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Empirical Investigation of CCTV Surveillance System Effectiveness in Crime Prevention in The United Arab Emirates Public Agencies

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Abstract

This study examines the factors that influence CCTV surveillance system effectiveness in crime prevention in UAE region and among public agencies. With the advent of technology and the possible outcomes that can be gained from such CCTV system implementation in many countries have triggered much attention to be further investigated. Furthermore, this study also examines the impact of, location, institutional framework, social value, policy, centralized monitoring system, technical capacity, authority control, and privacy. This study uses an integrated model in order to examine the impact of those factors of CCTV system effectiveness, and subsequently the impact on the crime prevention. This study used a mixed method in order to achieve the objectives of this study for the quantitative method was mainly random sampling from city surveillance management in Abu Dhabi and surveyed to 480 integrators that qualified to install CCTV across city of Abu Dhabi with valid responses of 428. Data was collected and the statistical analysis and interview were carried out in order to analyze the relationship formed in the framework. SmartPLS was used in order to interpret and explain the relations among the selected factors and also test the hypotheses. Empirical results derived from the survey bring to notice that the selected variables were significantly correlated and impact towards more effective use of the CCTV system. The respondents confirmed that timely response from Abu Dhabi monitoring & Control Center for any technical clarification and the standards provided by the authority increases CCTV effectiveness.

Keywords: *CCTV, Crime Prevention, System Effectiveness, Public Agencies.*

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Introduction

CCTV system surveillance has dominated most industries and publics and has shown significant contribution to most countries in security control, crime prevention and public safety, (Albayan, 2017). Moreover, social media allows more effective communications and enables more effective marketing, (Taylor-Wessing, 2014). Countries nowadays can more effectively protect and secure the public throughout an effective implementation of CCTV system surveillance. Valid evidences from the literature have shown that CCTV systems can be such useful tools to authorities and many industries if operations carried out correctly and effectively, (Lim et al., 2016). Prior studies have considered the factors influence the implementation of CCTV system and also the type of CCTVs, (Qureshi, 2013). This article focuses on those dimensions combined along with the

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effectiveness of CCTV system in crime prevention, (Taylor-Wessing, 2014). Furthermore, this study has considered the the public agencies in the UAE region as population of this study as they contribute to the public safety. Hence, this study examines the factors impact the effectiveness of CCTV system surveillance in the context of UAE. Factors were selected based on critical review of relevant literatures, namely: location, institutional framework, social value, policy, centralized monitoring system, technical capacity, authority control, and privacy.

Literature Review and Theoretical Framework

In last 10 years the United Arab Emirates tends to increase the deployed of surveillance camera which helping in assuring Security and safety procedures and tracking any criminal events everywhere and anytime. In Dubai only there are about 30,000 and about 3000 of them located only in airport (Hilotin, 2013). Also, Abu Dhabi interested in deployed the surveillance camera which expressed in the Safety and Security Planning Manual (SSPM) in its 2030 vision (Vision 2030, 2017). There is legislative framework regarding the surveillance camera which regulated by law,a law no 24 of 2008 have obligated the public and private sectors in Dubai, especially the commercial zones to installed a surveillance camera and it provides guidelines for service providers and users in how and when the surveillance camera will be setting (Taylor-Wessing, 2014).For expanding the domain of security and safety to include the residential units and towers, another new law No.10 of 2014 was issued to amend the provision of pervious one no 24 of 2008, which permit owner of those building to install a surveillance camera through allowance period of 3 months (Siassios, and Tamimi, 2014). The increasing demand for buying surveillance camera, in the same time there is a unified law covers the standard of surveillance camera, resulted in a large market for selling unregulated and substandard surveillance camera system equipment, (Al-Shanaq, A. 2015). Although, Telecommunications Regulatory Authority (TRA), is the only agency which give the approval for any telephone, mobile or smart phone to be sold in the UAE market, there is no approval procedures in the term of surveillance camera (Hilotin, 2014). There are many factors should be considered when installing the surveillance system and gain enormous benefits, factors such as the proper location, institutional framework, social value, policy, centralized monitoring system, technical capacity, authority control, and privacy to be more assistance for operators and law enforcement agencies. The following sections will consequently explain these factors and the formulated hypotheses.

Location

One of the most important factors to the effectiveness of CCTV system surveillance is the location of the cameras and where its placed at. It plays an important role in the surveillance process, (Awang, Z. 2012). The cameras must capture as much as possibly can and cover big range of the public areas. In fact, it changes the behaviors of criminals and law offenders. Placement of CCTV cameras must be well distributed and installed to the city, (Ekblom et al, 2013). The geographical location of CCTV cameras is a critical factor which determines the success of the system purposes and therefore provide safer environment. Consequently, the following hypothesis was formulated in order to measure the impact of location on the effectiveness of CCTV system as follows:

Hypothesis 1: *It is hypothesized that location impacts the CCTV effectiveness through a causal and statistical relationship.*

Institutional Framework

The role of institutional framework in the CCTV system installation and operation is crucial and considered as a key role to the success of the system. The authorities and the public agencies must standardize their operational framework and features of the CCTV cameras, (Grivna et al, 2012). The standardized installation of cameras must include the policies, budget, privacy and locations of cameras in order to ensure more effective operations and control. Furthermore, the standardized mechanism of

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handling situations is highly required in the CCTV system surveillance, there should be protocols of these systems to be followed all across the region, those protocols include accessibility and control, (Haggerty, K. D., & Samaras, M. 2010). Therefore, institutional framework plays a significant role in the CCTV system effectiveness in the crime prevention. Consequently, the following hypothesis was formulated in order to measure the impact of institutional framework on the CCTV system effectiveness as follows:

Hypothesis 2: *It is hypothesized that institutional framework impacts the CCTV effectiveness through a causal and statistical relationship.*

Social Value

Social value refers to the norms and values that the community carries for the CCTV system surveillance and to what extent they value and accept those systems. The degree of the awareness and values the community gives will significantly impact on the system effectiveness as outcomes, (Haggerty et al, 2011). Community plays the key role in the installation and operation process. The acceptance of community in general somewhat a reflection and therefore can change the behaviour of people, (Han et al, 2015). Social value can also impact on the number of offences in communities, as a results of CCTV cameras people can change their attitude in handling situations as long as they value these systems and believe that their actions have been captured and shall be reviewed by authorities. Hence, the following hypothesis was formulated in order to understand the impact of social value on the CCTV system effectiveness as follows:

Hypothesis 3: *It is hypothesized that social value impacts the CCTV effectiveness through a causal and statistical relationship.*

Policy

Policy in the CCTV system can either encourage or discourage authorities and public agencies in deciding of the implementation process and as results will impact on the system effectiveness in crime prevention and security control of the region, (Kim et al, 2016). The policy plays an important role in the operation and recording process. Organizations need to follow the declared surveillance policy as an accordance of the authorities. Furthermore, a clear statement or policy from the public authority will result in a systematic operation taking into considerations the publics' privacy and safety, (Makin et al, 2016). Therefore, it's the public authority responsibility to provide clear guidance and funding of those CCTV systems. Consequently, the following hypothesis is formulated in order to explain the role of policy in the CCTV system effectiveness as follows:

Hypothesis 4: *It is hypothesized that policy impacts the CCTV effectiveness through a causal and statistical relationship.*

Centralized Monitoring System

The centralized monitoring system refers to effective monitor using integrated centralized systems where all operators are dedicated in the surveillance. The Controlling room of the public should be located at all authorities and public agencies (police stations), (Piza, E. L. 2016). Centralized monitoring system should also be supported with authority response and directives in order to take needed actions of certain situations in the city. Therefore, the centralized monitoring system plays a key role in the CCTV system effectiveness in crime prevention as long as it gets the public authority support and prompt actions accordingly, (Simonato, M. 2014). Consequently, the following hypothesis was formulated in order to explain the role of centralized monitoring system on CCTV system effectiveness in crime prevention as follows:

Hypothesis 5: *It is hypothesized that centralized monitoring system impacts the CCTV effectiveness through a causal and statistical relationship.*

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Technical Capacity

The availability of technical capacity plays a key role of successful implementation of CCTV systems and can lead to more effectiveness of CCTV cameras in crime preventions. The CCTV system should have the ability to record and capture day to day interaction of the public and digitize it into the systems, (Stutzer et al, 2013). Therefore, those systems must contain the huge number of records and videos captured and make use of it to better controlled and secured environment. The technical capacity of CCTV cameras represented in the speed, memory, clarity of images, and digitizing content, (Taylor, E. 2012.) . Hence the authority should play a critical role in advancing those cameras and further enable them for better surveillance. Consequently, the following hypothesis tries to explain the impact of technical capacity on CCTV system effectiveness as follows:

Hypothesis 6: *It is hypothesized that technical capacity impacts the CCTV effectiveness through a causal and statistical relationship.*

Authority Control

The CCTV cameras with no doubt play an important role to prevent crimes and provide safer living in many countries. However, the role of authority in the effectiveness of CCTV systems is crucial and to the success and effectiveness of CCTV cameras in many regions. Authorities must be able to control these cameras in terms of specifications, features, locations, and privacy of the public, (Trimek, J. 2016). As results, this makes it possible to control the overall law offences and prevent crimes happening in the country. Thus, authority must follow a strategy in controlling the CCTV cameras in city/region which can enhance the safety of public, (Chileshe et al, 2016). Authority control can also be seen in the allocation of resources for more effective operations. Consequently, the following hypothesis is formulated to explain the impact of authority control on the CCTV system effectiveness as follows:

Hypothesis 7: *It is hypothesized that authority control impacts the CCTV effectiveness through a causal and statistical relationship.*

Privacy

Privacy refers to the degree of security of data and public information that has been captured and revealed to different parties. One of the key determinants of CCTV system effectiveness is the privacy of which people feel that their images and videos will not be misused the otherwise, (Creswell, J. 2014). The public expect their data and information are in safe hand and used prospectively in certain situations. Therefore, privacy is an important component to the CCTV systems effectiveness, (Cumming et al, 2015). Hence if the public feels that their images and videos are protected the will accept and encourage further installation of cameras of the area. Consequently, the following hypothesis tries to explain the impact of privacy on CCTV system effectiveness in crime prevention as follows:

Hypothesis 8: *It is hypothesized that privacy impacts the CCTV effectiveness through a causal and statistical relationship.*

CCTV Standards Installation

Standard installation of Closed Circuit Television Camera (CCTV) is important for crime prevention and security. The standard design of CCTV could operate effectively at country level to collect images, which are transferred to a monitor- recording device, where they are available to be watched, reviewed and stored. It is a situational measure that enables an area to be kept under surveillance remotely. This makes it possible for the police, and other law and regulatory agencies such as private security, to respond to incidents when alerted, and to have information about what to look for when they arrive. The storing of images facilitates post incident analysis to an investigation. . Therefore, the following hypothesis was developed in order to measure the CCTV standard installation impact on the CCTV system effectiveness as follows:

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Hypothesis 9: *It is hypothesized that CCTV standard installation impacts the CCTV effectiveness through a causal and statistical relationship.*

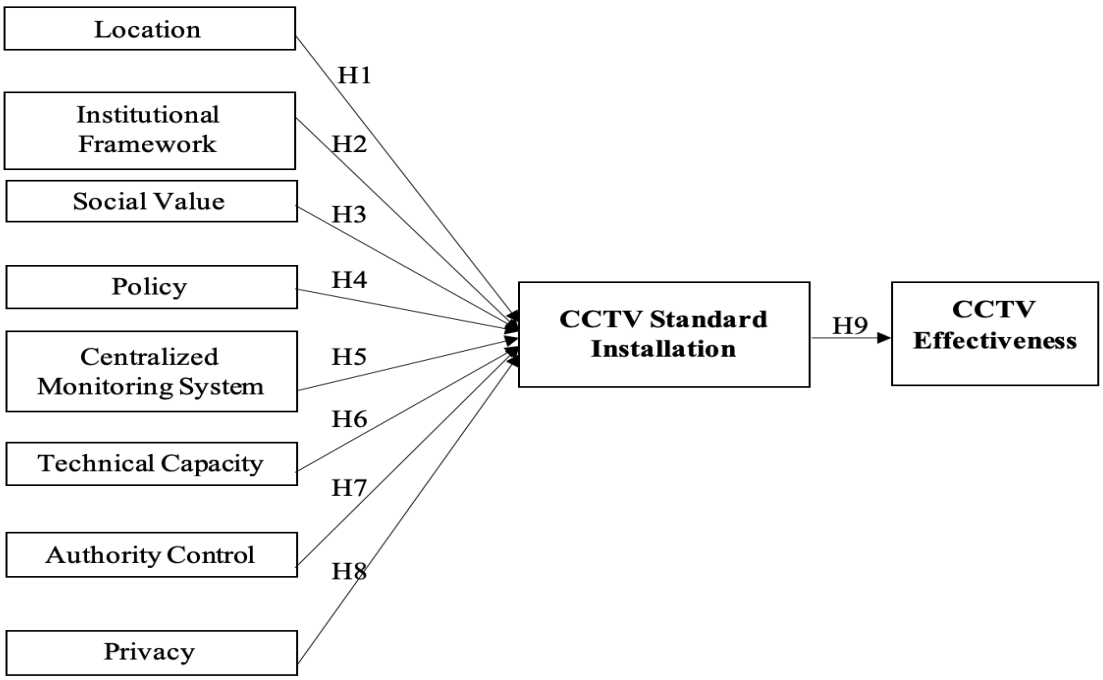

Figure 1: Conceptual Framework of CCTV system Effectiveness

Methodology

This study used a mixed method in order to achieve the objectives of this study for the quantitative method was mainly random sampling from city surveillance management in Abu Dhabi and surveyed to 480 integrators that qualified to install CCTV across city of Abu Dhabi with valid responses of 428. Data was collected and the statistical analysis and interview were carried out in order to analyze the relationship formed in the framework. SmartPLS 3. was used in order to interpret and explain the relations among the selected factors and also test the hypotheses. Moreover, this study conducted interview with 20 interviewees. The analysis of the qualitative data obtained from the interview conducted with twenty (20) participants. The purpose of the interview is to capture the necessary information that is required towards answering the main research question on the CCTV system effectiveness in crime prevention as well as highlighting the influential factors from practitioners' point of view. Averagely, the duration of the interview lasted for 30 minutes. The interview session was recorded using digital recording device with the permission of the interviewee.

Sampling

The targeted population of this study are public agencies all across Abu Dhabi who has installed CCTV system surveillance as a protective tools in their daily activities. The selected organizations were well profiled. This study targeted population who have CCTV systems applications and tools with total respondents of 480. The survey was carried out online using google forms in order to cover and obtain much possible of responses form the targeted respondents. The survey was held over three months in a row. However, invitations were given twice during the period of those three months in order to obtain sufficient number of responses, (Harris et al, 2010). The study targeted 480 at the first attempt, however with data cleaning and filtering the researchers were

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able to obtain 428 which were valid and usable to fulfil the purpose of the study. The data validity and reliability were applied and achieved in this study. Proper five point scaling Likert was applied to the questionnaire so that the respondents can be able to answer to the different subjects provided. The respondents demographics were analyzed and reported in table 1 below. The table shows the number of respondents from different organizations location, The survey was held over four months in a row. However, invitations were given twice during the period of those three months in order to obtain sufficient number of responses, (Soper, D. 2016).The questionnaire was distributed to understand the CCTV system effectiveness in crime prevention in the UAE region. The questionnaires were developed based on the selected factors namely: location, institutional framework, social value, policy, centralized monitoring system, technical capacity, authority control, and privacy. The data validity and reliability were applied and achieved in this study. The characteristics of the targeted organizations were well profiled and explained as shown in table 1 below.

Table 1: Respondents' Demographic Information

CHARACTERISTICS	ITEM	FREQUENCY	PERCENT
Gender	Male	270	63.03%
	Female	158	36.03%
Age	25 – 30	58	13.55%
	31 – 35	107	25%
	36 – 40	113	26.40%
	41 – 45	51	11.91%
	46 – 50	62	14.48%
	>50	37	8.64%
Highest Level Of Education	Bachelor	214	50%
	Master	137	32%
	PhD	77	17.99%
I Am Working As	Senior manager	80	26.8%
	IT director	36	12.08%
	Sales director	60	20.13%
	Security Director	73	24.49%
	COE	49	16.44%
Total Number Of Employees	300 - 400	112	37.58%
	400 - 500	76	25.50%
	500 - 600	39	13.08%
	600 – 700	30	10.06%
	>700	41	13.75%
Nature Of Your Business	Private	285	95.63%
	Public	13	4.36%
Do You Use Cctv Cameras In Your Organization?	Yes	252	84.56%
	No	46	15.43%

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How Many Years?	2	8	2.68%
	3	15	5.03%
	4	11	3.69%
	5	72	24.16%
	> 5	192	64.41%
Purpose Of Using Cctv?	Monitoring	63	21.14%
	Safety	50	16.77%
	Security	75	25.16%
	Public safety	52	17.44%
	Others	58	19.46%
What Are The Challenges Of Implementing Cctv Cameras?	Lack of budget	79	26.51%
	Technological issues	28	9.39%
	Lack of training	98	32.88%
	Lack of skills	66	22.14%
	Technical challenges	10	3.35%
	Others,	17	5.70%

Measurement Model

This study uses the Partial Least Square (PLS) technique to analyze data by using SmartPLS 3.0 software for validating measurements and testing the hypothesis. The evaluation of the measurement model is based on the assessment of internal consistency (composite reliability), indicator reliability (outer loadings), convergent validity (average variance extracted (AVE)) and discriminant validity, (Hair et al., 2010). In order to retain an item in the measurement model, it must have significant outer loadings. The indicator outer loadings should be higher than 0.708. The measurement models of the study and the factor loadings (outer loadings) of the constructs were acceptable as showing in table 2 below. In this study, constructs such as relative advantage, interactivity, privacy, cost effectiveness were validated and considered reliable as per the results demonstrated. The values of composite reliability and AVE to test the reliability and validity of the constructs are reported in Table 2. Results of the study revealed that the values of the composite reliability are 0.6 and AVE is greater than 0.5 for all the constructs, thus construct reliability and convergent validity is achieved. The next evaluation criterion for reflective models is to check for discriminant validity. The results of Fornell-Larcker criterion showed that the square root of AVE for the constructs is greater than other inter-constructs' correlation value. Therefore, discriminant validity is achieved as shown in table 3 below.

Table 2: Summary of Internal Consistency and indicator reliability test

Construct	**Cronbach 's Alpha**	**Composite reliability**	**Items**	**Outer Loading**
	>0.6	**>0.7**		**≥0.7**
			Loc1	**0.897**

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Location	**0.884**	**0.920**	Loc2	**0.869**
			Loc3	**0.870**
			Loc4	**0.808**
Institutional Framework	**0.870**	**0.906**	InsF1	**0.787**
			InsF2	**0.823**
			InsF3	**0.857**
			InsF4	**0.813**
			InsF5	**0.774**
Policy	**0.909**	**0.933**	Po1	**0.767**
			Po2	**0.854**
			Po3	**0.873**
			Po4	**0.877**
			Po5	**0.910**
Social Value	**0.924**	**0.946**	SV1	**0.928**
			SV2	**0.921**
			SV3	**0.915**
			SV4	**0.843**
Centralized Monitoring System	**0.854**	**0.902**	CMS1	**0.837**
			CMS2	**0.883**
			CMS3	**0.776**
			CMS4	**0.839**
Technical Capacity	**0.906**	**0.934**	TC1	**0.902**
			TC2	**0.886**
			TC3	**0.887**
			TC4	**0.860**
Authority Control	**0.732**	**0.849**	AC1	**0.846**
			AC2	**0.725**
			AC3	**0.847**
Privacy	**0.911**	**0.937**	PRI1	**0.882**
			PRI2	**0.898**
			PRI3	**0.911**
			PRI4	**0.860**
Standard Installation	**0.836**	**0.891**	SI1	**0.846**
			SI2	**0.746**
			SI3	**0.798**
			SI4	**0.884**
CCTV Effectiveness	**0.909**	**0.936**	EFF1	**0.889**
			EFF2	**0.907**
			EFF3	**0.870**
			EFF4	**0.880**

Table 3: Discriminant validity by Fornell-Larcker Criterion Matrix

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	AC	CMS	Eff	InsF	Loc	PRI	Po	SI	SV	TC
AC	0.808									
CMS	0.341	0.835								
Eff	0.580	0.408	0.887							
InsF	0.527	0.330	0.468	0.811						
Loc	0.338	0.324	0.271	0.321	0.861					
PRI	0.471	0.262	0.445	0.324	0.254	0.888				
Po	0.500	0.282	0.505	0.448	0.236	0.358	0.858			
SI	0.742	0.498	0.738	0.652	0.463	0.559	0.644	0.820		
SV	0.147	0.127	0.065	0.084	0.085	0.094	0.078	0.135	0.902	
TC	0.370	0.248	0.366	0.344	0.298	0.234	0.320	0.505	0.044	0.884

Table 4: Results of the structural model path coefficient

Path	Path coefficient (β)	Standard Deviation	*t*-values statistics	*p*-value
Loc -> SI_	0.109	0.023	5.054***	**0.000**
InsF_ -> SI_	0.203	0.030	6.747***	**0.000**
Po -> SI_	0.230	0.034	6.746***	**0.000**
SV -> SI_	0.005	0.021	0.262	**0.793**
CMS -> SI_	0.149	0.025	5.943***	**0.000**
TC -> SI_	0.141	0.028	5.054***	**0.000**
AC -> SI_	0.298	0.032	9.394***	**0.000**
PRI -> SI_	0.171	0.026	6.560***	**0.000**
SI_ -> Eff_	0.738	0.022	33.804***	**0.000**

Critical t-values for two-tailed test: * >2.57

Therefore, in order to test the significance of the hypothesized relationship, bootstrapping was applied which provides the t-value that indicates whether the corresponding path coefficient is significantly different from zero (Hair et al., 2006). In this study, in order to ensure that the path coefficients are significant, t values were assessed. These were obtained by means of bootstrapping. Further, t values were calculated SmartPLS V 3.0. Figure 2. below describes the significance of path coefficient between constructs in the model used for this study as reported by SmartPLS v 3.0.

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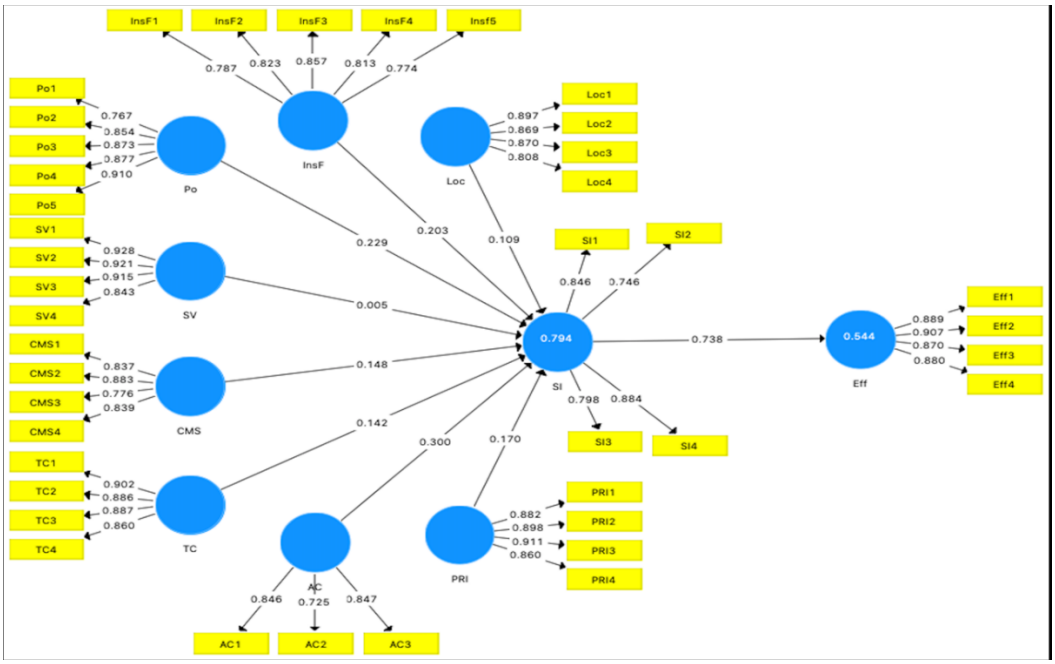

Figure 2: Path Coefficient

Interview Findings

Consideration before implementing public surveillance system

One of the research questions targets at understanding the various considerations that should be in place before public surveillance system is implemented. The rationale behind the question is to tap into the interviewees' reality of the necessary factors that needs to be considered when implementing surveillance system in public buildings. Figure 3. below shows the themes and sub-themes that emerged from the analysis of the interview data.

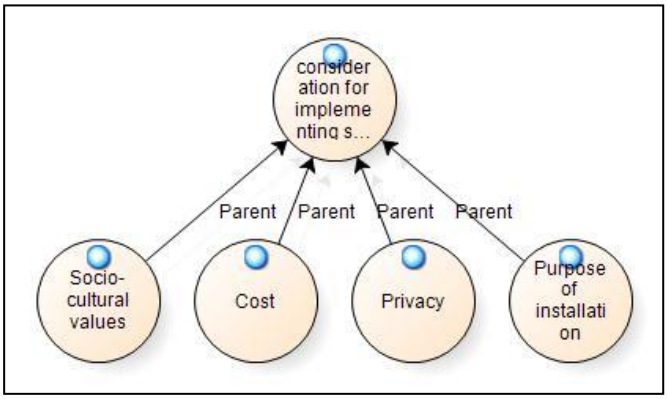

Figure 3: Factors to be considered before implementing public surveillance system

Best surveillance camera systems for public agencies

Another finding from the interview is aimed at uncovering the best camera system for public agencies in the study area. The analysis of the interview data is presented in Figure 4. below:

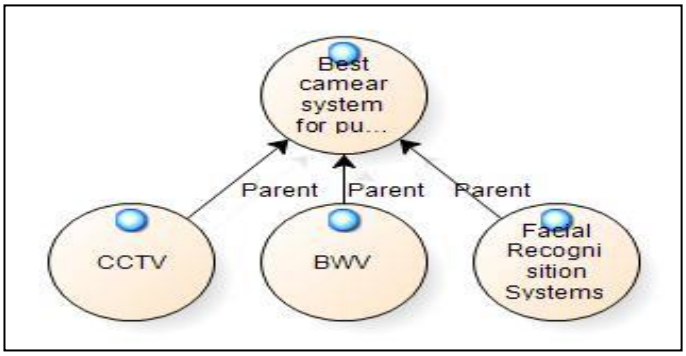

Figure 4: Best surveillance Camera System in Public Building

Technologies that Integrate Well with a Public Surveillance System (PSS)

The opinion of the interview participants was sought to understand the best technologies that can integrate well with the public surveillance system. The analysis of their response is presented in this section. Figure 5. below shows the emergent sub-themes where three key technologies are identified, namely: artificial

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intelligence (AI), Big Data/Internet of Things and cloud-based storage.

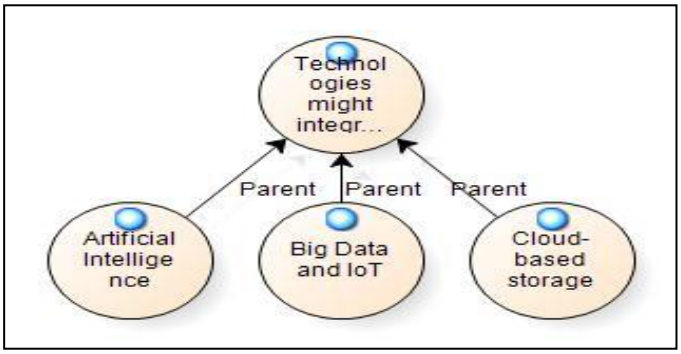

Figure 5: Best technologies to integrate with PSS

Discussion

Authority control has shown a significant impact on CCTV system effectiveness in crime prevention among UAE public agencies. Moreover, policy has second significant positive relationship on the CCTV system effectiveness. Which means the clearer policy to these systems the higher effectiveness of CCTV systems in UAE context. Policy is an important element to be designed and integrated into CCTV system installation tools. Another significant fact is that privacy seemed to play a vital role towards more effective installation in crime prevention context. Based on the findings institutional framework can with no doubt effect the CCTV system effectiveness in crime prevention and should be considered into integration into the CCTV system installation, operations, and monitoring. From the public agencies' point of view CCTV cameras have to be well maintained and controlled. Public agencies concern is with the private information and data on these systems to be misused or tampered with others. Nevertheless, the study has supported the integrated factors namely, location, institutional framework, social value, policy, centralized monitoring system, technical capacity, authority control, and privacy. The significant findings of this study show that all relationships were supported.

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