network devices. The analysis involved identifying blind-spot areas, evaluating camera coverage, position, orientation, connectivity, and network configuration, as well as determining the requirements for system improvement.

The preparation process included device inspection, camera-position evaluation, network configuration, connectivity testing, and adjustment or addition of CCTV devices. The research stages consisted of problem identification, literature review, data collection, CCTV device preparation, system testing, data analysis, and reporting. Data were analyzed descriptively, with source and method triangulation applied to improve data validity. The final system was evaluated by comparing surveillance conditions before and after device preparation to determine improvements in coverage and device functionality.

IV. RESULTS AND DISCUSSION

4.1 Observation Results

Observations were conducted to assess the initial condition of the CCTV system at Bank BRI Cempaka Mas Branch Office, Jakarta, focusing on CCTV equipment, network infrastructure, surveillance coverage, and blind spots. The existing system consisted of 16 Hikvision IP cameras connected through a LAN network, PoE switches, and an NVR. Initial observations identified five areas with suboptimal surveillance coverage.

The CCTV network employed a star topology, in which IP cameras were connected to PoE switches and subsequently to the NVR. Although the infrastructure remained

functional, several network components required improvement, particularly cable organization, RJ-45 connector inspection, network labeling, and preparation of additional network paths.

Table 1. Initial and Post-Preparation CCTV Infrastructure

Component	Initial	Post-Preparation
IP Cameras	16 units	24 units
NVR	1 unit	1 unit
PoE Switches	2 units	2 units
Network cables	Required organization	Organized and tested
RJ-45 connectors	Required inspection	Inspected/terminated
UPS	Available	Normal
Documentation	Incomplete	Structured

Network cables were identified as the main communication medium between the cameras, PoE switches, and NVR. Several cable routes required reorganization, while RJ-45 connectors were inspected using a LAN cable tester. Cable identification and organization were subsequently improved to facilitate maintenance.

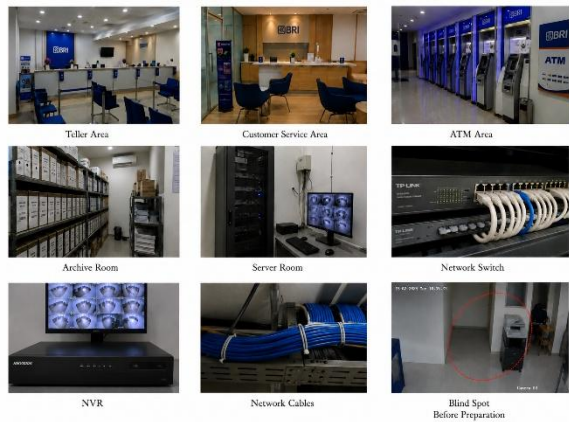


Figure 1. Initial CCTV Infrastructure and Equipment

Use existing photographs showing the Teller Area, Customer Service Area, ATM Area, Archive Room, Server Room, and Network Switch. The CCTV system was expanded from 16 to 24 cameras by adding eight units.

Table 2. Camera Deployment

Condition	Number
Before Development	16
Additional cameras	8
After development	24

Initial mapping identified five blind spot areas: the corridor behind the archive room, the teller area corner, the document storage room, the rear parking area, and the side corridor. These areas were addressed through camera installation or repositioning.

Table 3. Identified Blind Spots and Corrective Actions

Location	Initial Condition	Corrective Action
Archive rear corridor	Not monitored	Additional camera
Teller corner	Obstructed by partition	Repositioning
Document storage	No camera	Additional camera
Rear parking	Limited viewing angle	Addition/repositioning
Side corridor	Insufficient coverage	Additional camera

4.2 CCTV System Development

The development process was based on the initial observation and blind spot mapping. The main activities included equipment inspection, network topology design, cable installation, camera installation, IP configuration, NVR configuration, and system testing.

A star topology was maintained because it facilitates system expansion and maintenance. Each camera was connected to the PoE switch and then integrated with the NVR.

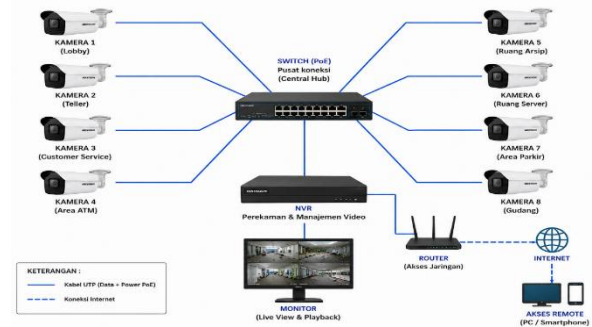


Figure 2. CCTV Network Topology
During installation, network cables were routed, RJ-45 connectors were terminated, cameras and PoE switches were installed, and the devices were connected to the NVR. The developed system used the 192.168.10.0/24 network, with camera addresses ranging from 192.168.10.101 to 192.168.10.124. Each camera was assigned a unique IP address to

prevent conflicts and simplify system management.

Table 4. Network Configuration

Parameter	Configuration
Network	192.168.10.0/24
Subnet Mask	255.255.255.0
Gateway	192.168.10.1
Camera IP Range	192.168.10.101–124
Total Cameras	24

The NVR was configured to receive all 24 cameras and support live view, recording, playback, motion detection, and multi-screen monitoring. All functions were successfully configured.

Table 5. NVR Configuration Results

Function	Result
Camera detection	Successful
Live view	Normal
Recording	Successful
Playback	Successful
Motion detection	Active
Multi-screen	Successful

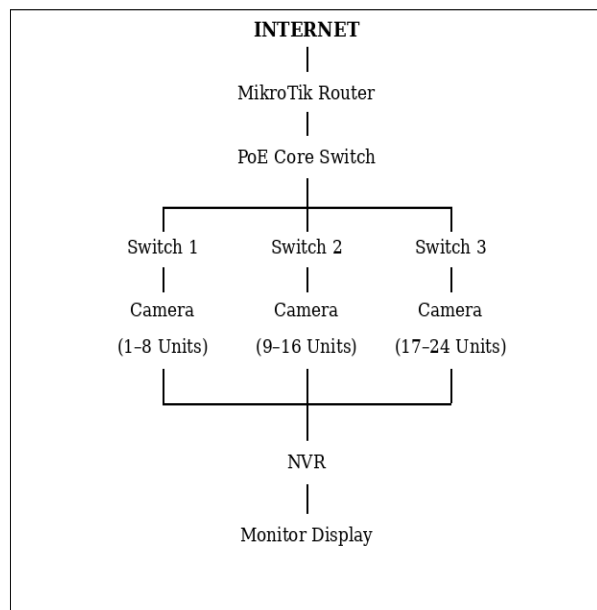


Figure 4. Network Topology after CCTV Development

4.3 System Testing

System testing was performed after installation and configuration. The evaluation covered network connectivity, video quality, viewing angles, blind spots, storage, and monitoring functions.

a. Connectivity Testing

A ping test was performed on all 24 cameras. All cameras responded successfully, with a 100% connection rate and no detected packet loss or IP conflicts.

Table 6. Connectivity Test Results

Parameter	Result
Cameras tested	24
Connected cameras	24
Connection success	100%
Packet loss	0%
IP conflicts	None

b. Video Quality Testing

All cameras provided Full HD video at 1920×1080 pixels. Daytime images were generally clear to very clear, while a slight reduction in image quality was observed in the outdoor parking area at night.

Table 7. Video Quality Test

Location	Resolution	Day	Night	Status
Entrance	1920×1080	Clear	Clear	Good
Teller	1920×1080	Very clear	Clear	Good
ATM	1920×1080	Very clear	Clear	Good
Customer Service	1920×1080	Very clear	Clear	Good
Parking	1920×1080	Clear	Fairly clear	Good

c. Viewing Angle and Blind Spot Testing

Camera repositioning and the installation of additional cameras improved surveillance coverage in the teller, customer service, ATM, parking, lobby, and rear corridor areas. The five blind spot areas identified during the initial assessment were no longer identified after the development process.

Table 8. Blind Spot and Viewing Coverage

Indicator	Before	After
Blind spots	5 areas	0 areas
Teller coverage	Limited	Optimal
Customer Service	Limited	Optimal
Parking	Insufficient	Optimal
Lobby	Adequate	Optimal

d. Storage and Monitoring

The NVR successfully received and recorded all 24 cameras. Live view, multi-screen, recording, playback, motion detection, and recording search functions operated normally.

4.4 Result Analysis

The comparison between the initial and developed systems indicates improvements in camera capacity, surveillance coverage, monitoring performance, and network stability.

Table 9. Comparison Before and After CCTV Development

Parameter	Before	After	Improvement
Number of cameras	16	24	+8 units
Blind spots	5 areas	0 areas	Resolved
Surveillance coverage	±80%	100%	Increased
Packet loss	2%*	0%	Reduced
Monitoring	Less optimal	Optimal	Improved
Video quality	Good	Very good	Improved
Network stability	Stable	Very stable	Improved
Recording	Normal	Normal	Maintained

The addition of eight cameras increased camera capacity by 50% and addressed the five initially identified blind spot areas. Based on the location mapping conducted in the study, surveillance coverage increased from approximately 80% to 100%.

The improvement was not solely attributable to the additional cameras. Cable organization, connector inspection, IP configuration, PoE optimization, camera repositioning, and NVR configuration collectively contributed to improved system performance and communication stability.

4.5 Research Constraints

Several constraints were encountered during implementation, including restricted access to some rooms, limited installation time due to bank operating hours, complex cable routes, camera positioning requirements, IP configuration, and variations in nighttime lighting.

Table 10. Research Constraints and Mitigation

Constraint	Mitigation
Limited room access	Coordination with bank personnel
Limited installation time	Scheduling
Complex cable routes	Gradual cable organization
Camera positioning	Camera repositioning
IP configuration	Static IP addresses
Nighttime lighting	IR optimization

The study was limited to one branch office and a specific observation period; therefore, long-term system performance and generalization to other branch offices were not evaluated.

4.6 Solution Implemented

The implemented solutions combined CCTV equipment development with network infrastructure improvements. The main measures consisted of adding cameras, repositioning existing cameras, organizing cables, configuring static IP addresses, optimizing PoE utilization, and configuring the NVR.

Table 11. Problems, Solutions, and Outcomes

Problem	Solution	Outcome
Blind spots	Addition of 8 cameras	Improved coverage
Suboptimal camera positions	Repositioning	Wider viewing angles
Cable/connector issues	Termination and organization	More stable connections

4.7 Final Research Results

The CCTV development successfully increased the system capacity from 16 to 24 cameras and addressed the five blind spot areas identified during the initial assessment. All 24 cameras were successfully integrated with the NVR and operated the required monitoring and recording functions.

Table 12. Summary of Final Results

Indicator	Before	After
CCTV cameras	16	24
Blind spots	5 areas	0 areas
Surveillance coverage	±80%	100%
Cameras connected to NVR	16	24
Packet loss	2%*	0%
Monitoring	Less optimal	Optimal
Recording	Normal	Normal
Documentation	Incomplete	Structured

Overall, the combination of camera additions, camera repositioning, network improvements, IP configuration, PoE optimization, and NVR configuration improved the effectiveness of the CCTV system. The developed system successfully integrated 24 cameras, eliminated the initially identified blind spots, and increased

the observed surveillance coverage from approximately 80% to 100%.

V. CONCLUSION

The The CCTV development at BRI Cempaka Mas Branch Office successfully increased the number of cameras from 16 to 24 units and eliminated the five identified blind spots. Camera repositioning, network improvement, IP configuration, PoE optimization, and NVR configuration also improved surveillance coverage and system stability. Overall, the developed system increased observed surveillance coverage from approximately 80% to 100%, while all cameras operated successfully for monitoring and recording.

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