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# Framework for the Adoption of CCTV Camera for Supervision of Construction Projects in Lagos State Nigeria.

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**Abstract**

*Professionals in the Nigeria construction industry faces challenges of manual supervision, which results in project delays, cost overruns, and safety concerns. However, innovations in digital technologies and a drive for more Artificial Intelligence (AI) application have motivated the use of Closed-Circuit Television (CCTV) camera for construction projects supervisions. This study developed a framework for the adoption of CCTV camera for supervision of construction projects in Nigeria. The framework considered the level of awareness, adoption, benefits of CCTV camera on project execution, and skills and training needed to use CCTV camera. Stratified random sampling techniques was used to distribute three hundred (300) questionnaires to construction professionals (architects, builders, and engineers) in Lagos State. One hundred and sixty eight (168) questionnaires representing 56% was retrieved and use for analysis. Level of adoption of CCTV camera for construction projects are for security and crime prevention, monitoring public areas, business, and homes and for remote monitoring and surveillance. Level of awareness of CCTV camera are for security and crime prevention evidence of litigation, and proof for dispute resolution. The benefits of using CCTV camera on the execution of construction projects are for improved security, real-time monitoring, and to enhance projects management. The result of the LSD Post hoc test, reveals that there is a significant difference between the pairs of architects and engineers (p-value = 0.02) on the use of CCTV camera. The major skills and training needed to use CCTV camera on construction projects are observational skills, surveillance proficiency, and technical reporting. From the findings of the study, the level of adoption of CCTV camera for supervision is low in Lagos State. In conclusion, the developed framework will guild construction profession to use CCTV camera for supervision of construction projects.*

**Key words: CCTV Camera; Construction; Framework; Projects**; **Supervision.**

## 1.0 INTRODUCTION

In Nigeria, the construction industry is rapidly growing, with numerous ongoing projects in various sectors, including infrastructure, residential, and commercial development (Adedeji, 2023). However, the industry faces significant challenges, including project delays, cost overruns, and safety concerns (Akanni *et al*., 2022; Ijigah & David, 2024). The advent of technological advancements has ushered in innovative solutions with the implementation of CCTV camera emerging as a promising approach for site supervision. This introduction sets the stage for exploring the multifaceted role of CCTV cameras in enhancing construction works performance, encompassing their benefits, challenges, and future implications.

A construction project involves series of complex and interrelated activities during the project initiation stage, planning, design, construction, and maintenance stages (Baduge *et al*., 2022; Kerzner, 2025). Construction sites are inherently complex environments, characterized by diverse activities, intricate workflows, and a myriad of safety hazards. The product in the case of a construction project is the constructed facility such as buildings, assembling of some infrastructures and provision of services (Sacks *et al*., 2018). Key professionals like the architects, engineers, builders, contractors, and the non- professionals like the skilled and unskilled operatives and brought together to execute construction project to meet the time, cost quality and other performance indices (Ijigah & Olubiyi 2025). On most construction project, the professionals closely monitors the non-professionals to enhance the performance of the project (Jackson, 2020).

According to Ijigah (2023), the professionals carry out task like supervisions, tracking, evaluation and project management to enhance the projects performance. Traditional supervision methods rely on physical presence and human observation, which can be limited and prone to errors (Kerzner, 2023). Traditional methods of supervision, reliant on manual patrols and periodic inspections, often fall short in providing real-time insights into site dynamics and potential risks (Kerzner, 2023). In contrast, CCTV cameras offer a proactive and comprehensive means of monitoring construction activities, enabling stakeholders to remotely observe and manage site operations with precision and immediacy (Yab *et al*., 2023). It also has the advantage of electronic storage of supervision and site activity data, which can be used for future planning.

Professionals on construction projects carry out physical supervision of projects, using score sheets, checklist and timing card to monitor, supervise, track, and evaluate construction projects (Jackson, 2020). The advent of digital technological advancement, Information and Communication Technologies (ICT), design software, and Building Information Modelling (BIM) have created a drive for more application of Artificial Intelligence (AI) to construction processes. In addition, clients are now more familiar with the design concept, pictures and models before the actual construction works begins. Construction professionals needs a more innovative way of supervising their projects to meets the client's needs.

The increasing demand for efficient and cost-effective project delivery has highlighted the need for innovative supervision methods (Ijigah, 2025). The use of CCTV camera on construction sites has the potential to enhance supervision, improve project outcomes, and address the performance challenges facing the industry (Abdullah *et al.*, 2025). However, the adoption of CCTV camera usage in

Nigerian building construction projects sites is limited, and their effectiveness has not been fully explored to improve supervision of construction projects.

CCTV camera have been widely used in various industries, including security (Welsh *et al*., 2020), law enforcement (Slobogin & Brayne, 2023), and traffic management (Abdel-Aty *et al*., 2022), to enhance monitoring and supervision. Recent studies have highlighted the benefits of CCTV camera in construction, including improved project timelines, reduced costs, and enhanced security (Dave-Bhargav *et al.,* 2023). In the construction industry, CCTV camera have the potential to improve supervision, reduce errors, enhance safety, and prevent criminal activities (Al-Rimawi *et al*., 2023). Research study have proved that the level of monitoring, supervisions, tracking, evaluation and project management enhance the quality of the project (Musyimi & Ondara, 2022; Kerzner, 2023; Ijigah, 2025). It was also proven that professionals prompt engagement on construction project reduce re-work, cost of project, and enhance time delivery of construction projects ( Walker *et al*., 2022; Karimulla *et al*., 2024). The integration of CCTV camera systems into construction site supervision will bring several advantages, real-time monitoring capabilities empower project managers and site supervisors to detect and address issues promptly. This will minimize delays, optimize resource allocation, and enhance overall project efficiency. In light of these developments, this research study produced a framework that will assist the adoption of CCTV camera for supervision of building construction projects in Lagos, Nigeria with the view to enhancing productivity and bridge the gaps in literature and application of the subject matter.

## 2.0 LITERATURE REVIEW

### 2.1 Level of Adoption and Usage of CCTV Smart Camera

The adoption and usage of CCTV smart camera for supervision has been steadily growing, but the level varies depending on region, project scale, and organizational maturity in technology use (Abdullah *et al* , 2025; Thach *et al* , 2024). The level of adoption of CCTV smart camera is high in regions like North America, Europe, Singapore South Korea and Japan (Abdullah *et al*., 2025). Large construction industries in developed countries use CCTV smart camera for site management, safety, security, and progress monitoring (Abdullah *et al.*, 2023). The level of usage of CCTV smart camera is moderate in developing countries like Nigeria as it is only used by large infrastructure and government projects (Ilesanmi *et al*., 2024). However, small- and medium-scale contractors rely more on manual supervision due to cost constraints in Africa and South Asia countries (Mbazor *et al.*, 2024). The level of adoption of CCTV camera also varies by projects.

Large-scale projects like Infrastructure (highways, railways, and airports), high-rise buildings, and smart city projects typically include CCTV as part of project monitoring strategy (Abdullah *et al*., 2025). According to Kim *et al*. (2022), medium-scale projects like commercial buildings, mid-rise housing projects use CCTV camera selectively for main entrances, storage areas, and high-risk zones. While, small scale projects like residential buildings constructed by small contractors use limited or no CCTV as they mostly rely on manual site supervisors (Kim *et al*., 2022).

The use of CCTV smart camera in the construction industry is limited mostly for site security (theft prevention) rather than advanced supervision of construction projects (Hossain *et al* , 2024). CCTV smart camera is use in the construction industry for security to prevent loss, theft, vandalism, unauthorized access (Kim *et al*. (2022). It is also used for safety monitoring of construction workers compliance with personal protective equipment, detect unsafe practices, and support incident investigation (Hossain *et al*., 2024). CCTV is also used for progress tracking when integrated with time-lapse tools and AI to measure work completed (Abdullah *et al* , 2023).

CCTV camera can be used for remote supervision and enable site managers, clients, and consultants to monitor sites without being physically present (Thach *et al* , 2024). CCTV when integrated with Artificial intelligence and internet of things can advance sites real-time analysis of worker counts, hazard detection, and productivity tracking (Thach *et al*., 2024). Although, they is growing awareness among construction professional as the cost of cameras and cloud storage are reducing globally (Ilesanmi *et al*., 2024; Abdullah *et al*., 2025). Abdulla *et al*. (2023) opined that the installation of CCTV cameras presented a number of significant difficulties, such as a widespread lack of information about how they work, a lack of expertise in IT security, and a mismatch in the perspectives of different stakeholders about preservation of public safety. The effectiveness of CCTV monitoring tactics in Nigeria has been a subject of heated discussions due to these shortcomings. This study therefore produceed a framework that will guild the adoption of CCTV smart camera in developing countries live Nigeria.

## 2.2 Benefits of Using CCTV Cameras for Construction Projects

According to Kerzner (2025), construction projects are becoming increasingly complex and valuable, making the need for effective supervision very important. One of such measure that has become increasingly popular in recent years is the use of CCTV cameras. According to Raul (2023), the use of CCTV cameras has a positive impact on productivity and efficiency of construction projects. CCTV cameras improve security, reduce the risk

of theft and vandalis. The camera also monitor the progress of construction work, and reduces accidents and injuries. The use of CCTV cameras ensured that projects are complete on time, within budget, and to a high standard.

Harris, (2015) examines how the implementation of CCTV cameras in construction projects generally leads to improved timelines, budgets, and quality through enhanced monitoring, better resource management, and increased safety. Lu and Deng (2022) cited that supervisors are primarily responsible for physical monitoring and identifying hazardous worker behaviours on construction sites, which has serious drawbacks. The intelligent surveillance system, which is based on traditional video surveillance, makes use of computer vision technology, which has altered the conventional management mode and enhanced the effectiveness and calibre of supervision. By using image or video recognition technology and the intelligent surveillance system (CCTV camera) can automatically detect dangerous worker behaviour, enabling thorough and real-time worker monitoring that can safeguard the workforce and raise the standard and effectiveness of project management (Seong *et al*., 2023). According to Cocca *et al*. (2016), the use of CCTV camera can curb the menace of scavengers and other security challenges. Table 1 presented summary of literature review on the benefits of using CCTV camera for construction project execution.

**Table 1: Benefits of Using CCTV Camera for Construction Projects**

| Benefits of CCTV Camera | Citation | Benefits of CCTV Camera | Citation |
|---|---|---|---|
| Improved security | Kim *et al*. (2022) | Remote sensing | Thach *et al*. (2024) |
| Real-time monitoring | Tian *et al*. (2024) | Better record-keeping | Seong *et al*. (2023) |
| Enhance projects management | Seong *et al*. (2023) | Improves project performance | Abdullah *et al*. (2023) |
| Curbing the menace of scavengers | Cocca *et al*. (2016) | Compliance monitoring | Thach *et al*. (2024) |
| Enhanced site surveys | Mbazor *et al*. (2024) | Increased productivity | Abdullah *et al*. (2025) |
| Remote supervision | Thach *et al*. (2024) | Improved safety | Hossain *et al* , (2024) |
| Enhanced quality control | Abdullah *et al*, (2025) | Work measurements | Chen *et al*. (2023) |
| Reduced disputes | Ijigah *et al* (2023) | Reduced costs | Mbazor *et al*. (2024) |

**Source: Author's work (2025)**

## 2.3 Skills and Training Gaps for the Application of CCTV Camera on Construction Projects

According to Aliu *et al*. (2025), a new era of extraordinary automation, connectivity, and data sharing has been ushered in by digital technology. This trends is forcing industries to accept and adjust to this wave of innovation in order to remain competitive in the ever changing digital race (Jaafar *et al*., 2025). Similar to several industries worldwide, digital technology have proliferated in many aspects like the Architectural, Engineering, Construction

and Operation (AECO) sector (Eze *et al*. 2024, Thirumal *et al*., 2024). Several digital technologies have made inroads into construction projects. This include artificial intelligence, building information modeling, cloud-based project management platforms, advanced analytics and machine learning, 3D scanning and drone technology, virtual reality and augmented reality. Others are computer-aided design, internet of things and sensor technology, digital twins, advanced communication tools, robotics and autonomous systems and block chain technology, among several others (Aliu & Oke 2023, Chen *et al*., 2023).

According to Mukdem *et al*. (2022), a number of factors, including poor planning, issues with finance, corruption, recruitment and selection procedures, motivation and labour relations practices, and insufficient training and skill development, are to blame for the decline in the construction industry's contribution to the national GDP (Tunji-Olayeni, *et al*., 2017; Ameh & Daniel, 2017). Furthermore, the number of building collapses in Nigeria is rising daily, and regrettably, some of these failures happen during construction and usage, necessitating urgent attention (Egunjobi & Adebayo, 2016). According to Okolie, *et al*. (2019), numerous issues led to the collapse of building structures. These includes including unethical behaviour, inadequate commitment and knowledge, negligence, dishonesty, and unfair tactics that are common in the Nigerian construction sector (Osuizugbo & Ojelabi, 2020).

The current state of training and skill development in Nigeria digital technology is insufficient, which has resulted in gaps in the sector and skill shortages (Kwaghbo, 2021; Ijigah & Olubiyi, 2025). This has an impact on the industry's performance, resulting in low and continuously declining productivity throughout time. Another urgent problem in Nigeria's construction sector is the skill level of its workforce, which is already having a significant impact on the sector and the country's economy (Ameh & Daniel, 2017). Nonetheless, it is crucial that workers in the construction sector receive training and skill development in the application of CCTV camera for supervision to improve the performance of the industry. Untrained and incompetent workers endanger project execution success by reducing product quality, influencing project tardiness, and raising project costs (Zannah *et al*., 2017).Notwithstanding the construction industry's acceptance of digital technologies, there is still a glaring study gap regarding the prerequisites for achieving best performance through skills and training. This gap is particularly evident in regions such as Lagos State, Nigeria.

### 2.4 Framework for the Adoption of CCTV Camera for Supervision of Construction Projects

The research framework presented in

Figure I, explored the use of manual supervision and compared it with the use of CCTV cameral for construction project in Lagos, Nigeria. The framework also assessed the level of awareness and adoption of CCTV camera and the skills and training needed to operate CCTV camera in the study area. Lastly, the study assessed the benefits of using CCTV camera for construction project executions in Nigeria.

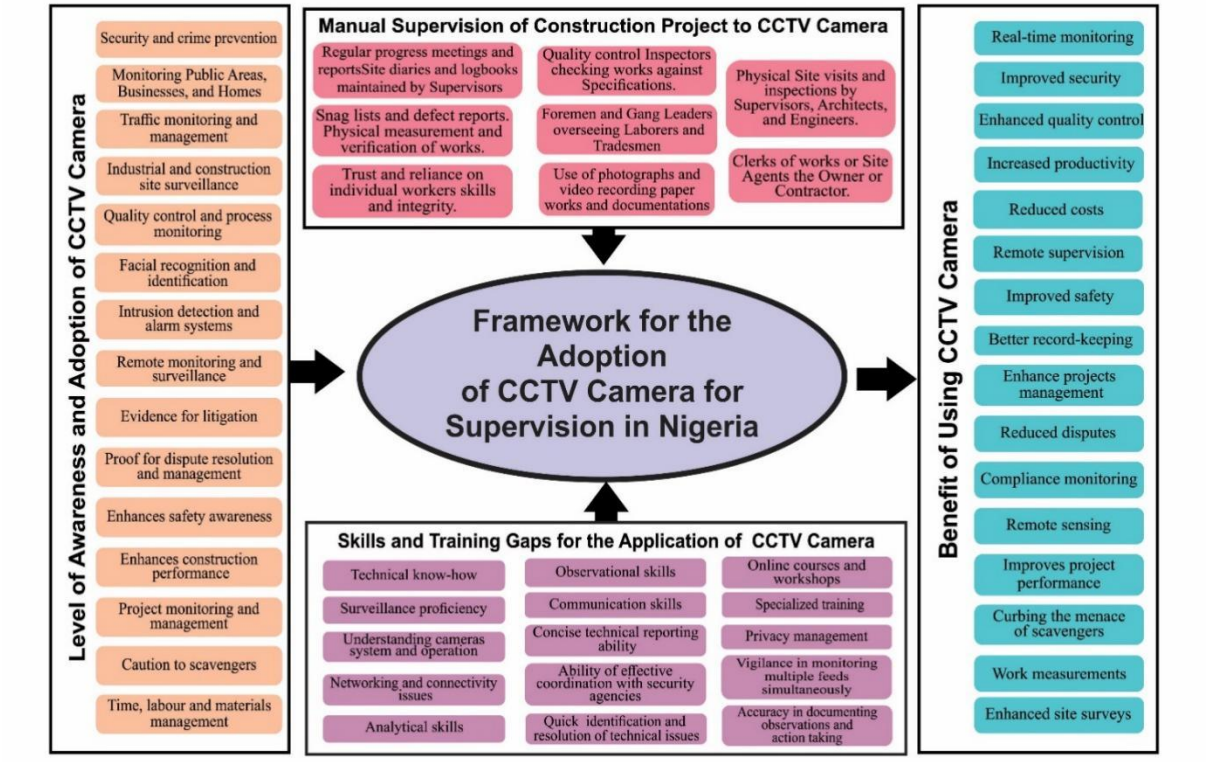



**Figure 1: Framework for the Adoption of CCTV Camera for Supervision in Nigeria**

## 3.0 RESEARCH METHODS

The study used a stratified random sampling survey research design and closed-ended questionnaires. Table 2 shows the population and sample size of development and property corporation current joint-ventures estate projects, Lagos State. One thousand two hundred and eighty four (1284) construction professionals were selected but a sample size of 300 was calculated using proportional sampling size (Chaokromthong & Sintao, 2021). Table 3 shows the number of questionnaires administered with the response rate. Three hundred (300) questionnaires were administered based on the location of the projects. The respondents were clients, contractors and consultants (Architects, Builders, Engineers, Project Managers Quantity surveyors,), subcontractors, and suppliers who had been involved in the supervision of construction projects in Lagos state, Nigeria. Other criteria used to

assess the respondents are respondents' educational qualification, year of experience of the respondent, and professional position of the respondent on the project.

**Table 2: Population and Sample Size of the Project Stakeholders**

| S/N | Projects | Location | Units |
|---|---|---|---|
| 1 | Bayview Estate | Ikate - Elegushi, Lekki | 100 |
| 2 | Templeton Apartments | Okrika, Ikoyi | 24 |
| 3 | Garnet Residence | Victoria Island | 25 |
| 4 | The Nexus | Victoria Island | 70 |
| 5 | Toll Heights | Ogudu | 192 |
| 6 | Ilupeju Gardens | Ilupeju | 209 |
| 7 | Davilla Court | Ogudu | 138 |
| 8 | Addy's Haven Apartments | Apapa | 42 |
| 9 | Pearl Residence | Ajiwe, Lekki | 180 |
| 10 | Exclusive Homes | Ajiwe, Lekki | 200 |
| 11 | The Mews | Abijo GRA, Ibeju – Lekki | 104 |
| | **TOTAL** | | **1,284** |

**Source: lsdpc.gov.ng (2025).**

One hundred and sixty eight questionnaires were retrieved from the respondent (56%). The respondents did not submit the remaining one hundred and thirty two (132) representing (44%). The percentage retrieved was considered sufficient for this study based on the assertion of (Chaokromthong & Sintao, 2021) that the result of a survey could be considered as unbiased and significant if the return rate was not lower than 40 - 50%.

**Table 3: Number of Questionnaire Administered and Retrieved in the Study Area.**

| Administered | Retrieved | Percentage (%) |
|---|---|---|
| 300 | 168 | 56 |

**Source: Author's work (2025)**

## 4.0 RESULT AND DISCUSSION

Table 4 presented the result of the background information of the respondents. From Table 4, it is evident that all the respondents were educated. 48.40% were B. Tech/B.sc holder, 11.30% were M.Sc. holders, 35.50% were HND holders, Ph.D holders were 4.80% while none was in the category of ND/NCE. From the result of the study, 55.70% of the respondents are professionals who have carried out building construction projects for over 10 years, while 44.30% of the respondents have executed projects for less than 10 years. In terms of respondents' professional qualification, it was shown

from Table 4 In terms of respondents' professional qualification, it was shown that engineers have the highest representation with 67.70%, Builders were represented with 22.70%, and the Architects were represented with 19.64%. The three professional represents 91.66 % of the respondents. These professionals are mostly involved in physical supervision of construction project in Lagos State, Nigeria.

**Table 4: Background Information of the Respondents**

| S/No | Categories | Classification | N | Percentage | Frequency |
|---|---|---|---|---|---|
| 1 | **Educational qualification** | ND/NCE | 0 | 0 | 0 |
| | | HND | 60 | 35.50 | 35.50 |
| | | B.Tech/B.sc | 81 | 48.40 | 84.20 |
| | | M.SC | 19 | 11.30 | 95.50 |
| | | Ph. D | 8 | 4.80 | 100.0 |
| | | **Total** | **168** | **100.00** | |
| 2 | **Respondent's year of experience** | 1 - 5 years | 19 | 11.50 | 11.50 |
| | | 6 - 10 years | 55 | 32.80 | 44.30 |
| | | 11 - 15 years | 41 | 24.60 | 68.90 |
| | | 16 - 20 years | 39 | 23.00 | 91.90 |
| | | 21 and above | 14 | 8.10 | 100 |
| | | **Total** | **168** | **100.00** | |
| 3 | **Respondent's Professional Group** | Architect | 33 | 19.64 | 19.64 |
| | | Builders | 48 | 28.57 | 48.21 |
| | | Engineers | 73 | 43.45 | 91.66 |
| | | Project Manager | 8 | 4.80 | 96.66 |
| | | Quantity Surveyor | 6 | 3.34 | 100,00 |
| | | **Total** | **168** | **100** | |

**Source: Author's work (2025)**

Table 5 assessed the level of adoption of CCTV cameras for construction application in Lagos State. From the result in Table 5, security and crime prevention with Mean Score (MS= 3.33), and Standard Deviation (S.D. =0.71) was ranked 1st, while monitoring public areas, business, and homes (MS= 3.29; S.D. =0.75) was ranked 2nd. Remote monitoring and surveillance (MS= 3.26; S.D. =0.67) was ranked 3rd. Evidence of litigation (MS= 2.10; S.D. =0.80) was ranked least among the fifteen levels of adoption of CCTV cameras for construction application in Lagos State. All the listed levels of adoption of CCTV cameras for construction application in Lagos State are significant, as the mean score is higher than 2.00 (MS ≥ 2.00). The result of the study was in agreement with the findings by Ilesanmi *et al*. (2024) that CCTV is only used for security on construction projects in Nigeria.

Table 5 also assessed the level of

awareness of CCTV cameras for construction application in Lagos State. From the result in Table 5, security and crime prevention with Mean Score (MS= 3.18), and Standard Deviation (S.D. =1.01) was ranked 1st, while evidence of litigation (MS= 2.97; S.D. =1.15) was ranked 2nd. Proof for dispute resolution (MS= 2.95; S.D. =1.15) was ranked 3rd. Time, labour and materials monitoring (MS= 2.05; S.D. =0.92) was ranked least among the fifteen levels of awareness of CCTV cameras for construction application in Lagos State. All the listed levels of awareness of CCTV cameras for construction application in Lagos State are significant. The result of the findings was in agreement with the findings by Ilesanmi *et al*. (2024) that Nigerian construction professionals are mostly aware that CCTV camera can be used for security to stop stealing of construction materials. They are not aware that CCTV camera can be used for supervision of construction projects. The level of adoption and awareness of the use of CCTV camera for supervistion of construction projrcts in nigeria is low and should be enhanced. Other usese of CCTV camera in the study are for montoring of public places, and for surveillance. These findings is in aggrement with the result of Abdullah et al. (2025), Kim *et al*. (2022), and Hossain *et al*. (2024)

Table 5 reveals the mean gap analysis between the level of awareness and the level of adoption of CCTV cameras for construction application in Lagos State. Out of the fifteen (15) levels of usage of CCTV cameras identified for construction application from the literature. There exist positive gaps in nine (9) level of usage of CCTV cameras for construction application while the remaining six (6) level of usage of CCTV cameras for construction application experience negative gap. This then implies that cognate attention should be given to the level of usage of CCTV cameras for construction application with positive gaps over others.

The level of usage of CCTV cameras for construction application with positive gaps, are traffic monitoring and management (1.05), facial recognition and identification (0.74), monitoring public areas, business, and homes (0.72), industrial and construction site surveillance (0.71), intrusion detection and alarm systems (0.62), remote monitoring and surveillance (0.59), time, labour and materials monitoring (0.56), quality control and process monitoring (0.39), and security and crime prevention (0.15). The level of usage of CCTV cameras for construction application with negative gaps, are project monitoring and management (-0.15), caution to scavengers and cart pushers (-0.28), enhancement of safety awareness (-0.39), proof for dispute resolution (-0.41), enhances construction performance (-0.55), and evidence of litigation (-0.87). There is a gap between awareness and adoption of CCTV cameras for

construction application in Lagos State.

**Table 5: Level of Adoption and Awareness of CCTV Cameras for Construction Projects in Lagos State**

| Level of Adoption and Awareness of CCTV Camera | Adoption | | | | Awareness | | | GAP |
|---|---|---|---|---|---|---|---|---|
| | DF | M | SD | R | M | SD | R | |
| Security and crime prevention | 167 | 3.33 | 0.71 | 1 | 3.18 | 1.01 | 1 | 0.15 |
| Monitoring public areas, business, and homes | 167 | 3.29 | 0.75 | 2 | 2.57 | 1.16 | 9 | 0.72 |
| Remote monitoring and surveillance | 167 | 3.26 | 0.67 | 3 | 2.61 | 1.32 | 8 | 0.59 |
| Facial recognition and identification | 167 | 3.22 | 0.83 | 4 | 2.48 | 1.19 | 11 | 0.74 |
| Traffic monitoring and management | 167 | 3.22 | 0.81 | 5 | 2.17 | 1.00 | 13 | 1.05 |
| Intrusion detection and alarm systems | 167 | 3.14 | 0.74 | 6 | 2.52 | 1.32 | 10 | 0.62 |
| Industrial and construction site surveillance | 167 | 2.89 | 1.10 | 7 | 2.18 | 1.00 | 13 | 0.71 |
| Project monitoring and management | 167 | 2.72 | 0.82 | 8 | 2.87 | 1.16 | 7 | -0.15 |
| Quality control and process monitoring | 167 | 2.66 | 0.79 | 9 | 2.27 | 1.25 | 12 | 0.39 |
| Caution to scavengers and cart pushers | 167 | 2.65 | 0.83 | 10 | 2.93 | 1.15 | 5 | -0.28 |
| Time, labour and materials monitoring | 167 | 2.61 | 0.79 | 11 | 2.05 | 0.92 | 15 | 0.56 |
| Enhances safety awareness | 167 | 2.55 | 0.93 | 12 | 2.94 | 1.15 | 4 | -0.39 |
| Proof for dispute resolution | 167 | 2.54 | 0.87 | 13 | 2.95 | 1.15 | 3 | -0.41 |
| Enhances construction performance | 167 | 2.35 | 0.87 | 14 | 2.90 | 1.15 | 6 | -0.55 |
| Evidence of litigation | 167 | 2.10 | 0.80 | 15 | 2.97 | 1.15 | 2 | -0.87 |

**Source: Author's work (2025)**

Table 6 shows the result of Spearman's rho correlation carried out on the level of awareness and adoption of CCTV cameras for construction application in Lagos State. The level of awareness and adoption of CCTV cameras for construction application in Lagos State is significant at the (-.21 & .28 ≥ 0.01 level (2-tailed). In addition, the result of the Spearman's Correlation carried out on level of awareness and adoption of CCTV cameras for construction application in Lagos State is significant at the (-.26 & .34 ≥ 0.01 level (2-tailed).

**Table 6: Correlation between level of awareness and Adoption of CCTV Cameras for Construction Application in Lagos State**

| | | | Level of Adoption | Level of Awareness |
|---|---|---|---|---|
| Spearman's rho | **Level of Adoption** | Correlation Coefficient | 1.00 | **-.26** |
| | | Sig. (2-tailed) | . | **.34** |
| | | N | 168 | 168 |
| | **Level of awareness** | Correlation Coefficient | **-.26** | 1.00 |
| | | Sig. (2-tailed) | **.34** | . |
| | | N | 168 | 168 |

**Source: Author's work (2025)**

Table 7 reveals the paired sample t-test regarding the existence of significant difference or otherwise in the level of awareness and the level of adoption of CCTV cameras for construction application in Lagos State. Based on the result of the analysis carried out as shown on Table 10, it is therefore evident that there is a significant relationship (p-value (0.23) ≥ 0.05, two tailed) between the level of awareness and the level of adoption of CCTV cameras for construction application in Lagos State. The level of adoption is significantly related to the level of awareness of CCTVcamera.

**Table 7: Paired Sample Test between Level of Awareness and Adoption of CCTV Cameras for Construction Application in Lagos State**

| Awareness and Adoption Factors | Mean | Std deviation | Std. error mean | t | df | Sig. (2 tailed) |
|---|---|---|---|---|---|---|
| Level of adoption | 2.84 | .39 | .10 | | | |
| Level of awareness | 2.64 | .35 | .09 | 1.27 | 167 | 0.23 |

Table 8 shows the benefit of using CCTV cameras on the execution of construction projects. The effects of using CCTV camera on the execution of construction projects was tested by three professionals (architects 33; 19.64%, builders 44; 28.75% and engineers73; 43.45%). These professional were selected because they accounted for 91.66% of the respondents that answered the research questions. The respondents from the architects ranked real-time monitoring with Mean Score (MS) = 4.07 and Standard Deviation (SD) = 0.54 first, improved security (MS = 4.00; SD = 0.66) second while remote supervision (MS= 3.82; SD = 0.50) was ranked third. Reduced costs of construction (MS= 2.92; SD = 1.09) was the least ranked benefits of using CCTV camera on construction projects by the Architects. The respondents that are builders ranked enhance projects management (MS= 3.86; SD = 0.71) first, better record keeping (MS= 3.86; SD = 0.55) second while reduced disputes (MS= 3.85; SD = 0.80) was ranked third. Reduced costs of construction (MS= 2.83; SD = 1.07) was also ranked as the least benefits of using CCTV camera on construction projects by the builders. The respondents that are engineers ranked curbing the menace of scavengers (MS= 3.99; SD = 0.69) first, work measurements (MS= 3.85; SD = 0.89) second while enhance projects management (MS= 3.82; SD = 0.84) was ranked third. Reduced costs of construction (MS= 2.80; SD = 0.78) was also ranked as the least effect of using CCTV cameras on construction projects by the engineers.

Table 11 also shows the ranking of overall effects of using CCTV cameras on the

execution of construction projects. The top three benefits based on the perceptions of the respondents are improved security (MS= 3.86; SD = 0.70), real-time monitoring of construction projects (MS= 3.85; SD = 0.59), and enhance projects management (MS= 3.83; SD = 0.80). The least of the factor is reduced costs of construction (MS= 2.84; SD = 0.97). The findings of the study agrees with the findings by Kim *et al*. (2022) that the use of CCTV camera improves securiyy on construction sites. Also Tian *et al.* (2024) reported from their research that CCTV camera improve real time monitoringof construction projects. The study support the findings by Scong *et al*. (2024), that the use of CCTV camera will enhanced the performance of construction projects.

Using the professional group of the respondents as the basis to test the convergence or divergence in the opinions of the respondents regarding the benefits of using CCTV camera on the execution of construction projects, it is evidence from the Kruskal Wallis test that the respondents had convergence views on ten (10) effects out of the sixteen (16) effects listed. Real-time monitoring (0.001**), curbing the menace of scavengers (0.000**), remote supervision (0.029*), better record-keeping (0.000**), improves project performance (0.005**), and work measurements (0.000**) were the six factors that the professionals (architects, builders and engineers) had divergent views on the effects of using CCTV cameras on the execution of construction projects. The implication of these is that there are significant differences in the opinions of the respondents (p value <0.05), pertaining to the six listed factors, form the professionals (architects, builders and engineers) respectively. All the listed sixteen factors recorded high mean scores with the least mean score of 2.835 and an average mean of 3.643. Therefore, all the benefits of using CCTV camera on the execution of construction projects in the study area are significant.

**Table 8: Benefits of Using CCTV Cameras for the Execution of Construction Projects**

| | Architect | | | Builder | | | Engineers | | | Overall | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Effects of Using CCTV Cameras on the Execution of Construction Projects** | **M** | **SD** | **Rk** | **M** | **SD** | **Rk** | **M** | **SD** | **Rk** | **M** | **SD** | **Rk** | **Asymp. Sig** |
| Improved security | 4.00 | 0.66 | 2 | 3.84 | 0.72 | 6 | 3.80 | 0.69 | 5 | 3.86 | 0.70 | 1 | 0.315 |
| Real-time monitoring | 4.07 | 0.54 | 1 | 3.84 | 0.52 | 4 | 3.73 | 0.66 | 7 | 3.85 | 0.59 | 2 | **0.001**** |
| Enhance projects management | 3.80 | 0.61 | 4 | 3.86 | 0.71 | 1 | 3.82 | 0.84 | 3 | 3.83 | 0.80 | 3 | 0.945 |
| Curbing the menace of scavengers | 3.46 | 0.77 | 12 | 3.77 | 0.78 | 8 | 3.99 | 0.69 | 1 | 3.79 | 0.77 | 4 | **0.000**** |
| Enhanced site surveys | 3.80 | 0.85 | 6 | 3.75 | 0.79 | 9 | 3.80 | 0.78 | 6 | 3.78 | 0.79 | 5 | 0.650 |
| Remote supervision | 3.82 | 0.50 | 3 | 3.84 | 0.67 | 5 | 3.59 | 0.71 | 13 | 3.74 | 0.67 | 6 | **0.029*** |
| Enhanced quality control | 3.57 | 0.81 | 8 | 3.74 | 0.87 | 10 | 3.80 | 0.68 | 4 | 3.73 | 0.79 | 7 | 0.229 |
| Reduced disputes | 3.49 | 0.83 | 11 | 3.85 | 0.80 | 3 | 3.65 | 0.83 | 8 | 3.70 | 0.83 | 8 | 0.130 |
| Remote sensing | 3.80 | 0.40 | 5 | 3.71 | 0.60 | 11 | 3.61 | 0.94 | 12 | 3.69 | 0.72 | 9 | 0.340 |
| Better record-keeping | 3.20 | 0.44 | 14 | 3.86 | 0.55 | 2 | 3.65 | 0.64 | 9 | 3.64 | 0.62 | 10 | **0.000**** |
| Improves project | 3.53 | 0.91 | 9 | 3.82 | 0.96 | 7 | 3.49 | 0.55 | 15 | 3.63 | 0.83 | 11 | **0.005**** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| performance | | | | | | | | | | | | |
| Compliance monitoring | 3.41 | 0.86 | 13 | 3.70 | 0.85 | 12 | 3.61 | 1.05 | 11 | 3.61 | 0.94 | 12 | 0.072 |
| Increased productivity | 3.51 | 0.50 | 10 | 3.50 | 0.65 | 14 | 3.62 | 0.64 | 10 | 3.55 | 0.62 | 13 | 0.245 |
| Improved safety | 3.59 | 0.74 | 7 | 3.53 | 0.70 | 13 | 3.53 | 0.90 | 14 | 3.54 | 0.79 | 14 | 0.825 |
| Work measurements | 3.18 | 0.65 | 15 | 3.39 | 0.69 | 15 | 3.85 | 0.89 | 2 | 3.52 | 0.81 | 15 | **0.000**** |
| Reduced costs | 2.92 | 1.09 | 16 | 2.83 | 1.07 | 16 | 2.80 | 0.78 | 16 | 2.84 | 0.97 | 16 | 0.435 |

b) Kruskal Wallis Test (Grouping Variance – professionals (Architects, Builders and Engineers) on effects of using CCTV Cameras for the execution of construction projects). ** Significant at the 0.01 level, *Significant at the 0.05 level. **Source: Author's work (2025)**

Table 9 presented the analysis of ANOVA (variance) regarding the benefits of using CCTV camera on the execution of construction projects. Table 12 indicates that the f-Statistics (3.72) is greater than the f-Critical (K = 3 groups and a total sample of N ≥ 30 = 3.35). The result indicates there is a significant difference between the opinions of the professionals (architects, builders and engineers) on the effects of using CCTV camera on the execution of construction projects. The implication of this is that the professionals (architects, builders and engineers) had divergent views regarding the effects of using CCTV camera on the execution of construction projects. Further test was carried out to ascertain the professionals (architects, builders and engineers) with the different view.

**Table 9: ANOVA of Benefits of Using CCTV Cameras on the Execution of Construction Projects.**

| Professionals | N | Mean | Std. deviation | Std. error | F | Sig |
|---|---|---|---|---|---|---|
| Architects | 33 | 3.57 | 0.70 | 0.49 | | |
| Builders | 44 | 3.68 | 0.74 | 0.67 | 3.72 | 0.03 |
| Engineers | 73 | 3.65 | 0.77 | 0.75 | | |

**Source: Author's work (2025)**

Table 10 shows the post hoc test carried out to further determines where the actual effect lies among the respondents based on their position as professionals (architects, builders and engineers) on construction projects. Using LSD Post hoc test, the analysis reveals that there is a significant difference between the pairs of architects and Engineers (p-value = 0.02) based on the perceptions of the respondents on the effects of using CCTV camera on the execution of construction projects. Therefore, the position of architects and engineers varies on the six listed items which are real-time monitoring (0.001**), curbing the menace of scavengers (0.000**), remote supervision (0.029*), better record-keeping (0.000**), improves project performance (0.005**), and work measurements (0.000**). The result shows that CCTV camera can be used by construction professionals to improve the performance of construction projects in Nigeria.

**Table 10: LSD Post hoc test of Effects of Using CCTV Cameras on the Execution of**

**Construction Projects.**

| Stakeholders | Test statistic | Std. error | Std. test statistic | Sig. | Adj. Sig. |
|---|---|---|---|---|---|
| Architects - Builders | 14.22 | 9.19 | 1.64 | .10 | .600 |
| Architects - Engineers | 30.45 | 11.19 | 3.62 | .00 | **.002** |
| Builders – Engineers | 35.45 | 11.07 | 2.29 | .02 | .075 |

*. The mean different is significant at the 0.05 level. **Source: Author's work (2025)**

Table 11 evaluated the skills and training needed to use CCTV cameras on construction projects in Lagos State. From the result in Table 14, the highest rated skill gap was observational skills (M = 3.93; SD = 0.81) ranked first; surveillance proficiency ranked second (M = 3.85; S.D = 0.83), and technical reporting (M = 3.84; SD = 0.81). On the contrary, analytical skills was rated the lowest with Mean of 3.29 and SD of 0.98 This indicates negligence as a less critical skills and training gap for the application of CCTV cameras on building construction projects compared to others. The findings of the study is in agreement with the result of Eze *et al.* (2024) and Aliu and Oke (2023) , that the Nigeria construction industry needs skilled and trained workers to improve their performance. Skills and training will enhance the use of CCTV camera for supervision of construction projects and reduce physical supervision by the professionals.

**Table 11**: **Evaluating Skills and Training Gaps Needed to use of CCTV Cameras on Construction Projects in Lagos State**

| Skills and Training | DF | Mean | Std. Deviation | T | Sig. (2-tailed) | rank |
|---|---|---|---|---|---|---|
| Observational skills | 167 | 3.93 | 0.81 | 62.76 | 0.000 | 1 |
| Surveillance proficiency | 167 | 3.85 | 0.83 | 60.33 | 0.000 | 2 |
| Concise technical reporting ability | 167 | 3.84 | 0.81 | 61.69 | 0.000 | 3 |
| Vigilance in monitoring multiple feeds simultaneously | 167 | 3.80 | 0.89 | 55.55 | 0.000 | 4 |
| Quick identification and resolution of technical issues | 167 | 3.73 | 0.74 | 65.28 | 0.000 | 5 |
| Ability of effective coordination with security agencies | 167 | 3.62 | 0.78 | 60.13 | 0.000 | 6 |
| Technical know-how | 167 | 3.61 | 0.81 | 57.59 | 0.000 | 7 |
| Privacy management | 167 | 3.59 | 0.97 | 47.73 | 0.000 | 8 |
| Communication skills | 167 | 3.53 | 0.88 | 51.88 | 0.000 | 9 |
| Understanding cameras system and operation | 167 | 3.43 | 1.08 | 41.11 | 0.000 | 10 |
| Accuracy in documenting observations and action taking | 167 | 3.42 | 1.11 | 39.85 | 0.000 | 11 |
| Specialized training | 167 | 3.36 | 1.09 | 39.95 | 0.000 | 12 |
| Online courses and workshops | 167 | 3.32 | 1.01 | 42.56 | 0.000 | 13 |
| Networking and connectivity issues | 167 | 3.31 | 1.03 | 41.80 | 0.000 | 14 |
| Analytical skills | 167 | 3.29 | 0.98 | 43.47 | 0.000 | 15 |

**Source: Author's work (2025)**

## 5.0 Conclusion and Recommendations

i. The result of the level of adoption of CCTV camera for construction application in Lagos are for security and crime prevention, monitoring public areas, business, and homes and for remote monitoring and surveillance. The level of awareness of CCTV camera construction application in Lagos are for security and crime prevention evidence of litigation, and proof for dispute resolution. The three positive gaps of level of adoption and awareness are for traffic monitoring and management, facial recognition and identification and monitoring of public areas, business, and homes. From the result of the study, there exist a significant relationship between the level of awareness and adoption of CCTV cameras for construction application in Lagos State. The level of adoption and awareness of CCTV for supervision is low in the study area.

ii. From the result of the study, the benefit of using CCTV camera in the execution of construction projects are for improved security, real-time monitoring of construction projects, and to enhance projects management. The benefit of using CCTV camera with divergence views from the result of the Kruskal Wallis test are for real-time monitoring, curbing the menace of scavengers, remote supervision, better record-keeping, improves project performance, and work measurements. The result of the ANOVA and LSD Post hoc test reveals that there is a significant difference between the pairs of Architects and Engineers six listed items from the Kruskal Wallis test. Most of the construction professionals examined are not aware of the benefits of using CCTV camera for supervision of construction projects.

iii. The major skills and training needed to use CCTV cameras on construction projects in Lagos are observational skills, surveillance proficiency, and technical reporting. From the result of the findings, there are still skilled and training gaps that should be filled before the adoption of CCTV camera for supervision of construction projects.

### 5.2 Recommendations

In view of the conclusions that were enumerated from this research, the following recommendations are proposed to enhance the usage of CCTV cameras in the execution of construction projects in Lagos State, Nigeria at large.

1 The level of adoption and awareness of CCTV for supervision of building construction projects in Lagos State should be encouraged.

2 Seminars and conferences should be

organized to promote awareness of the benefits of using CCTV camera for supervision of construction projects.

3 Skills and training gaps that will encourage the adoption of CCTV camera for supervision of construction projects should be carried out periodically in Lagos State, Nigeria and other developing countries.

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