Covenant Journal of Research in the Built Environment (CJRBE) Vol. 5, No. 1, June 2017

An Open Access Journal available online

Crime Management on Construction Site: A Study of Ogun State, Nigeria

***Uche Emmanuel Edike and Ayeni Babatunde**

*Department of Building Technology,
Bells University of Technology, Ota, Ogun State, Nigeria
Email: edikeuche@yahoo.com

***Abstract*:** Crime impacts the success of a project and diminishes the potential profitability of a project under construction and it is a considerable problem in the construction industry. In view to improving construction site security management practices and mitigating security threats on construction site, the study assesses the crime management practices on construction site. A survey of 122 purposively sampled stakeholders resulted in 93 valid structured questionnaires comprising 52 contractors and 41 consultants. Data were analysed using mean score and Man-Whitney U test through IBM Statistical Package for Social Sciences (SPSS) version 20. The study found that the most commonly used construction site security management components are inventory of tools, materials and equipment with mean scores of 4.58, 4.53 and 4.49 respectively. The use of security tools such as CCTV and alarms systems as site security management practice is the least practice adopted with Mean Score of 1.33. The perceptions of contractors and consultants on the application of crime management components on construction site are the same. Construction site security model is proposed in the study and considered essential for setting up construction site, inspecting ongoing projects, and investigating crime on the event of any occurrence.

Keywords: construction site, security, crime, management practices, internal stakeholders, Nigeria

Introduction

Crime impacts the success of a project and diminishes the potential profitability of a project under construction. It is a considerable problem in the construction industry and will continue to be a threat (Farinloye, Matimidiwo, Adewunmi and Ajayi, 2009) as security considerations are often ignored facet of construction projects. Contractors frequently lose materials, tools and expensive equipment to theft and vandalism; both by on-site workers and by criminals who identify easy opportunities. Total losses due to short fall on construction sites security have

been increasing dramatically over the past decade. In some places, building sites are targets for thieves and vandals because valuable items are left on site over a long period, site location are easily approachable both at night and on weekends (Sakurai, Mayhew and White**,** 2008). Crime prevention on construction sites has become a major concern for many building contractors as losses from theft and vandalism can make the difference between making a profit and incurring a loss on a job (Farinloye *et al.,* 2013). Berg (2003) noted that control and management of crime on site is often difficult particularly on large construction sites, where workers are often casual labour and not easy to keep track of, and where large amounts of equipment, tools and building materials are difficult to monitor. Poor security measures on construction sites can result in serious injury or even, fatalities to workers or visitors. It is crucial that children do not get onto construction sites. Many children regard sites as something of a play area without realizing the very serious dangers they present. (AVIVA, 2011).

Past studies have demonstrated that theft and vandalism on building and construction sites poses considerable risks to the building industry. Little research has focused on the nature of management practices employed in combating these crimes on construction site. The present study aims to supply information to fill this research need with particular focus on internal stakeholders. The focus on internal stakeholders is based on the observation by Olander (2006) that the internal stakeholders are directly involved in the finance and management of a project. Adeyinka *et al*. (2013) asserted that architects, builders, quantity surveyors and engineers are key internal stakeholders who are involved throughout the various stages of design and construction. The study area, Ogun state, Nigeria is well known for its industrial hub and population over flow from Lagos State and currently the most industrialized state in Nigeria (Ogun: the making industrial hub, 2013). The overhauls of industries and exponential population growth rate have influenced the sporadic sprawling of buildings in all nooks and crannies of the state. High population and increased unemployment rate causes increase in crime rate (Iwuagwu, 2014). Smith and Walmsley (1999) found that equipment was frequently reported to be stolen from building and construction sites in urban areas which are characterized with high population.

The boom in the building construction industry in the mix of rapid population growth and high unemployment rate graft the attention of misguided individuals or groups into construction site as means of quick gains. Hence, the study assess the security management practices on construction site in Ogun state in view to improving construction site security management practices and mitigating security threats on construction site.

Literature Review

Construction security system cannot properly be guaranteed without conducting all the practices (Yulia, 2008). Therefore, construction security system should implement all of the components to achieve good security system and to accelerate the progress of a project.

Construction site security components

Construction site security encompasses several components. Arata, (2006)

identified five security component - physical security, personnel security, investigation security, information security and security awareness. Yakuria, Mayhew and White (2008) noted target removal, identifying property, surveillance devices, natural surveillance, and cooperation between government, community and industry as five key security component. The differences between the two sets of five security components is in nomenclature but similar in elements of security practices on construction site. Springfield Missouri Police Department and San Antonio Police Department in addition to the five security components included insurance on Construction Site Crime Prevention Tips.

Physical Security

Physical security is the protection of people and things from harm by using such methods as intrusion detection, access control, and security officers (Arata, 2006). Physical security countermeasures are the measures used to safeguard personnel from harm. It also protects property from unauthorized access to equipment, installations, material, and documents and safeguards against sabotage, damage, and theft. The main objective of physical security is to harden the target and make it unattractive for thieves and vandals to enter the site for fear of being caught. Perimeter Security as an aspect of physical security which starts at the perimeter of the job site (Gardener, 2003) is a temporary construction fence used to mark the boundary of the job site. It helps differentiate where the private and public lines begin and end. The study noted that perimeter fence is not designed to completely stop intruder. The perimeter security fence is used as a delaying tactic to slow down the intruder and does serve to control vehicle and pedestrian traffic access to the property. Other physical security measures use in conjunction with perimeter fence to improve security include security lighting, clear zone, intrusion detection of job trailer, lock and key control, video surveillance, electronic assess control and tools and equipment protection.

Clear zone

According to San Antonio Police Department tips on construction site crime prevention, establishing clear zones around the perimeter fencing is essential in detecting intruders. A clear zone is defined as an open area 1.5m out from the perimeter fence on both sides and the same for around the tool cribs. In the clear zones there are not any places for an intruder to hide. This means no brush, shrubs, pallets, or storage of any kind which will provide cover for an intruder within the 1.5m zone. Also, when there is a 1.5m clear zone on both sides of the perimeter fence, the job site can be monitored by roving police patrols from the street or by the job site security officers.

Locks and key control

Locks do not keep determined well-equipped thief out of the property. They are instead a delaying device similar to perimeter fences. The better the lock, the more delay for the intruder. Thieves do not spend much time working on the lock since time is important in criminal operation. The more time is spent on defeating the lock, the lesser the time available for the inside property, building, etc.

Video surveillance

Closed Circuit Television (CCTV) means that the system is a closed system and is intended for use by a facility to

monitor their premises. The idea of closed means that the system does not broadcast TV signals over the airwaves as do the commercial TV stations but transmits signals over a closed circuit. The system, in most cases, is designed and installed with the cameras wired to a central location on the site for monitoring and consists of cameras, multiplexers, monitors and recorders depending the on the size and complexity of the system. Lee (2002) recommended the use of site alarms and CCTV during construction process on site on the basis of Crime Prevention Victoria (CPV) work. CCTV systems are quite expensive but very cost effective in high risk projects and the ease of reuse in other projects could offset the initial cost implications (Barker & Bridgeman, 1994).

Tools and equipment protection

The securing of heavy equipment, portable equipment, tools, and materials are important part of security plan. Protecting equipment from theft is important as the theft of heavy and portable equipment is a growing and costly problem at job sites. According to the NER the top five most frequently stolen pieces of equipment account for 75% of all heavy construction equipment thefts within the United States. Skid-steer loaders are listed as the most common pieces stolen in 2004, accounting for 31% of all construction equipment thefts. Tractors, backhoes, generator or compressors, and excavators are shown as the other four major categories of construction equipment thefts (National Equipment Register, 2004). The two key factors in the type of equipment most likely to be stolen are value and mobility, the higher the value of an item and the easier it is to transport, the greater the chance of theft. Protection methods for tool and equipment according to Prince William County Police Department include marking of company tools and maintaining inventory, checking in/out of tools, strategic parking of equipment, removing the battery of equipment at night and removing keys in switches. Other measures use in protecting tools and equipment as identified by Springfield Missouri Police Department and San Antonio Police Department include equipment re-key, taking photos of all units from all four sides, engraving or stamping an identifier on all tools, distinctive colour painting of equipment for easy of identification and keeping brand, model, serial, owner applied ID (OAI), location of OAI, other description of all equipment and tools.

Electronic access control

Administration and procedures of access control system like access control lists, personnel recognition, ID cards, badges, and personal escorts all contribute to effective access control system. Hardware that reads the badges and permits access to the site by unlocking the entry doors and operating the perimeter fence gates is a key component of access control system.

The basic premise of an electronic access control system is based on the concept of PIN number for a keypad or a cipher lock, an ID access card with or without a picture, or a key fob. The ID card is the size of a credit card. When the card is inserted or read by placing it near the reader the information on the card is read and verified in the access control system's data base, the system sends a signal to operate an electric strike or magnetic lock to release the door for entry if the person has access.

Security officers

The use of security officers to help secure a job site can be a great help or add to the problem. Trained and motivated security officers provide valuable services but if the officers are poorly trained or not properly screened and supervised, it can add to the problem.

Delivery of materials

Standards should be established and followed for checking material on and off of the job site. One person should be assigned the responsibility of maintaining tight inventory control of all materials delivered, and each should be signed for only after the invoice is carefully checked for shortages. Expensive material should not be stored on the job site any longer than necessary. Whenever possible, the delivery of high value material or those in critical supply should be timed (San Antonio Police Department).

Security inventories and markings

As part of an organization's security plan, standards for equipment inventories should be established. Routine inventories not only improve equipment accountability, they also establish work-site conditions that discourage theft. At a minimum, organization should inventory 100% of its equipment annually. To minimize work disruption, the inventories should be spread throughout the year. Periodic unannounced inventories are also a good idea to maintain accountability of high-risk items like air compressors and power tools. A supervisor should be assigned the duty of managing the inventories. It is also good practice to sporadically change the personnel conducting the inventories (Gransberg, et al, 2006).

Personnel Security

Personnel security is mainly concerned with practices and procedures for hiring, terminations, and workplace issues and response. Screening procedures and background checks are also part of personnel security (Matthews, *et al*, 2006). Many companies issue standing instructions to site personnel covering the obvious aspects of site works, administration and procedures for discipline or dismissal in these or similar instructions. Sharma and Bausman (2010) noted that termination of employee caught stealing or committing vandalism is one of the security practices in use by contractors in South Carolina.

Investigation Security

The purpose of investigation security is to make sure that a person who applied for a job is in fact that person and there are no surprises in their background that could be a problem. Background or pre-employment investigations are conducted internally for several reasons such as pre-employment screening, theft of company property, fraud and embezzlement, policy and procedural violations.

Information Security

Information security is the protection of company and customer documents. The documents can be either hardcopy or soft copy. A hard-copy document is one that is on paper and a soft copy is on a computer disk or in the computer files. To protect hard copies, keep documents locked in a file cabinet when not in use. The hard copies can consist of anything that is considered proprietary information and can include the drawings of the project if they detail a special process or equipment. When using the drawings for the project, only

those that have a need to know should be given access.

When the information is in soft copy in computer files it needs to be protected as well. Methods used to protect company's information could be administrative, physical or/and technical. Information security is a necessary part of the site security plan.

Security awareness

Security awareness is an important part of the job site security program. Security awareness is defined as a method for changing the attitudes of the company and personnel toward security to realize its importance. Awareness reminds company personnel of the importance of security (Arata, 2006). Security awareness takes many forms such as: formal presentations, posters, memos, web sites, security bulletins, security slogans and contests.

Insurance

According to San Antonio Police D ıent, insurance is the main m that construction equipment owners use to protect themselves from the risk of construction equipment theft and vandalism. The broad area of insurance that construction equipment falls within is called inland marine insurance. The term inland marine derives from the days when all materials insured were associated with the ships used to transport goods from port to port. Inland marine items were all items not associated directly with ships (American Insurance Association, 1997).

Hypothesis of the study

The null hypothesis postulated for the study states that there is no significant difference in the perceptions of contractors and consultants on the security management strategies use in crime management on construction site. The alternative hypothesis states that there is significant difference in the perceptions of contractors and consultants on the effects of security management strategies use in crime management on construction site. The hypothesis will help to know the level of internal stakeholders' agreement on security management practices on construction site and thereby engineer efficient crime management model development for the construction industry.

Method

The study adopted exploratory survey design approach using structured questionnaires. The population consists of contractors and consultants with professional affiliations involved in the execution of building projects in Ogun State, Nigeria. The study purposively sampled 122 stakeholders who are directly involved in the management of on-going building construction works on sites and are therefore dimed highly knowledgeable in the subject matter and can provide valid information. The sample frame consists of 93 valid questionnaires comprising 52 contractors and 41 consultants. Data were collected from the internal stakeholders using structured questionnaires comprising 30 construction site security management practices drafted from literature which were designed for easy understanding. The measurements were on a five-point Likert scale, namely: not used = 1, hardly used = 2, moderately used = 3, used = 4 and always used = 5. Data collected were processed using IBM Statistics Package for Social Sc 37 (SPSS) version 20, to determine the effects of security management practices and the priority placed on the practices using the mean score (MS) of

the Likert ratings. The variation of the effects and priority placed on the security management practices between the stakeholders were analysed using Man-Whitney U tests, since the data were obtained on an ordinal scale through subjective/cognitive evaluation. Likert scale data can be analysed with an interval measurement scale as this reflects meaningful relative distances between points (Trochim, 2006 and Boone and Boone, 2012). The interval between points equals to the ratio of the difference between upper and lower limits, to the number of points (in this case 4/5 = 0.8).

The decision rule is that any security management practice whose mean is equal to one (1.00) is regarded as "not used" while the ones that falls between 1.01 – 1.80 is regarded as "rarely used", 1.81 – 2.60 is "hardly used", 2.61 – 3.40 is "moderately used", 3.41 – 4.20 is "used" and 4.21 – 5.00 is regarded as "always used" based on the interval ranges or values between points.. For the Man-Whitney U test, decision to accept a null hypothesis is based on the P value and the significance (2-tailed). If the significance level or the probability value (p) is greater than or equal to 0.05, it implies there is no statistically significant difference in the result, thereby accepting the null hypothesis.

Result of Data Analysis

Characteristics of Respondents Used for the Study

The characteristics of the respondents – contractors and consultants that supplied the data used for the study were analysed for an understanding of the stakeholders whose perceptions were investigated. For this purpose, affiliation, sex, age, qualification and experience of professionals, were all evaluated and the results are presented in Table 1.

Table 1: Respondents' Characteristics

Characteristics of respondents	**Sub-characteristics**	**No**	**%**
All respondents	Contractors	52	56
	Consultants	41	44
	Total	93	100
Sex of respondents	Male	87	94
	Female	6	6
	Total	93	100
Age of respondents	1 – 17yrs	0	0
	18 -60yrs	81	87
	> 60yrs	12	13
	Total	93	100
Professional affiliation	Architects	24	26
	Builders	14	15
	Quantity surveyors	17	18
	Engineers	38	41
	Total	93	100
Experience	1 -5yrs	10	11
	6 – 10yrs	37	40
	11 – 15yrs	26	28
	16 -20yrs	16	17
	>20yrs	4	4
	Total	93	100
Qualification	ND	8	9
	HND	17	18
	BSc	25	27
	MSc	39	42
	PHD	04	4
	Total	93	100

Size of establishment	Small (1 – 49 workers)	22	24
	Medium (50 – 500 workers)	58	62
	Large (>500 workers)	13	14
	Total	93	100

Source: Author's Analysis (2017)

Table 1 shows that the majority of the respondents sampled were contractors, perhaps because the questionnaires were majorly administered at the site where contractors' presence is dominant. The result also shows that 41% of the respondents are engineers (comprising civil engineers, electrical engineers, mechanical engineers, structural engineers and other engineers in engineering field), architects 26%, quantity surveyors 18% and 15% builders. Also, the table reveals that majority of the respondents work with medium scale companies and 89% have over 5 years working experience, hence the contractors and consultants could be relied upon for information on the subject matter.

In order to evaluate the status of the construction site security management practices among internal stakeholders, 30 security management components were drafted from literature. Respondents were then requested to rank the level at which the various construction site security management practices are used on their construction site using the five-point Likert scale. The results are presented in Tables 2, 3 and 4.

Crime/Security Management Practices

This section evaluates the security management practices on construction site. The scale adopted allowed individuals to express their opinion on how frequent a particular crime management practice is been used on respondents' construction site ranging from "Not Used" to "Always Used''. Table 2 shows the results of analysis of internal stakeholders on construction site security management practices.

Table 2: Internal Stakeholders' Construction Site Security Management Practices

Security Management Practices	**N**	**Sum**	**Mean**	**Rank**
Inventory of tools	93	426	**4.58**	**1**
Inventory of materials	93	421	**4.53**	**2**
Inventory of equipment	93	418	**4.49**	**3**
Storing of goods in secured compound	93	392	**4.22**	**4**
Marking of plants and machinery (concrete mixer, trucks etc.) for identification	93	392	**4.22**	**4**
Perimeter fencing for the site.	93	383	**4.12**	**6**
Site office positioned well to minimize access to opportunist thief	93	383	**4.12**	**6**
Strategic parking for large equipment	93	372	**4.00**	**8**
Goods to be received by a trustworthy worker	93	364	**3.91**	**9**
Securing access ladders with chains	93	354	**3.81**	**10**
Marking of equipment (drilling machine etc.) for identification	93	351	**3.77**	**11**
Use of protectors for vulnerable doors and windows	93	333	**3.58**	**12**
Securing hazardous chemical	93	325	**3.49**	**13**
Computer based documentation of information on site	93	323	**3.47**	**14**
Security planning and design	93	323	**3.47**	**14**
Marking of tools (hammer, shovel etc.) for identification	93	307	**3.30**	**16**

Use lockbox for tools and small equipment.	93	297	**3.19**	**17**
Barricading hazardous areas with suitable high visible mesh barrier	93	290	**3.12**	**18**
Use of locks	93	281	**3.02**	**19**
Security awareness (use of signage)	93	277	**2.98**	**20**
Use of trained and motivated security officers to secure construction site from theft and all criminal action that can possibly occur	93	274	**2.95**	**21**
Just in time delivery of materials and tools	93	273	**2.94**	**22**
Security checks on entry and exit in the site	93	266	**2.86**	**23**
Use of pre-employment screening investigations to verify the applicants relating to their employment, education and criminal history	93	260	**2.80**	**24**
Applying tow hitch locks to trailer	93	260	**2.80**	**24**
Insurance of plants and equipment	93	255	**2.74**	**26**
Staff security awareness training	93	218	**2.34**	**27**
Exterior lighting on site	93	197	**2.12**	**28**
For high risk plants, the use of tracking devices	93	149	**1.60**	**29**
Use of security tools such as CCTV and alarm systems to protect site	93	124	**1.33**	**30**
Valid N	93			

NOTE: 1 = Not Used 2 = Hardly Used 3 = Moderately Used 4 = Used 5 = Always Used

Table 2 shows results of analysis of internal stakeholders' data on security management practices used on construction site. On the table inventory of tools, materials and equipment had mean scores of 4.58, 4.53 and 4.49 ranking first, second and third respectively. The high mean score on inventory indicates that it is always used on construction site for security purposes. The continuous use of inventory reduces occurrence of materials, tools and equipment theft on site as noted in previous study that theft of material, tools and equipment were ranked low on the occurrence of construction site security challenges. Use of security tools such as CCTV and alarms systems as site security management practice is the least practice adopted with Mean Score of 1.33 and is ranked 30th, indicating that it is rarely used on construction sites. The rare use of CCTV could be attributed to the sizes of the construction firms in the survey as majority of the firms are small and medium scale construction firms and may not be buoyant enough to afford CCTV. CCTV are quite expensive, however contractors are encouraged to adopt the crime prevention measure in all their construction sites as it alleviates risk in high risk projects and the ease of reuse in other projects could offset the initial cost implications (Barker & Bridgeman, 1994). Marking of tools, equipment and plants with Mean Score of 3.30, 3.77 and 4.21 respectively are moderately used. Perimeter fencing has Mean Score of 4.12. The table also shows that site offices are always positioned well to minimize access to opportunist thieves with mean score of 4.12 and is ranked 6th. Strategic parking of large equipment on site is ranked 8th with mean score of 4.00. Use of lockbox for tools and small equipment with mean score of 3.19 and is ranked 17th. Use of pre-employment screening investigations to verify the applicants relating to their employment, education and criminal history is ranked 24th with mean score of 2.79 which shows that it is moderately used.

Table 2 is a summary or total view of the internal stakeholders and might not completely reflect the perceptions of the contractors and consultants in the application of the crime management strategies on construction site. The different perceptions of the contractors and consultants were analysed to investigate the priority place on each crime management practices on construction site. The relative positions of the crime management practices is necessary in ensuring uniformity in the development of construction site security model. Construction site security models are proposed in the study and considered essential for setting up construction site, inspecting ongoing projects, and investigating crime on the event of any occurrence. Table 3 shows the result of contractors and consultants perceptions on crime management in construction site.

Table 3: Perceptions of contractors and consultants on crime management practices on construction site

Security Management Practices	**Contractors**				**Consultants**			
	N	**Sum**	**Mean**	**Rr**	**N**	**Sum**	**Mean**	**Rr**
Inventory of tools	52	241	**4.63**	**1**	41	**185**	**4.51**	**2**
Inventory of materials	52	233	**4.48**	**3**	41	**188**	**4.59**	**1**
Inventory of equipment	52	238	**4.57**	**2**	**41**	**180**	**4.39**	**3**
Storing of goods in secured compound	52	214	**4.11**	**7**	**41**	**178**	**4.34**	**4**
Marking of plants and machinery (concrete mixer, trucks etc.) for identification	52	216	**4.15**	**5**	**41**	**176**	**4.29**	**5**
Perimeter fencing for the site.	52	215	**4.13**	**6**	**41**	**168**	**4.10**	**8**
Site office positioned well to minimize access to opportunist thief	52	210	**4.04**	**8**	**41**	**173**	**4.22**	**6**
Strategic parking for large equipment	52	201	**3.86**	**9**	**41**	**171**	**4.17**	**7**
Goods to be received by a trustworthy worker	52	219	**4.21**	**4**	**41**	**145**	**3.54**	**11**
Securing access ladders with chains	52	202	**3.82**	**10**	**41**	**152**	**3.71**	**10**
Marking of equipment (drilling machine etc.) for identification	52	195	**3.75**	**11**	**41**	**156**	**3.80**	**9**
Use of protectors for vulnerable doors and windows	52	193	**3.71**	**12**	**41**	**140**	**3.41**	**13**
Securing hazardous chemical	52	181	**3.48**	**15**	**41**	**144**	**3.51**	**12**
Computer based documentation of information on site	52	185	**3.56**	**14**	**41**	**138**	**3.37**	**15**
Security planning and design	52	186	**3.58**	**13**	**41**	**137**	**3.34**	**16**
Marking of tools (hammer, shovel etc.) for identification	52	168	**3.23**	**16**	**41**	**139**	**3.39**	**14**
Use lockbox for tools and small equipment.	52	165	**3.17**	**17**	**41**	**132**	**3.22**	**18**
Barricading hazardous areas with suitable high visible mesh barrier	52	164	**3.15**	**18**	**41**	**126**	**3.07**	**19**
Use of locks	52	148	**2.86**	**25**	**41**	**133**	**3.24**	**17**
Security awareness (use of signage)	52	163	**3.13**	**19**	**41**	**114**	**2.78**	**22**

Use of trained and motivated security officers to secure construction site from theft and all criminal action that can possibly occur	52	161	**3.10**	**20**	**41**	**113**	**2.76**	**23**
Just in time delivery of materials and tools	52	150	**2.88**	**24**	**41**	**123**	**3.00**	**21**
Security checks on entry and exit in the site	52	142	**2.73**	**26**	**41**	**124**	**3.02**	**20**
Use of pre-employment screening investigations to verify the applicants relating to their employment, education and criminal history	52	152	**2.92**	**23**	**41**	**108**	**2.63**	**24**
Applying tow hitch locks to trailer	52	157	**3.02**	**21**	**41**	**103**	**2.51**	**25**
Insurance of plants and equipment	52	154	**2.96**	**22**	**41**	**101**	**2.46**	**27**
Staff security awareness training	52	116	**2.23**	**27**	**41**	**102**	**2.49**	**26**
Exterior lighting on site	52	102	**1.96**	**28**	**41**	**95**	**2.32**	**28**
For high risk plants, the use of tracking devices	52	87	**1.67**	**29**	**41**	**62**	**1.51**	**29**
Use of security tools such as CCTV and alarm systems to protect site	52	74	**1.42**	**30**	**41**	**50**	**1.22**	**30**
Valid N	52				41			

NOTE: 1 = Not Used 2 = Hardly Used 3 = Moderately Used 4 = Used 5 = Always Used

In Table 3 contractors ranked inventory of tools first while it is ranked second by consultants. Also consultants consider that inventory of materials being ranked first is most commonly used while contractors ranked it third. In summary, both contractors and consultants ranked 25 components of crime management on construction site differently. While five (5) components namely; marking of plants and machinery, securing access ladder with chain, exterior lighting on site, the use of tracking device, and use of CCTV and alarm systems were ranked equally.

Given the result in Table 3, it is tempting to conclude that the contractors and consultants hold different views on the application of the crime management components on construction site. The differences in the internal stakeholders' view were examined for statistical significance in line with the null hypothesis using Mann-Whitney U test. The result of the Mann-Whitney U test is shown in Table 4.

Table 4: Mann-Whitney U Test of Contractors and Consultants Perceptions on Security Management Strategies/Components in Construction Site.

S/N	Null Hypothesis	Test	Sig	Decision
1	The distribution of ranks is the same across categories of group.	Independent Samples Mann-Whitney U Test	1.000	Retain the null hypothesis.
1	The distribution of ranks is the same across categories of group.	Independent Samples Mann-Whitney U Test	1.000	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is 0.05.

The Mann-Whitney U test in Table 4 shows that the distribution of ranks on the security management practice is the same among the contractors and consultants with P value of 1.00 which is greater than 0.05. Hence the decision to retain the null hypothesis which states that the perceptions of contractors and consultants on the application of crime management components on construction site are the same. Thus the internal stakeholders agree on the order of the application of crime management strategy. The result would advance the development of construction site security management model which would help to alleviate construction site security challenges. In line with the above results a construction site security management model is proposed. The proposed construction site security management mode is shown in Table 5.

Table 5: Proposed Construction Site Security Management Model

Security Management Practices	**SSCF**	**MSCC**	**LSCC**
Inventory of tools	✓	✓	✓
Inventory of materials	✓	✓	✓
Inventory of equipment	✓	✓	✓
Storing of goods in secured compound	✓	✓	✓
Marking of plants and machinery (concrete mixer, trucks etc.) for identification	✓	✓	✓
Perimeter fencing for the site.	✓	✓	✓
Site office positioned well to minimize access to opportunist thief	✓	✓	✓
Strategic parking for large equipment	✓	✓	✓
Goods to be received by a trustworthy worker	✓	✓	✓
Securing access ladders with chains	✓	✓	✓
Marking of equipment (drilling machine etc.) for identification	✓	✓	✓
Use of protectors for vulnerable doors and windows	✓	✓	✓
Securing hazardous chemical	✓	✓	✓
Computer based documentation of information on site	✓	✓	✓
Security planning and design	✓	✓	✓
Marking of tools (hammer, shovel etc.) for identification	✓	✓	✓
Use lockbox for tools and small equipment.	✓	✓	✓
Barricading hazardous areas with suitable high visible mesh barrier	✓	✓	✓
Use of locks	✓	✓	✓
Security awareness (use of signage)	✓	✓	✓
Use of trained and motivated security officers to secure construction site from theft and all criminal action that can possibly occur	✓	✓	✓
Just in time delivery of materials and tools	✓	✓	✓
Security checks on entry and exit in the site	✓	✓	✓
Use of pre-employment screening investigations to verify the applicants relating to their employment, education and criminal history	✓	✓	✓
Applying tow hitch locks to trailer	✓	✓	✓
Insurance of plants and equipment	✓	✓	✓
Staff security awareness training	✓	✓	✓
Exterior lighting on site	✓	✓	✓
For high risk plants, the use of tracking devices		✓	✓
Use of security tools such as CCTV and alarm systems to protect site		✓	✓

NOTE: SSCF = Small Scale Construction Firms MSCC = Medium Scale Construction Companies LSCC = Large Scale Construction Companies

Table 5 shows the proposed construction site security management model for the construction industry. All construction companies are encouraged to apply all the construction site security management components though small construction firms may be excused from tracking devices, CCTV and alarm systems application due to the relatively low risk construction project such firms usually execute and the cost implication of acquiring such devices. However, in line with (Barker & Bridgeman, 1994) contractors are encouraged to adopt the crime prevention measures in all their construction sites as it alleviates risk in projects and the ease of reuse in other projects could offset the initial cost implications.

Implementation level of Site Security Management Practices on Site.

To examine the level of implementation of site security management practices on construction sites, the mean scores of the practices were compared with a test value of 3 (i.e. moderately used on the Likert scale). The test result helps to identify crime prevention measures on site that requires improvement. The result is shown in Table 4.

Table 4: Implementation level of Construction Site Security Management Practices

One-Sample Test				
Construction Site Security Management Practices	**Test Value = 3**			
	t	df	Sig. (2-tailed)	**Mean Difference**
Use of security tools such as CCTV and alarm systems to protect site	-12.305	92	.000	**-1.674**
Marking of tools (hammer, shovel etc.) for identification	2.110	92	.041	**.302**
Marking of equipment (drilling machine etc.) for identification	4.935	92	.000	**.767**
Marking of plants and machinery (concrete mixer, trucks etc.) for identification	7.487	92	.000	**1.209**
Use of trained and motivated security officers to secure construction site from theft and all criminal action that can possibly occur	-.202	92	.841	**-.047**
Inventory of materials	11.773	92	.000	**1.535**
Inventory of tools	14.179	92	.000	**1.581**
Inventory of equipment	10.731	92	.000	**1.488**
Computer based documentation of information on site	2.580	92	.013	**.465**
Use of pre-employment screening investigations to verify the applicants relating to their employment, education and criminal history	-.876	92	.386	**-.209**
Use lockbox for tools and small equipment.	1.185	92	.243	**.186**
Strategic parking for large equipment	5.783	92	.000	**1.000**
Perimeter fencing for the site.	6.207	92	.000	**1.116**

Exterior lighting on site	-3.994	92	.000	**-.884**
Security checks on entry and exit in the site	-.758	92	.453	**-.140**
Use of physical security device locks	.113	92	.911	**.023**
Staff security awareness training	-3.098	92	.003	**-.651**
Security awareness (use of signage)	-.105	92	.917	**-.023**
For high risk plants, the use of tracking devices	-9.845	92	.000	**-1.395**
Just in time delivery of materials and tools	-.464	92	.645	**-.070**
Goods to be received by a trustworthy worker	6.123	92	.000	**.907**
Storing of goods in secured compound	10.689	92	.000	**1.209**
Site office positioned well to minimize access to opportunist thief	6.431	92	.000	**1.116**
Use of protectors for vulnerable doors and windows	3.705	92	.001	**.581**
Applying tow hitch locks to trailer	-.932	92	.357	**-.209**
Securing hazardous chemical	1.972	92	.055	**.488**
Securing access ladders with chains	4.375	92	.000	**.814**
Barricading hazardous areas with suitable high visible mesh barrier	.462	92	.646	**.116**
Insurance of plants and equipment	-1.336	92	.189	**-.256**
Security planning and design	2.351	92	.024	**.465**

Table 4 shows that 11 construction site security management practices have negative mean differences indicating that the use of the crime prevention measures are below expectation, hence there is need for improvement to further alleviate construction site security threats. The site security management practices that requires improvement are use of CCTV and alarm system, the use of tracking devices for high risk plants, security checks on entry and exit from the site, exterior lighting on site, staff security awareness training and use of pre-employment screening investigations to verify the applicants. Others include insurance of plants and equipment, applying tow hitch locks to trailer, just in time delivery of materials and tools, security awareness (use of signage) and use of trained and motivated security officers to secure construction site,

Finding and Recommendation

The study found that the most commonly used construction site security management components are inventory of tools, materials and equipment with mean scores of 4.58, 4.53 and 4.49 ranking first, second and third respectively. Other construction site security management practice effectively utilized on construction site include marking of plants and machinery, perimeter fencing, strategic parking of large equipment, use of trustworthy workers to receive goods and use of locks. However, the use of security tools such as CCTV and alarms systems as site security management practice is the least practice adopted

with Mean Score of 1.33 and is ranked 30th.

Also the study found that 11 construction site security management practices are not effectively utilized in crime prevention on construction site. The site security management practices that are not effectively employed are use of CCTV and alarm system, the use of tracking devices for high risk plants, security checks on entry and exit from the site, exterior lighting on site, staff security awareness training and use of pre-employment screening investigations to verify the applicants, insurance of plants and equipment, timely delivery of material and tools, use of signage and use of trained security officers.

Contractors and consultants (internal stakeholders) agree on the order of application of crime management measures in combating security threats on construction site. The unison of the internal stakeholder on the methods of crime management on construction site advanced the development of construction site security management model which would help to alleviate construction site security challenges. Construction site security management model is proposed.

Internal stakeholders are encouraged to adopt all the crime prevention measures in all their construction sites as it alleviates risk in high risk projects.

Internal stakeholders in the construction industry and government agencies should apply the proposed construction site security management model in setting up construction site and inspection of on-going construction project to mitigate security threat and reduce risk in construction projects and help in investigating crime on the event of any bridge of security.

References

Abhishek Sharma and Dennis Bausman (2010). *Construction site security – The impact of company size and loss history on security measures*. Retrieved on 28 June, 2016 from: http://ascpro0.ascweb.org/archives/ cd/2010/paper /CPRT119002010.pdf

Adeyinka B.F., Jagboro O., Ojo G.K., Odediran S.J. (2013). Level of compliance of core construction professionals to ethical standards in Nigeria. *Global Journal of Management and Business Research*. 13(12):26 - 36.

Arata, M.J.Jr (2006). *Construction Site Security*. 1st Edition. New York: McGraw Hill Book Company.

AVIVA (2011). *Security on construction sites.* Retrieved from: www.aviva.co.uk

Barker M. & Bridgeman C. (1994). *Preventing vandalism: what works?* Crime detection & prevention series no. 56. London: Police Research Group

Berg, R. (2003). *Jobsite security on commercial construction projects.* Graduate School of the University of Florida. MSc theses

Boone, H. N. & Boone, D. A. (2012). Analyzing likert data. *Journal of Extension*. 50(2).

Farinloye, O., Mafimidiwo, B., Adewunmi, Y. & Ajayi O. (2009). Prevalence of theft and vandalism on building site. *Proceeding of the RICS COBRA Conference University of Cape Town, South Africa*, 150-164.

Farinloye O, Odusami K., Adewumi Y, (2013). Theft and vandalism control measures on building sites in Lagos. *Nigeria Journal of Engineering Project, and Production Management*, 3(1), 9-21.

Gardner, T. (2003). *Security in Construction and Beyond; Protecting Your Site, Even During Build-up.* Virgo Publishing, Inc. http://www.insideselfstorage.com/articles/291feat4.html.

Gransberg,D.D., Popescu, C.M., and Ryan, R.R. (2006). *Construction Equipment Management for Engineers, Estimators, and Owners.* Boca Raton, FL. Taylor & Francis Group, LLC

Matthews B., Sylvie J.R, Sang-Hoon Lee, Thomas S.R., Chapman R.E, and Gibson G.E. (2006). addressing Security in Early Stages of Project Life Cycle. *Journal of Management in Engineering*, Vol. 22, No.4, October 1. 196 - 202. ASCE

Olander S. (2006). *External stakeholder analysis in construction project management*[dissertation]. Lund University, Sweden.

Ogun: the making industrial hub. (2013). Retrieved from: https://thenationonlineng.net/ogun-making-industrial-hub.

Iwuagwu, C. E. (2014). Statistical appraisal of crime rate in Nigeria. *Journal of Physical Science and Innovation*, 6(1), 38 – 43.

Lee K. (2002). *Building site crime prevention initiative: final report August 2001 – June 2002*. Melbourne: Crime Prevention Victoria

National Equipment Register. (2004). *Equipment Theft Report*. New York: National Equipment Register Inc.

Prince William County Police Department. *Crime Prevention on the Construction Site* . Retrieved from: *www.pwcgov.org/docLibrary /PDF/002443.pdf*

Sakurai Yukau, Mayhew Pat and White Mark **(**2008). Theft and Vandalism at residential building sites in Australia. *Australian Institute of Criminology*. San Antonio Police Department. *Construction Site Crime Prevention Tips.* Retrieved from:www.sanantonio.gov/saPD/pdf/CONSTRUCTION_SITE.pdf

Smith A. & Walmsley R. (1999). *The nature and extent of construction plant theft*. Police research series no. 117. London: Home Office

Springfield Missouri Police Department. *Construction Site Crime Prevention.* Retrieved from:

http://www.ci.springfield.mo.us/spd/GeneralInfo/crimeprevtips/Work/construction site.html

Trochim, W.M.K. (2006). Levels of measurement. Research Methods Knowledge Bas. Web Centre for Social Research Methods.

Yulia Setiani (2008). Construction Site Security management and control. [Master Dissertation].Universiti Teknologi, Malaysia.