CLOSE CIRCUIT TELEVISION CAMERA APPLICATIONS IN ABU DHABI UNITED ARAB EMIRATES: SURVEILLANCE SYSTEM EFFECTIVENESS ASSESSMENT

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ABSTRACT

Closed-circuit television (CCTV) cameras are intensively used in Abu Dhabi to maintain surveillance for ensuring law enforcement and helping with crime control at public places. However, there are challenges regarding CCTV cameras, such as limited knowledge of CCTV functioning and improper understanding of several stakeholders towards the maintenance of public safety. Therefore, the current study aimed to identify the factors that impact CCTV effectiveness in the United Arab Emirates (UAE). The study has two objectives. The first objective was to identify the factors related to CCTV effectiveness. The second objective aimed to investigate the impact of the identified factors on the effectiveness of the surveillance management system. This study used a case study from city surveillance management in Abu Dhabi. It surveyed 250 integrators that qualified to install CCTV across the city of Abu Dhabi with a valid response of 196. The findings showed that the three factors (Authority monitoring and control, Government CCTV standards, and CCTV integrators) have a significant impact on the effectiveness of the surveillance management system. The highest level of correlation was found between CCTV effectiveness and government CCTV standards. This can be understood by the notion that the role of Authority control and monitoring using CCTV shows that Abu Dhabi monitoring & control centre standard provides clear guidance to integrators. The finding confirmed that timely response from the Abu Dhabi monitoring & control centre for any technical clarification and the standards provided by the authority increases CCTV effectiveness. The study proposes a smart city surveillance system to electronically monitor the important cities in UAE and the entire nation.

ABSTRAK

Kamera litar tertutup (CCTV) digunakan secara meluas dalam pengawasan bandar untuk penguatkuasaan undang-undang dan mengamal jenayah di tempat awam di Abu Dhabi. Walau bagaimanapun, terdapat tiga cabaran utama dalam penggunaan CCTV seperti pengetahuan yang terhad dan ketidakfahaman pihak berkepentingan terhadap pengawalan keselamatan awam. Oleh itu, tujuan kajian ini ialah untuk mengenalpasati faktor-faktor yang mempengaruhi keberkesanan CCTV di United Arab Emirates (UAE). Kajian ini mempunyai dua objektif iaitu pertamanya ialah untuk mengenalpasti faktor-faktor yang mempengaruhi keberkesanan CCTV. Objektif kedua ialah ialah bagi mengenalpsati keberkesanan faktor tersebut kepada keberkesanan sistem pengurusan pengawasan awam. Kajian ini menggunakan kajian kes dari pengurusan pemantauan bandar di Abu Dhabi. Kajian ini menggunakan soal selidik kepada 250 kontraktor pemasangan CCTV di Abu Dhabi dengan 196 maklumbalas. Hasil empirikal menunjukkan bahawa tiga pemboleh ubah tidak bersandar iaitu penguasaan autoriti dan pemantauan, standard CCTV kerajaan, dan penyatuan CCTV) secara signifikan mempengaruhi Keberkesanan CCTV. Tahap korelasi tertinggi didapati antara keberkesanan CCTV dan standard CCTV kerajaan. Ini dapat difahami dengan anggapan bahawa pihak berkuasa menggunakan CCTV menunjukkan bahawa pusat pemantauan & kawalan CCTV Abu Dhabi memberikan panduan yang jelas kepada kontraktor pemasangan CCTV. Dapatan juga mengesahkan bahawa pihak pusat kawalan memberi respons yang tepat terhadap sebarang pengesahan teknikal dalam meningkatkan keberkesanan CCTV. Kajian ini mengesyorkan supaya pengawasan bandar secara eletronik dapat digunakan di bandar-bandar lain yang penting di United Arab Emirates dan seluruh negara.

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CHAPTER 1

INTRODUCTION

1.1 Background

The rapid development of IT has facilitated the use of Information and Communication Technology (ICT) to enhance Closed-Circuit Television (CCTV) (Mohanty *et al.*, 2016). The use of CCTV has been found in different areas like smart cities, education, health, security, and transportation. The effectiveness and efficiency of smart cities can be enhanced through the use of the Internet of Things (IoT) and the concept of Big Data (Treboux *et al.*, 2015; Alexandrie, 2017; Rawat & Ghafoor, 2018). Better surveillance is required at several places, which include areas hosting large events, accident- or crime-prone areas, areas with high congestion, among others. Moreover, CCTV installations may also be required for vehicular analysis and management at junctions, intersections, roundabouts, and alleys (Alexandrie, 2017).

Installation of CCTV cameras cannot be done unsystematically since several factors must be considered for effective CCTV implementation. A study conducted on the South Korean city of Gwang Myeong highlights the successful use of CCTV systems in reducing the crime rate, where armed robbery and theft decreased by 47.4%. Moreover, neighbouring cities also witnessed lesser criminal activities (Park, Kim, & Kang, 2018).

Surveillance systems play significant roles. They also contain useful visual information that can be used for different kinds of tasks, such as Traffic flow monitoring, Violence detection, Fire detection, Criminal and missing people recognition, Law enforcement, automatic number-plate recognition, and smart parking. Surveillance Systems applications can be divided into event-based activities recognition (decision made based on a series of frame sequences) and object detection

and classification (decision can be made base on one frame/image in any time of the given video) (Alexandrie, 2017; Rawat & Ghafoor, 2018; Park *et al.,* 2018).

A camera network is used for public surveillance systems along with devices that help record, transmit, and monitor images and videos (Ajenikoko *et al.,* 2020). Newer systems usually have a better image and video quality. Additionally, the latest systems may be equipped with zoom, pan, and tilt ability, in addition to night vision and colour recording.

A majority of the cameras keep track of a predetermined area and follow the set pattern. Such cameras could either be operated automatically using computer software or manually by security staff to pinpoint activities or areas requiring attention (Laufs *et al.,* 2020). Advanced systems have in-built audio functionality and may have motion-sensing capabilities to provide enhanced information regarding the monitored area, which includes recognising vehicle license numbers or detecting gunshots (Schoenherr, 2020).

This research aims to assess the effectiveness and need for surveillance systems in the context of civilian safety in developed countries like those in the United Arab Emirates. An extensive literature review has been conducted regarding the implementation of CCTV camera systems and their effectiveness. This research intends to address issues like inadequate IT infrastructure, inadequate security infrastructure, lack of expertise concerning security, and the roles of various stakeholders towards the enforcement of public safety. This research proposes that the United Arab Emirates, in its entirety, should be considered for electronic surveillance in the context of smart cities.

The CCTV is deepening on multiple criteria, which will affect the system effectiveness in any area. Several applications use CCTV systems, and there are several thousand closed-circuit television (CCTV) systems in operation across the streets and within business premises in Abu Dhabi.

The emirate has spent millions in the acquisition, installation, and maintenance of the CCTV system with the stated goal of public safety, asset protection, crime prevention and investigation, and road monitoring. The government urged all the establishments to install CCTV cameras. As of 2019, there are a lot of cameras installed in the whole region of Abu Dhabi. According to the rankings released by Comparitech on 15 August last year for the most-shrivelled city, Abu Dhabi, the UAE ranked at 12th placed – 20,000 cameras for 1,452,057 people = 13.77 cameras per

1,000 people. The visibility of CCTV cameras around Abu Dhabi have proven effects and impacts on public safety. The fear of being caught by camera surveillance inculcates a habit. Subsequently, the effectiveness of CCTV across the emirate has been established.

All of that has been achieved by specific precede created by the security regulator in Abu Dhabi ADMCC. All the three main elements of CCTV effectiveness work together to achieve the best use of CCTV. The government created the ADMCC in 2011, which created the MCC standard in 2014 and started the integrator registration and training in 2017.

1.2 Problem Statement

Countries primarily use CCTV surveillance to provide enhanced security and prevent crimes. There is a transition from previous generation analogue devices to network-linked high-definition digital CCTV systems. The need for integrated control is promoting the adoption of network-based CCTV setups (Schoenherr, 2020). Integrating CCTV systems with networks leads to several challenges if there is not authority control and monitoring since CCTVs provide active and real-time information to the police (Cayford, & Pieters, 2018; Shukla *et al.*, 2020). Therefore, the weakness of authority control and monitoring might not make CCTV that useful in enhancing the country's security.

Over time, additional police personnel are deployed to provide adequate security to citizens. However, the frequency of violent crimes and issues regarding law and order is increasing, thereby warranting the need for nationwide network-linked CCTV standards to ensure the protection of the citizens and keep them secure (Ashby, 2017). The evolution of the internet and associated technologies has led to surveillance evolving from detecting illegal trash dumping to facilitate public order, prevent crime, reduce illegal parking, and inappropriate vehicular stops, among other use cases. Even though there has been rapid installation and expansion of CCTV infrastructure, the lack of clear standards from governments and rapid rollout of standards lead to potential security challenges (Lawson, Rogerson & Barnacle, 2018).

Security, both internal and perimeter, is the most prominent feature of most correctional institutions. Efforts to provide security, both for the general public from the residents and for the residents from each other, have taken many forms, both

architectural and programmatic. Nevertheless, the weakness in CCTV integrators leads to weakness in the effectiveness of these technologies to enhance security, and this might be understood from the general dissatisfaction with the security surveillance effectiveness aspects of most institutions that currently exist (Badiora & Adebara, 2020). That is, one reflection of this basic dissatisfaction on the part of integrators is the burgeoning demand for security hardware to make up for the deficiencies in existing or even proposed institutions.

During the last few years, the UAE has seen very high population growth due to the prospering economy, which has attracted personnel having different cultural backgrounds and religious inclinations. The UAE had a population of 4.1 million in 2005, which grew to 9.8 million in 2020. Of these individuals, UAE natives are less than around a million. Abu Dhabi and Dubai are the cultural and financial hubs of the emirates. The population of the UAE has significant diversity, where only about 10% of the population is native, while the remaining comprises expatriates. Therefore, there is mounting pressure on the government to deploy surveillance to provide an appropriate response to threats and attacks in the interest of national security (Kajalo & Lindblom, 2011). Lack of IT security education among integrators that install CCTV in the UAE can be harmful. The government of the UAE has set up several programs to ensure safety in the country. Nevertheless, there are several challenges during the implementation of such programs since CCTV systems installed by the operators are prone to failure.

When the governments formulate policies regarding IT security, education has always been at the forefront; however, given that education pertaining to security is still inadequate, there is often a lack of proper understanding of such aspects, which ultimately translates to problems concerning the public and education policies. It must be mentioned that, in the context of the UAE, not all the emirates have set standards concerning security and surveillance systems. Dubai, Abu Dhabi, and Ras Al Khaimah have sophisticated security requirements and security systems, while other emirates are still in the developmental stages. Since policies may vary across different emirates, it is crucial for technology providers to understand the regulations set by the emirates. A majority of people are not fully aware of the regulations of CCTV systems and their functionality (Shrivastava, 2020). In this context, the UAE has several such projects waiting for approval since they do not comply with the existing regulations. In light of

the abovementioned, there is an urgent need to enhance security-specific knowledge in the country (Jang *et al.*, 2018).

Evidence for the efficacy of CCTV in reducing the problems mentioned above and crime levels, in general, is relatively scant. Results of existing studies are contradictory or show little or no reductive impact on crime (Kajalo & Lindblom, 2016). The most comprehensive study around the world to date (Renaud, Flowerday, English, & Volkamer, 2016) – examining 14 British CCTV systems was unable to find definitive proof that CCTV has any overall decreasing effect on crime. (Bonfanti, 2016) did uncover findings that suggest CCTV is of utility for some specific, directed purposes. Therefore, the current study will highlight the CCTV-related factors of CCTV authority control and monitoring, CCTV standards, and CCTV integrators to enhance CCTV utilisation in the UAE.

1.3 Research Questions

On the basis of the problem statement, several questions arise as follows:

1. What are the factors that contribute to CCTV effectiveness among integrators in Abu Dhabi?
2. What are the significant levels of CCTV effectiveness based on the identified factors?

1.4 Research Objectives

This study is being conducted with the main objective of evaluating the aspects that affect surveillance effectiveness provided by integrators in Abu Dhabi, UAE. The following objectives explicitly define the scope of the study:

3. To determine factors that contribute to CCTV effectiveness among integrators in Abu Dhabi.
4. To analyse the significant levels of CCTV effectiveness based on the identified factors.

1.5 Hypothesis of the Study

1. Hypothesis 1:

   H0: Authority Control and Monitoring has no effect on City Surveillance Management System Effectiveness.

   H1: Authority Control and Monitoring has a significant effect on City Surveillance Management System Effectiveness.

2. Hypothesis 2:

   H0: CCTV standards has no effect on City Surveillance Management System Effectiveness.

   H1: CCTV standard has a significant effect on City Surveillance Management System Effectiveness.

3. Hypothesis 3:

   H0: CCTV integrator competency has no effect on City Surveillance Management System Effectiveness.

   H1: CCTV integrator competency has a significant effect on City Surveillance Management System Effectiveness.

1.6 Significance of Study

Governments across the globe have recognised public safety among the top priorities, which refers to a nation's duty to provide adequate safety to its citizens, businesses, and organisations. Moreover, it is the responsibility of the government to maintain law and order to facilitate well-being in the country. The growing urban population provides increasing economic activity but also brings with it challenges concerning safety and security.

Violence and crime in cities create fear and lead to many challenges. The fundamentals of good governance should comprise strategies concerning public safety, which facilitate a reduction in crime and issues like insecurity.

Cities are leveraging integrated information and communications technology (ICT) to help solve problems with transportation, energy supply, social infrastructure, economic stability, physical infrastructure and security.

This study suggests the use of a smart city surveillance system for monitoring the entirety of the UAE. The proposed system comprises advanced technology and

superior experience to provide a tailored central management system. This system aims to use critical security indicators in an integrated manner to provide enhanced security. This study assesses the significance of such surveillance and the role of technology in maintaining security and safety in the UAE, which is a developed country.

1.7 Scope of the Study

The scope of the study in terms of the topic is limited to evaluating the elements that have an effect on surveillance effectiveness provided by integrators. The focus is on three variables: authority control and monitoring; CCTV standard; and CCTV integrator competency, which excludes other variables from the study. In terms of the participants of the study, the sample is limited to the individuals serving as CCTV integrators in the capital of the UAE, Abu Dhabi, which excludes other employees. In terms of the context of the study, it is limited to Abu Dhabi, UAE, which excludes other cities in the UAE.

1.8 Research Methodology

The current study employed the quantitative approach since it allows the researcher to collect data from a large number of samples. The participants in the current research are 250 individuals who serve as CCTV integrators in the capital city, Abu Dhabi. The researcher designed the survey based on past literature, and then data was collected from the participants. The analysis of the data was through the Statistical Package of Social Sciences (SPSS). First, the researcher used SPSS for data screening before the analysis of the findings of each research objective. To achieve the first research objective, the researcher used descriptive analysis through means. For the second research objective, which has three sub-objectives, the researcher used ANOVA to test the significant relationship between independent variables (authority control and monitoring, CCTV standards, CCTV integrator) and the dependent variable (management system effectiveness). A summary of the methodology and data analysis is shown in Table 1.1. below.

1.1: Summary of research methodology

Research Objectives	Instrument	Data Analysis
To determine factors that contribute to CCTV effectiveness among integrators in Abu Dhabi.	Past literature + survey	SPSS using descriptive analysis
To analyse the significant levels of CCTV effectiveness based on the identified factors. a. To identify the effect of authority control and monitoring on city surveillance management system effectiveness. b. To examine the effect of CCTV standards on city surveillance management system effectiveness. c. To analyse the effect of CCTV integrator on city surveillance management system effectiveness.	Survey	SPSS using ANOVA

1.9 Thesis Format

This thesis has five chapters. The first chapter is the introduction chapter that provides the background of the study along with the statement of the problem, study questions, study objectives, study hypotheses, the significance of the study, and the scope of the study. The second chapter is the literature review chapter that reviews the main terms of the study in the context of past literature. The discussion in this chapter included the development of surveillance technology, CCTV categories, CCTV components, CCTV design, CCTV usage, CCTV law and standard, and hypothesis development. The third chapter presents the research methodology that is followed to achieve the study objectives, such as research design, research sample, research instrument, data collection, and data analysis. The fourth chapter is the findings of the study to answer the research objectives. The last chapter is chapter five, which presents an overview of the study objectives and findings under different sub-headings, namely authority control and monitoring, government CCTV standards, CCTV integrators, and CCTV

effectiveness. This chapter ends with research limitations, research recommendations, and the conclusion of the study.

1.10 Summary

This chapter presents the introduction and background of the thesis, followed by the statement of the problem that motivates carrying out this thesis. Also, this chapter provided the research questions and research objectives formulated based on the discussion in the problem statement. The research hypotheses are also presented in this chapter based on the study's research objectives and research questions. This chapter also presented the significance of the study and thesis format that is composed of five chapters.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Public safety has emerged as an important function for governments across the world. It refers to the duty and function of the state to ensure the safety of its citizens, organizations, and institutions against threats to their well-being as well as the traditional functions of law and order. There is a widespread and growing use of closed-circuit television (CCTV) cameras by law enforcement officials to identify and control crime in public places. This has led to a rather intensive debate about CCTV cameras and surveillance strategies centring on the unease in the community concerning their effectiveness.

Surveillance has been described as a set of management tools or as a concept by numerous criminologists, sociologists, and people from other disciplines. Norris and Armstrong (1999) describe surveillance as an "elementary building block of all human societies, a form of power," which represents the advances in technology. Surveillance could be categorised into private and public forms. Among the widely used forms of surveillance is video, which is captured and monitor using closed-circuit television (CCTV) systems.

Video surveillance makes use of cameras that may be installed by the authorities at public places to prevent crime or help with prosecution. Video surveillance has several use cases, where the first uses were to manage accidents, traffic, fire, and crime, among others (Hempel, & Töpfer, 2002). A typical system comprises several video cameras linked via closed circuits, which provide live feeds and images that are monitored centrally using television sets inside control rooms. Lyon (2007) suggests that surveillance may comprise monitoring from a distance using

equipment like CCTV cameras or intercepting electronic traffic such as phone calls or internet packets. Moreover, there might not be a need for sophisticated technology or technology at all for that matter. Interception of posts and the use of human intelligence are some such methods (Kille & Maximino, 2014).

Governments employ surveillance to gather intelligence, protect citizens or objects, prevent criminal acts, and investigate crime. Ironically, it is also used by criminals to commit criminal acts like kidnapping and robbery. Additionally, businesses use surveillance to gather intelligence, while private investigators also use the same. In today's world, technology is everywhere but how technology management contributes to the safety of the public. To have a comprehensive understanding of the idea, the fundamentals must be understood. Technology management refers to organised processes used by businesses to manage technology to be competitively better placed in the market.

The technology management function allows an organisation to grasp how technology is essential. Continuous technological advancement is useful only if it generates customer value. Hence, the technology management function should provide organisations with guidance on the right time to invest in technology and the time to redact funding.

Roberts (2004) suggests that primitive video surveillance comprised continuous monitoring since the recording and saving of information were challenging. According to Hoinville (2013), reel media facilitated surveillance videos to be recorded. Such systems used magnetic tapes that were required to be manually threaded, thereby leading to an expensive and time-consuming process. The process required the operator to manually load the used video from the tape recorder to a take-up reel.

These limitations prevented the widespread adoption of video surveillance. It wasn't until the 1970s that video surveillance started becoming common. The VCR provided an easy way to record and erase data. Digital multiplexing was developed in the 1990s, thereby facilitating the recording of several streams simultaneously and the ability to have features like the motion-only and time-lapse recording. Such features decreased costs and brought about additional time savings, leading to higher CCTV adoption.

2.2 Population in the UAE

The Economist Intelligence Unit (2017) report suggests that the urban population exceeds the rural population. Moreover, this migration is set to continue as cities offer better employment, improved living standards and financial prosperity. As per the government websites of the UAE, the nation has a majority of expatriates. The government intends to bring demographic equality by balancing the mix of expatriates and natives by the year 2021. The UAE saw rapid population growth during the last few years due to the noteworthy prosperity in several economic sectors, leading to an influx of personnel belonging to different cultures and having different religious backgrounds. The population of the UAE more than doubled from 4.1 million in 2005 to 8.3 million by year-end 2010. Of these individuals, the native Emirati population is less than one million (947,947).

As per the World Bank and The Department of Census and Statistics (United Nations), in 2014, the population of the UAE was approximately 9 million; expatriates still formed the majority. According to the Statistics Centre, population statistics indicate that Abu Dhabi had about 2.6 million residents, while the number was 2.3 million for Dubai as per the data provided by the Dubai Statistics Centre.

The government of the UAE intends to create a better demographic balance in the context of the expatriates and the natives. In this regard, the President of the UAE, H. H. Sheikh Khalifa bin Zayed Al Nahyan, declared the year 2008 as the "year of national identity." Consequently, in this era of globalisation, the UAE began activities towards retaining the nation's identity. Population statistics of Abu Dhabi are shown in Table 2.1 and Figure 2.1.

Table 2.1: Population Statistics for Abu Dhabi (as of 2021)

Population					
Key Figures					
Indicator	2017	2018	2019	2020	2021
Total Population estimate – Emirate of Abu Dhabi	1,343,353	1,419,699	1,452,057	1,482,816	1,511,768
Population growth rate – Emirate of Abu Dhabi	5.68%	5.68%	2.28%	2.12%	1.95%
Population density estimate – Emirate of Abu Dhabi	72,241	76,346	32,358	30,759	28,952

Source: (www.Worldometers.info)

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