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Factors affecting building security cost sustainability using PCA

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Abstract

Purpose – The purpose of this study is to evaluate built environment experts' perception of factors affecting the building security cost for sustainable development. It examines the effects of building characteristics and protective measures on the cost of building security within the built environment.

Design/methodology/approach – The study uses a quantitative research technique, using questionnaires to source relevant information from respondents. Of the 333 questionnaires administered, 293 usable responses were returned, giving an 88 per cent response rate. Exploratory factor analysis (EFA) is used to examine the suitability of these data for factor analysis. Principal component analysis (PCA) is used to extract the factors.

Findings – Components 1, 2 and 3 reflect concern for procurement of security devices, design process of security requirements and safety of life and property and fear of crime, respectively. The communalities represented by R^2 are relatively strong across the variables. Aesthetics is significant with an R^2 value of 0.71, which shows that this factor should be given due consideration when procuring building security devices. Also, height, location and use of building are significant with R^2 values of 0.70, 0.63 and 0.71, respectively. These factors positively influence the building security cost and should be given due consideration when designing protective buildings.

Practical implications – The findings would assist in the evaluation, planning and control of the rising cost of building security.

Social implications – This study serves to sensitize built environment experts, criminologists and policymakers of the design implication of protective requirements of building security.

Originality/value – This study provides empirical evidence that the various factors considered have an effect on the building security cost and contribute immensely towards sustainable the building security cost within the built environment.

Keywords Built environment, Principal component analysis, Crime prevention, Building security cost, Burglary, Sustainability assessment

Paper type Research paper

1.Introduction

Security is progressively of increasing significance around the world. The historical background of housing cannot be divorced from criminal activities. In some scenarios,

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the level of security of a locality tends to form the basis for the measurement of its social and economic development. The security of life and properties within the built environment is of great importance to the socio-economic, health and general well-being of people around the globe (Cozens, 2008). According to Maxwell (2006), adequate security brings about safety and ensures social, economic and political order that enables a city to function well and allows its citizens to succeed in life.

Conversely, insecurity has serious negative social, economic and policy implications. It further creates a situation of fear and anxiety that affects people's psychological state of mind and the level of their productivity (Hirst, 2013; Edelman, 2013). Thus, security is a global matter that requires urgent attention from the government and stakeholders worldwide (Morenikeji *et al.*, 2008). According to UN-Habitat (2007), crime and violence are major threats to human security that also engender fear and insecurity.

Moreover, crime and violence are being recognized globally as an unacceptable phenomenon and abuse of a fundamental human right. Despite the fact that criminal activities occur all over, most cities remain still secure. Many of citizens are, however, neither victims of crime and violence nor perpetrators. Crime is minimal in certain parts of a city and in neighbourhoods that are well-monitored by the police and its citizens. Crime rates show that crime occurrence recorded for every 100,000 people over the period of 1980-2000, rose to 700 crimes committed; an indication that criminal activities are on the increase (Lott, 2013), even though the trend varies across the globe.

In Nigeria, serious crime has grown to nearly epidemic proportions, particularly in urbanized areas, which are categorized by rapid escalation and change, stark economic disparity and deprivation, social ineptness and insufficient government service and law enforcement capabilities (Usman *et al.*, 2012). Most information services regard published crime statistics as grossly understated. Property crime accounts for more than half the offences, with thefts and housebreaking and entering covering 80 to 90 per cent in most years. Assaults constituted 70 to 75 per cent of all crimes against persons (Dikko *et al.*, 2013). Literature provides evidence that the security of persons and property are essential to both individuals and the government. However, studies on empirical relationships between design implication of buildings and security-related costs have not received detailed research attention. Hence, this study helps bridge that research gap as part of a sustainable the building security cost within the built environment.

2. Sustainable development and building security

Cozens (2008) assessed the redesigning of the city model for sustainable development and investigated the degree of integration of crime and fear of crime within the framework. The cities of the twenty-first century have diverse impacts on the environment and its residents in current and for future generations. Crime against personal safety and security of both the built environment and its citizens are included within the framework of sustainability. Recorded crime statistics often represent the indicator of "crime", but this approach is extremely narrow and also neglects the essential aspect of citizens' fear of crime. Crime is very complex and brings with it many explanations. The correlation between the built environment and crime represents an issue that planners can influence directly.

Sustainable development is defined as the development that meets the needs of the present without compromising the ability of future generations to respond to their needs. Also, sustainable community is defined as safe, perceives itself to be safe and is considered to be safe by others (Cozens, 2002). A form of sustainable urban development that incorporates crime prevention through environmental design (CPTED) measures may move towards the development of what might be defined as "Sustainable Urban Environmentalism". The standardization of CPTED concepts in building regulation may avoid the repetition of some of the "unsustainable" design failures of the recent past, as "environmental design modifications aimed at creating safer communities in many cases also address the socio-economic requirements for more sustainable settlements, and the solutions complement each other" (Du Plessis, 1999; Cozens, 2002). This approach seeks to merge the dichotomy comprising the social and physical milieu and provide a more holistic, multidisciplinary perspective on managing crime and promoting sustainable urban development (Cozens, 2002).

The reviews of core findings from recently published place-based crime prevention studies revealed a growing body of knowledge that supports the claim that CPTED is effective in reducing both crime and fear of crime in the community (Cozens *et al.*, 2005). Moreover, Cozens *et al.* (2001) affirmed that design as such does not signify the universal remedy for lessening criminogeneity, rather that "defensible space" CPTED and secured by design (SBD) ought to be considered as crime deterrence tactics, which can, in the same manner as other initiatives, add to handling the issues of residential crime. Target hardening is also a basic CPTED principle, in which access control and surveillance are implemented to reduce the opportunities for crime (Fleissner and Heinzelmann, 1996). Millie and Hough (2004) stated that some crime-prevention strategies are effective in reducing burglary. This is achievable by enhancing physical security, reducing access to areas by gating alleyways, improving the environment to deter burglary, marking property and improving street lighting. Previous studies have shown that burglary risk for properties with no security devices were nearly three times (Budd, 1999), five times (Clontz, 1997) and six times (Morphy and Eder, 2010) higher than properties with basic security features. The validation of CPTED by Marzbali *et al.* (2012b) revealed access control, natural surveillance, exterior maintenance and territoriality as the key variables that could be used in the designing process of a crime-free built environment.

The crime assessment of England and Wales have shown that 2.1 per cent of families in these countries were burgled in 2012/2013 and experienced 694,000 burglaries. The impact of a burglary on victims is significant and includes considerable psychological costs to add to the financial costs of replacements and repairs (Tseloni *et al.*, 2014). The crime assessment in Australia revealed that the economic costs of crime to the community were AUD32bn per annum. Burglary constitutes AUD2.4bn per annum, while the significant segments of the community were anxious about their personal safety and loss of property when visiting the city (Mayhew, 2003; Cozens, 2008). In Malaysia, reports have shown that housebreaking and theft were the most frequent types of crime after the theft of motorcycles, and a similar trend is experienced in the Penang province (Royal Malaysia Police, 2010). According to Marzbali *et al.* (2012a), the amount of losses to housebreaking and theft in Malaysia surpassed other types of property crime.

In tackling this menace, several households have adopted security measures of a different kind. Victim support and crime prevention officers regularly advise victims of crime on improving aspects of their home security. However, security is generally at the discretion of the individual in the United Kingdom, as there is no government support, unlike the "green" intervention. The utilization of protective security measures is escalating in most countries, with the highest levels in developed countries, which correlates with a higher proportion of attempted, rather than successful, burglaries in these countries (Tseloni *et al.*, 2014). Houses with no or low-level security have seven times and 75 per cent, respectively, more burglaries than houses with high-level security (Pease and Gill, 2012). A previous study by Vollaard and van Ours (2011) revealed the significance of security protection on the newly built houses fortified with burglary protection in Netherlands. The study showed that the burglary rate dropped in areas built with new housing regulation without displacement to areas with older less-protected houses. The conclusion was reached that in 2010, the national burglary rate in the Netherlands was 5 per cent lower than it would have been otherwise.

Burglary is one of the more common crimes in Nigeria. According to Grabosky (1995), burglary is defined as breaking and entering a dwelling with the intention of committing a felony. Also, burglary is defined as the illegal and unlawful entry into a home or structure to commit a felony or theft (Badiora *et al.*, 2014; Weisel, 2002). Burglary as a crime has generally increased around the globe, particularly in the urban setting during the last part of the twentieth century (Weisel, 2002; Badiora *et al.*, 2014). The official crime rate reports in Nigeria indicate burglary and the attempts to burgle have continually escalated (Badiora *et al.*, 2014). UNODC (2015) revealed that the Nigerian burglary was 1.5 per 100,000 of the population in 2013. However, a drastic fall was experienced between 2007 and 2009 after which it increased again.

The growing rate of burglars in Nigerian towns and cities gave rise to diverse responses to residential, commercial burglary and other types of crime (Badiora *et al.*, 2014). To make an impression on a neighbourhood and dwelling's security with a view of less susceptibility to crime in the country, residents adopt noticeable clues based on recommendation (Newman, 1973; Jeffery, 1977). These spatial planners found that some features of physical settings, such as indicators of territory and surveillance opportunities like burglary proof to openings, fencing, and lighting, can reduce crime (Badiora, 2014). However, there is a general trend towards the erection of high perimeter fences, large gates and strong locks, fortification of buildings with burglary proofing and installation of security lighting to deter intruders at night and a host of other security measures.

Badiora (2014) revealed the most occurring crime types in the traditional town centre, middle-income residential area, high-income residential area, post-crisis residential area and Ile-Ife Township using the crime rate occurrence index (CROI). It was found that store breaking, housebreaking and burglary were the top three criminal occurrences at different residential areas. Also, Adepoju *et al.* (2014) used geo-spatial technologies for crime hot-spot mapping and analysis of Abuja, Nigeria. The study emphasized the need for modern management techniques for effective crime mapping, monitoring and management to attain a liveable environment in spite of the architectural expression of the modern city in Abuja.

Building construction for residential and commercial purposes in Nigeria nowadays routinely includes security-conscious components such as perimeter fencing, gate house and exterior lighting to the building territory. Also, anti-burglar screen to doors and windows, glass-break detection, sensor lights, burglar alarms systems and security cameras are used to detect and control the access. However, the rate of inclusion of these components in houses tends to imply that they are a necessity and that the costs involved are no longer a deciding factor. Such costs do, however, inflate the cost of construction. The implications of such costs in relation to the total building cost are so far unknown. This study therefore seeks to evaluate the built environment experts' perception of a sustainable the building security cost within the built environment in Nigeria, with a view to providing practical evidence of the factors that affect cost of building security.

3. Methodology

The study used a quantitative research technique, using questionnaires to source relevant information from respondents. Glatte (2015) described this method as useful for generating and processing measurable key indicators that can be expressed in figures and units. Thus, the adoption of this method analyzed and presented the findings of the key indicators in tables, figures and units for clarification. This study focuses on built environment experts, namely architects, builders, quantity surveyors, urban and regional planners and estate surveyors and valuers, all registered under their recognized professional bodies or institutions within the Federal Capital Territory Abuja, Nigeria.

The study examines the effects of the physical characteristics of building "descriptor variables" and security measures "influence variables" on the cost of building security. According to Sekaran and Bougie (2009), dependent variables are variables of primary interest to the researcher, while independent variables influence the dependent variables in either a positive or a negative way. Therefore, with the presence of both variables, a unit increase in independent variables implies an increase in the dependent variable or otherwise.

For the purposes of this study, probability sampling technique was used to select the required number of participants. Probability sampling is utilized in a situation where the element being stated is known, while non-probability sampling is adopted when the researcher is not concerned about how well the samples represent the population (Morenikeji, 2007). The choice of sampling technique is based on the availability of data sourced from five relevant professional bodies at the institutes secretariat. The Institutes provided the population of their members from which the sample was derived. The finite population formula used by Krejcie and Morgan (1970) and Sekaran and Bougie (2009), which was similar to that used by Williams *et al.* (2009), was used to determine the sample size. Response rate in research refers to the percentage representation of completed and returned questionnaires out of the target sample size.

According to Ali *et al.* (2010), a typical research survey requires at least 30 per cent response rate to provide reliable and convincing results, while Frohlich (2002) set it at an average of 32 per cent for a typical survey research. However, out of 333 questionnaires distributed in this research, 300 were returned and only 293 were usable, resulting in an 88 per cent response rate. This response could be regarded as acceptable when compared with previous research carried out in Nigeria. For instance, Fagbenle and Oluwunmi (2010) returned a 60 per cent response rate in their study of building failure and collapse in Nigeria. Also, Afon and Badiora (2013), in their study of spatial distribution of delinquent behaviour in Ile-Ife (a traditional city in Nigeria), had a response rate of 94 per cent. Therefore, based on these, the 88 per cent response rate achieved in this study is considered appropriate for analysis.

The instrument for this research work is a questionnaire, whereby some of the questions provided were rephrased from previously conducted research questions to suit this study. Closed-ended survey questions were used, which require the respondent to choose from a limited number of responses predetermined by the researcher. The approach was used to provide primarily quantitative data for factors influencing the cost of building security. To ensure that the set of items that tap the concept were adequately represented in the measurement, content validity was chosen to validate the instruments used.

Sekaran and Bougie (2009) described content validity as a method used to measure how items in the questionnaire adequately represent a concept. This research thus adopted the procedure of content validity to address the adequacy and representativeness of the items in the questionnaire under study. Two approaches were used; first by consulting a small sample of typical respondents to evaluate the suitability of the items selected to measure the construct (Hair *et al.*, 2010). Second, a draft instrument of the study was distributed to some experts for review to check the suitability, adequacy and clarity of the study instrument. Their comments and suggestions were integrated with the improvement of the contents and the wordings of the questions. For instance, the use of common and daily terms were suggested by the experts, while it was advised to avoid the use of technical and generic terms for easy understanding of the questionnaire. Also, it was advised to avoid long and complex sentences, while it was also suggested to rephrase others to achieve clarity.

Data analysis was carried out using statistical package for social science (SPSS 21.0 version) to test the reliability. Cronbach's alpha was used to determine whether the data were reliable or not. Also, the normality plot (histogram) and normal P-P plot were plotted to affirm the reliability and normality of the data. Exploratory factor analysis (EFA) was, in addition, used to examine the suitability of data for factor analysis and to identify both the positive and negative factors under consideration. Principal component analysis (PCA) was used to extract factors, while the number of factors to be reserved was assessed in line with the following decision rules: eigenvalues greater than 1, scree plot and parallel analysis. Also, the suitability of data was checked by assessment of the correlation matrix for confirmations of coefficients above 0.3 are many, when few factor analysis is not appropriate (Tabachnick and Fidell, 2007). Furthermore, the Bartlett's test of sphericity should be significant at $p < 0.05$ for factor analysis to be considered appropriate as well as the Kaiser-Meyer-Olkin (KMO) index (ranges from 0 to 1), with 0.6 as the benchmark value for a good factor analysis.

Factor extraction was used to verify the factors with a higher effect among the items using principal component analysis, similar to the study conducted by Ahmadu *et al.* (2015); Trost and Oberlender (2003) and Nuruddeen and Said (2012). Kaiser's criterion or eigenvalue rule (eigenvalue of 1 and above are retained) and parallel analysis (Choi *et al.*, 2001; Stöber, 1998) are used to discover the exact components to be retained. Factors are rotated so as to get the pattern of loadings for simple interpretation using direct oblimin rotation.

4. Analysis and results

4.1 Demography of respondents

Table I presents the frequency and percentage of the respondents' job title or discipline, age, level of education and their years of experience.

4.2 Normality and reliability test of the data

Table II presents the summary of items statistics with the average mean of 4.28 for the construct, an indication that they are effective. Also, the mean inter-item correlation is 0.37 which falls within the optimal range of 0.2 and 0.4 as recommended for inter-item correlation (Pallant, 2011). This is an indication that there is a strong relationship between the factors and, thus, shows that the factors affect the sustainability of the building security cost within the built environment.

Parameters	Frequency	(%)	Valid percent	Cumulative %
Job title				
Architects	85	29.0	29.0	29.0
Builders	33	11.3	11.3	40.3
Quantity surveyors	78	26.6	26.6	66.9
Urban and regional planners	62	21.2	21.2	88.1
Estate surveyors and valuers	35	11.9	11.9	100.0
Age				
Upto 29	74	25.2	25.2	25.2
30-40	137	46.8	46.8	72.1
41-45	66	22.5	22.5	94.6
46-50	16	5.5	5.5	100.0
Level of education				
HND	32	10.9	10.9	10.9
Bachelor	55	18.8	18.8	29.7
Master	190	64.8	64.8	94.5
PhD	16	5.5	5.5	100.0
Years of experience				
1-5	34	11.6	11.6	11.6
6-10	65	22.2	22.2	33.8
11-15	112	38.2	38.2	72.0
16-20	41	14.0	14.0	86.0
21-25	41	14.0	14.0	100.0

Table I. Demographic information of the respondents' survey

	Mean	Minimum	Maximum	Range	Maximum/ Minimum	Variance	No. of items
Item means	4.278	3.870	4.451	0.580	1.150	0.026	17
Inter-item correlations	0.374	−0.045	0.835	0.881	–18.437	0.039	17

Table II. Summary item statistics

Table III presents the reliability of the entire construct. The Cronbach's alpha of 0.908 observed is appropriate for this construct, given excellent internal consistency reliability for the scale with this sample. The result of this reliability test is consistent with the recommendation of DeVellis (2011) and Maiyaki and Mokhtar (2012) that a Cronbach's alpha of above 0.7 is acceptable, while a Cronbach's alpha of 0.8 and above is preferable. Thus, the observed Cronbach's alpha for this study suggests that the constructs are reliable and can be used to predict the cost of building security within the built environment. Figure 1 presents a histogram of the data with a bell-like shape, which is assumed to be normally distributed. In addition, Figure 2 presents the P-P plot values, which were also very close to the reference lines, thereby indicating that the data are normally distributed and reliable.

4.3 Factor analysis

Factor analysis was performed on all the 17 items used to measure building security costs to determine the goodness of the instrument for this study. The items of the questionnaire were subjected to principal component analysis and direct oblimin

Table III.
Reliability statistics

Cronbach's alpha	Cronbach's alpha based on standardized items	No. of items
0.908	0.910	17

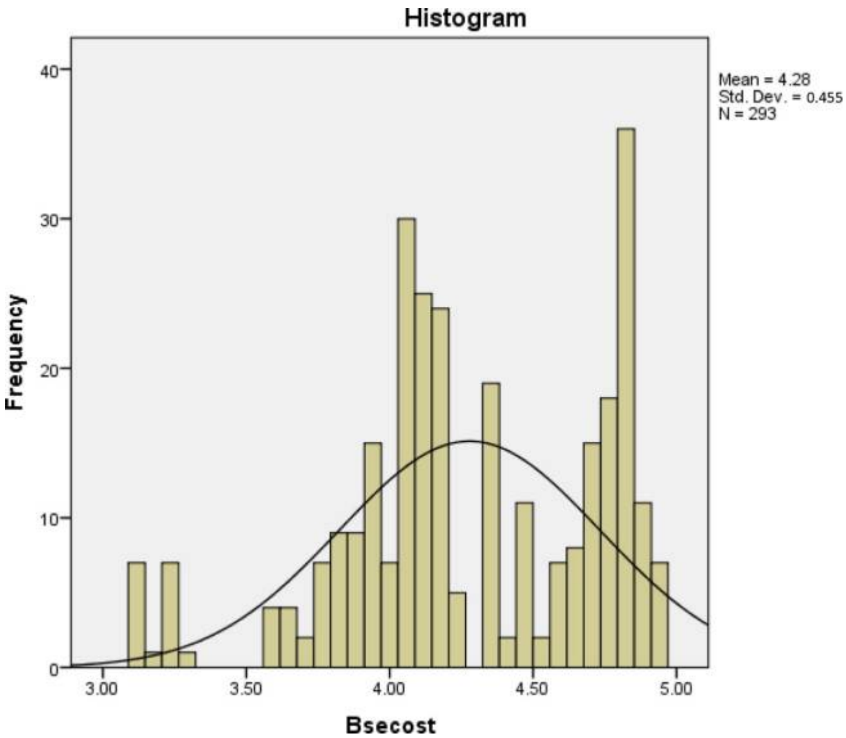

Figure 1.
Normality distribution of the data

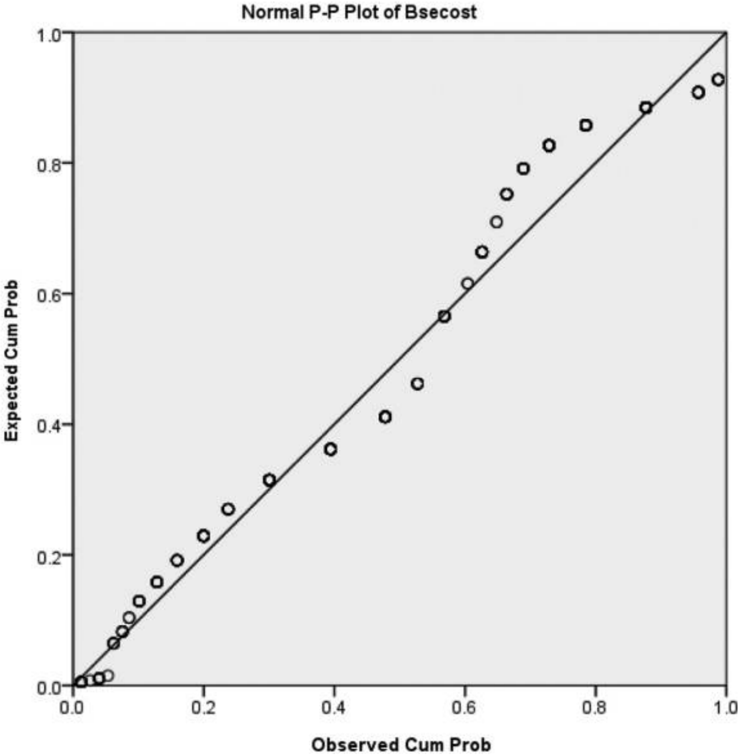

Figure 2.
Normal P-P plot of the data

rotation using SPSS 21.0 version. However, the appropriateness of the data for factor analysis was evaluated.

Table IV presents the correlation matrix of the items of the questionnaire affecting the building security costs within the built environment. The result reveals that 158 out of 289 items have a coefficient of 0.3 and above, which indicates that factor analysis can be used in this study.

Table V presents the KMO measure of sampling adequacy of the items, valued at 0.785, consistent with the value of 0.6 as recommended by Kaiser (1974). Moreover, the Bartlett's (1954) test of sphericity was statistically significant, with a value of 0.000 supporting the factorability of the correlation matrix.

Table VI presents the principal components analysis of the factors. Three components met the selection criteria of eigenvalues of greater than 1.0, explaining 43.724, 12.159 and 9.098 per cent of the variance in that order, with a total of 64.981 per cent variance in the items. This indicates that these factors are the ones that have a high effect on building security costs for sustainable cost evaluation within the built environment.

Figure 3 presents the scree plot of the data. An examination of the chart revealed a sudden and constant change after the third component. As a result, components just above this point are retained. These were additionally upheld by the outcomes of the parallel analysis (Table X), which indicated just three components with eigenvalues

Table IV.
Correlation matrix

Code	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CO10	CO11	CO12	CO13	CO14	CO15	CO16	CO17
CO1	1.000	0.208	0.500	0.573	0.216	0.268	0.387	0.297	0.343	0.064	0.461	0.581	0.497	0.492	0.038	-0.045	0.472
CO2	0.208	1.000	0.370	0.417	0.300	0.197	0.172	0.565	0.288	0.199	0.320	0.342	0.314	0.380	0.320	0.560	0.363
CO3	0.500	0.370	1.000	0.580	0.013	0.160	0.300	0.544	0.366	0.036	0.526	0.643	0.509	0.651	0.261	0.287	0.693
CO4	0.573	0.417	0.580	1.000	0.192	0.270	0.592	0.445	0.273	0.180	0.562	0.685	0.638	0.645	0.284	0.424	0.694
CO5	0.216	0.300	0.013	0.192	1.000	0.547	0.167	0.429	0.403	0.244	0.280	0.223	0.234	0.176	0.223	0.014	0.307
CO6	0.268	0.197	0.160	0.270	0.547	1.000	0.219	0.516	0.388	0.403	0.477	0.214	0.156	0.328	0.259	0.080	0.378
CO7	0.387	0.172	0.300	0.592	0.167	0.219	1.000	0.366	0.206	0.029	0.537	0.458	0.551	0.548	0.199	0.338	0.589
CO8	0.297	0.565	0.544	0.445	0.429	0.516	0.366	1.000	0.535	0.430	0.585	0.451	0.424	0.522	0.283	0.424	0.686
CO9	0.343	0.288	0.366	0.273	0.403	0.388	0.206	0.535	1.000	0.167	0.625	0.374	0.257	0.509	0.271	0.204	0.373
CO10	0.064	0.199	0.036	0.180	0.244	0.403	0.029	0.430	0.167	1.000	0.231	0.086	0.048	0.085	0.154	0.275	0.187
CO11	0.461	0.320	0.526	0.562	0.280	0.477	0.537	0.585	0.625	0.231	1.000	0.653	0.604	0.706	0.476	0.357	0.702
CO12	0.581	0.342	0.643	0.685	0.223	0.214	0.458	0.451	0.374	0.086	0.653	1.000	0.835	0.817	0.240	0.110	0.767
CO13	0.497	0.314	0.509	0.638	0.234	0.156	0.551	0.424	0.257	0.048	0.604	0.835	1.000	0.749	0.209	0.149	0.772
CO14	0.492	0.380	0.651	0.645	0.176	0.328	0.548	0.522	0.509	0.085	0.706	0.817	0.749	1.000	0.191	0.219	0.729
CO15	0.038	0.320	0.261	0.284	0.223	0.259	0.199	0.283	0.271	0.154	0.476	0.240	0.209	0.191	1.000	0.552	0.234
CO16	-0.045	0.560	0.287	0.424	0.014	0.080	0.338	0.424	0.204	0.275	0.357	0.110	0.149	0.219	0.552	1.000	0.208
CO17	0.472	0.363	0.693	0.694	0.307	0.378	0.589	0.686	0.373	0.187	0.702	0.767	0.772	0.729	0.234	0.208	1.000

surpassing the comparing benchmark values for an arbitrarily produced data matrix of the same size (17 variables × 293 respondents).

Table VII presents the component matrix showing the un-rotated loadings of each of the items on the three components. Items exceeding 0.4 are mostly loaded on the first component, little items are on the second and third components, respectively, which implies that Component 1 is more effective and Component 3 is less effective.

5. Discussion

The results presented reveal the factors affecting the building security cost within the built environment. The first component seems to reflect concern for procurement of security devices. The second component appears to reflect concern for design process of security requirements, while the third component appears to show concern for safety of life and property and fear of crime.

Table VIII presents a pattern matrix which shows the items loading on three factors with nine items loading above 0.3 on Component 1, five items loading on Component 2

Kaiser-Meyer-Olkin measure of sampling adequacy	0.785
Bartlett's test of sphericity	
Approx Chi-square	3,794.706
df	136
Sig.	0.000

Table V. Building security cost Kaiser-Meyer-Olkin (KMO) and Bartlett's test

Component	Initial eigenvalues Total	% of variance	Cumulative %	Extraction sums of squared loadings Total	% of variance	Cumulative %	Rotation sums of squared loadings[a] Total
1	7.433	43.724	43.724	7.433	43.724	43.724	6.780
2	2.067	12.159	55.883	2.067	12.159	55.883	3.636
3	1.547	9.098	64.981	1.547	9.098	64.981	3.106
4	0.924	5.432	70.413				
5	0.917	5.395	75.808				
6	0.785	4.617	80.426				
7	0.653	3.840	84.266				
8	0.641	3.770	88.036				
9	0.523	3.077	91.113				
10	0.391	2.298	93.411				
11	0.303	1.780	95.191				
12	0.213	1.253	96.444				
13	0.168	0.986	97.430				
14	0.159	0.936	98.366				
15	0.119	0.702	99.068				
16	0.093	0.545	99.613				
17	0.066	0.387	100.000				

Notes: Extraction method: principal component analysis (PCA); [a]when components are correlated, sums of squared loadings cannot be added to obtain a total variance

Table VI. Total variance explained

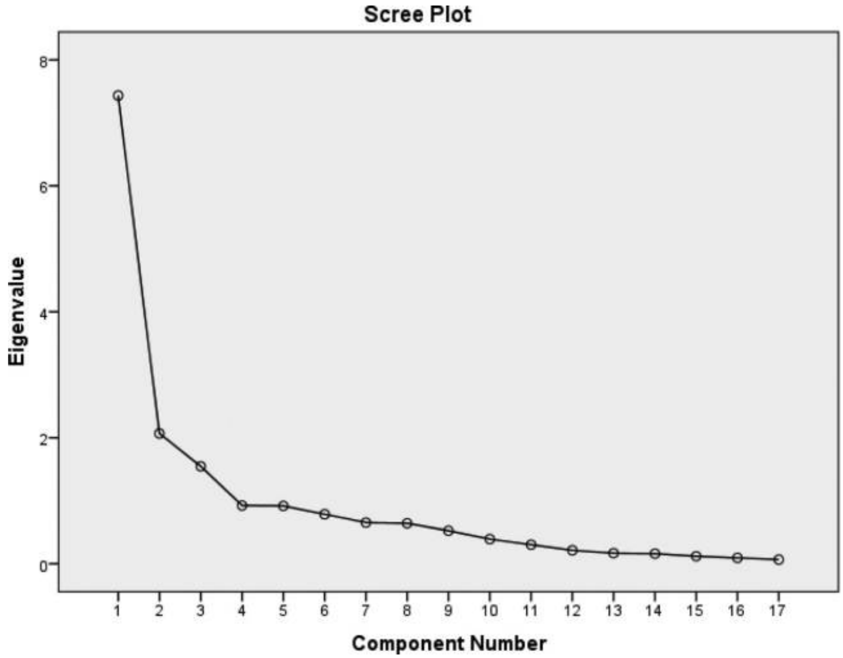

Figure 3.
Scree plot of the data

Table VII.
Component matrix[a]

Item	Component 1	2	3
BSC affects total building cost (TBC)	0.875	−0.175	−0.065
Cost of operating and maintaining security devices influences BSC	0.846	−0.265	−0.028
Increasing provision of aesthetics influences BSC	0.841	0.069	−0.037
Cost of acquiring security devices influences BSC	0.827	−0.368	−0.051
Cost of providing security lighting influences BSC	0.794	−0.175	0.183
Cost of installing security devices influences BSC	0.778	−0.383	0.000
Use of building influences BSC	0.755	0.375	−0.055
Cost of erecting PFPG influences BSC	0.720	−0.233	0.187
Increase in size influences BSC	0.631	−0.199	0.116
Cost of securing access influences BSC	0.608	−0.329	−0.281
Increase in number of external wall openings influences BSC	0.586	0.264	−0.255
Cost of installing intruder-detection gargets influences BSC	0.545	0.340	0.335
Complicated plan shape influences BSC	0.275	0.566	−0.132
Investment in building security reduces fear of crime	0.424	0.424	0.392
Investment in building security increases safety of life and property	0.420	0.446	0.714
Building location influences BSC	0.400	0.444	−0.518
Increase in storey height of building influences BSC	0.488	0.473	−0.497

Notes: Extraction method: principal component analysis; [a] three components extracted

Table VIII. Pattern and structure matrix for PCA with oblimin rotation

Item	Pattern coefficients Component 1	2	3	Structure coefficients Component 1	2	3	Communalities
Cost of acquiring security devices influences BSC	**0.926**	−0.008	−0.074	**0.904**	0.264	0.169	0.822
Cost of installing security devices influences BSC	**0.898**	−0.070	−0.049	**0.885**	0.327	0.250	0.753
Cost of operating and maintaining security devices influences BSC	**0.867**	0.053	0.007	**0.881**	0.421	0.288	0.786
BSC affects TBC	**0.825**	0.154	0.031	**0.863**	0.200	0.171	0.800
Cost of providing security lighting influences BSC	**0.761**	0.055	0.230	**0.804**	0.242	0.417	0.694
Cost of erecting PFPG influences BSC	**0.743**	0.119	0.186	**0.764**	0.539	0.423	0.607
Cost of securing access influences BSC	**0.723**	0.137	−0.300	**0.755**	0.162	0.352	0.558
Increase in size influences BSC	**0.648**	0.065	0.124	**0.686**	0.288	−0.074	0.451
Increasing provision of aesthetics influences BSC	**0.622**	0.297	0.183	**0.660**	0.170	0.279	0.713
Increase in storey height of building influences BSC	0.048	**0.841**	−0.069	0.294	**0.839**	0.157	0.709
Building location influences BSC	0.000	**0.813**	−0.122	0.223	**0.782**	0.084	0.625
Complicated plan shape influences BSC	−0.188	**0.575**	0.257	0.577	**0.691**	0.535	0.414
Increase in number of external wall openings influences BSC	0.277	**0.535**	0.047	0.458	**0.634**	0.256	0.478
Use of building influences BSC	0.334	**0.506**	0.319	0.061	**0.582**	0.353	0.713
Investment in building security increases safety of life and property	0.017	0.113	**0.959**	0.235	0.136	**0.935**	0.885
Investment in building security reduces fear of crime	0.035	0.116	**0.667**	0.247	0.296	**0.705**	0.513
Cost of installing intruder-detection gargets influences BSC	0.192	0.130	**0.596**	0.391	0.342	**0.680**	0.525

Note: Major loadings for each item are bolded and three on Component 3. As each component has three and above items loading, we consider this solution optimal. Also, the items that positively affect building security costs are strongly loaded on Component 1, while those that either positively or negatively affect sustainable building security are under Component 3. Furthermore, the strength of the correlation between factors presented by structure matrix is higher on Component 1, followed by Component 2 and then Component 3, respectively. It thus implies that items that have higher loadings under Components 1 and 2 have a positive effect on the costs of building security. Moreover, the items with higher loadings under Component 3 contribute either positively or negatively to sustainable building security costs within the built environment. However, the communalities which represent the R^2 values are relatively strong across the variables. For instance, aesthetics is significant with an R^2 value of 0.71, which shows that this factor should be given due consideration when procuring security devices for building. Also, height, location and use of building are significant with R^2 values of 0.70, 0.63 and 0.71, respectively.

The component correlation matrix of the factors as shown in Table IX indicates a weak or non-significant positive correlation between factors one and two (0.314), between factors one and three (0.265) and between factors two and three (0.254). These imply that each item is independent and does not affect each other. The Monte Carlo principal component analysis for parallel analysis presented in Table X also indicates that Items 1, 2 and 3 have the highest random eigenvalues in the parallel analysis, as it is compared in Table XI with the actual eigenvalues from principal component analysis. The criterion values from the parallel analysis are all less than the initial eigenvalue which make it acceptable.

6. Conclusion

A sustainable community is one that is safe, perceives itself to be safe and is considered to be safe by others. Factors that positively contribute to the building security cost include procurement, installation and maintenance of security devices; provision of security lighting, erection of perimeter fence protection and security house; and hardening of target openings, size and aesthetics of building. Also, height of building, location of building, plan shape, number of external openings and use of building contribute to the design implication of building security. Furthermore, investments in building security make a positive contribution to the safety of life and property and reduce the fear of crime, while non-investment in building security negatively affects the safety of life and property and escalates fear of crime.

The strong communalities observed across the variables is an indication that these factors positively influence building security costs and should be given due consideration when designing protective buildings. Thus, this study proves that the

Component	1	2	3
1	1.000	0.314	0.265
2	0.314	1.000	0.254
3	0.265	0.254	1.000

Notes: Extraction method: principal component analysis; rotation method: Oblimin with Kaiser normalization

Table IX. Component correlation matrix

Eigenvalue No.	Random eigenvalue	SD
1	1.4282	0.0462
2	1.3427	0.0299
3	1.2809	0.0284
4	1.2226	0.0275
5	1.1702	0.0268
6	1.1164	0.0237
7	1.0728	0.0202
8	1.0272	0.0220
9	0.9856	0.0224
10	0.9439	0.0217
11	0.9018	0.0188
12	0.8616	0.0211
13	0.8188	0.0220
14	0.7803	0.0227
15	0.7319	0.0232
16	0.6874	0.0240
17	0.6277	0.0285

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Number of variables: 17
Number of subjects: 293
Number of replications: 100
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Table X. Monte Carlo PCA for parallel analysis

Table XI. Comparison of eigenvalues from PCA and criterion values from parallel analysis

Component no.	Actual eigenvalue from PCA	Criterion value from parallel analysis	Decision
1	7.433	1.4282	Accept
2	2.067	1.3427	Accept
3	1.547	1.2809	Accept

factors mentioned above contribute immensely towards sustainable building security costs within the built environment. It further provides empirical evidence that the factors do have an effect on building security costs. Therefore, the findings of this study will invariably assist in the evaluation, planning and control of the rising cost of building security. The findings will also facilitate in the formulation of a tool for forecasting the probable costs of building security and procurement of security devices and services to be economically sustainable.

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