

## Design Defects and Quality of Government Funded Building Projects In Isiolo County, Kenya.

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### Abstract

*The Interface between design and pre-construction of government funded buildings projects is pivotal and yet very complicated. It is at this interface that defects emanating from design errors in the buildings have been found to occur adversely influencing the realization of quality buildings. This study investigated the influence of design defects on the quality of government funded building projects in Isiolo County. The study is guided by one theory; The Bad Apple Theory of human error. Descriptive survey research design is adopted. Study's target population consisted; 137 project clients, 92 contractors and 16 consultants. 149 respondents made up the study's sample size and final subjects selected using Stratified and Simple random sampling techniques. Primary data was collected using three questionnaires. The analysis of quantitative data was achieved making use of descriptive statistics and qualitative data on the other hand was reported in form of narratives pivoted on themes under study. The study established that poor functionality of building parts, buildings' fragility, high occurrence of unpleasant aesthetics in buildings and cost overruns were all as a result of design defects. This study concluded that design defects to a great extent influenced the quality of government funded building projects in Isiolo County. The study recommends that a design review involving project clients and consultants prior to the approval of the final design for construction should be under taken. Further, to address design defects architectures should provide clear graphic and written representations which will allow contractors to transform concepts into physical reality in execution of government funded building projects in Isiolo County.*

**Key Terms:** *Building Fragility, Cost Overruns, Design Defects, Government Funded, Unpleasant Aesthetics, Poor Functionality*

### 1.0 Introduction to Study

According to Knotten, Svalestuen, Hansen and Lædre (2015) design defects arise from the carelessness of designers combined with human errors. These they note could be avoided by addressing communication gaps between designers, carrying out design audits, re-evaluations and verifications to mitigate negative effects on quality of buildings (Knotten, et al., 2015). In a study, Suratkon and Jusoh (2015) identified various features that signify the quality of building projects; pleasant aesthetics, building structural stability and convenience in accessibility. Merhaba (2015) observed incompetence among architects as the primary cause of design defects adversely influencing the quality of public buildings. Further, Sinclair (2011) observed that as a measure of mitigating design defects while creatively meeting the needs of buildings project clients', architects ought to play an important leadership role of in the design management process.

However, Emmitt and Ruikar, (2013) note that architects need also to elaborately share their concepts with contractors and structural engineers as an effective means of addressing design defects that present adverse

effects to buildings. Design defects negatively affecting the quality of buildings are best addressed when there is a constant consultation between designers, structural engineers, quantity surveyors and contractors (Best, 2010).

### 1.1.1 Design Defects

Design defects are failures arising from omissions. A design is defective if it fails to meet the professional standard of care. Design also becomes defective if the contractor and subcontractors fail to execute work in accordance with the plans and specifications (Gray & Hughes, 2001). Construction defects can be visible to the eye or concealed deep within the structure. In Peru, Lopez, Love, Edwards and Davis (2010), did point out that design defects did adversely influence the quality of 75% of government funded building projects.

In Asia, Jaafar and Othman (2015) observed that design defects were responsible for an estimated 55% poor functionality building parts and unpleasant aesthetics adversely influencing the quality of public hospitals' buildings in Malaysia. In Pakistan, Choudhry, R. M., Gabriel, H.F., Khan, M.K., and Azhar, S. (2016) design defects were responsible for the poor functionality of building parts and structural instability of public buildings which significantly influenced the quality of these government funded buildings projects.

In Africa, Fugar and Agyakwan-Baah (2010) did report that design defects were responsible for delays in building construction projects funded by the government which adversely affected the quality of 73% of such projects in Ghana. In Nigeria, Adesoji (2011) did estimate that 81% of public housing projects were of poor quality due to numerous design defects, in Zambia, Muya Kaliba, Sichombo and Shakantu (2013), did report that design defects resulted in schedule overruns which was positively correlated to poor quality of government funded building. In Kenya, Matindi (2013) did point out that most public buildings constructed through government funding were poorly maintained and were at poor quality standards as evidenced by the numerous defects found in these houses.

## 2.0 Statement of the Problem

Whilst the quality of buildings and in particular those funded by governments in terms of; the availability of pleasant aesthetics, building durability and functionality of buildings parts is of vital importance to project clients and the populations they serve. Buildings funded by governments including; public hospital and schools buildings, public housing and government offices have been reported to be below quality standards. This has been reported to originate from; inconsistency of consultations on design and unreliable design specifications coupled with the involvement of incompetent contractors.

Government funded buildings in Isiolo County are no exception. These buildings according to a report done by the ministry of public works (2015) on fourteen (14) government funded buildings had both their

construction stopped and declared inhabitable due to quality related issues (Ministry of Public works-Isiolo). The report further points out that the buildings exhibited defects such as; stained ceilings, pipes leakage, water seepage, cracked walls, delaminated tiles, discoloured wall paint and peelings. This study sought therefore to investigate the influence of design defects on the quality of government funded building projects in Isiolo County.

### 3.0 Research Hypothesis

**H<sub>0</sub>:** Design defects do not have a significant relationship with the quality of government funded buildings projects.

**H<sub>1</sub>:** Design defects have a significant relationship with the quality of government funded buildings projects.

### 4.0 Design Defects and Quality of Government Funded Building Projects

According to Christensen, (2010) design defects do adversely influence the quality of building projects and in the process lead to both a decrease in their functionality quality and increase their vulnerability of collapse. He for instance pointed out that design errors can result to cracks in beams and pillars, poorly installed interiors such as doors, windows and hanging ceilings (Christensen, 2010). Love, Lopeza, Goh and Tam (2011), also noted that design errors remain an innate feature of buildings construction and engineering projects particularly those under government supervision.

For instance in a Danish study Pedersen, Aagaard and Neilsen (2009), demonstrated that cracks in beams and pillars that had arose from numerous design defects were responsible for the collapse of the government funded Rødovre Skating Arena. Reenberg, et al., (2010) who in their study on design errors in Danish public buildings did reiterate these findings by noting that design defects were responsible for collapse of government funded public recreation centres in the country. Similarly Pedersen, Nielsen and Aagaard (2011), in his study on factors responsible for the collapse of the Club Denmark Sports Centre did demonstrate that design defects that had arose from supervision lapses that lead to artisan incompetence making the building more fragile leading to its collapse. This study concluded that errors in design were responsible for the many cracks on the building's pillars and beams which weakened the building (Pedersen, et. al., 2011).

In a study in Malaysia, Hassan, Isa, Mat, Ithnin and Sapisey (2009), did also posit the poor quality in which public hospitals buildings were in did arise from design defects. This was echoed in a study by Haryati, Masnizan, Zarina and Zulkifli (2011), who did contend that most government funded public hospitals buildings had poor functionality arising from design defects. Further, they pointed out that most of these public hospital buildings had some inaccessible parts and had salient unpleasant aesthetics arising from

lapses in supervisions and incompetence artisans (Haryati et. al., 2011). Similar findings had been reported in an earlier study by Olanrewaju, Mohd Fris and Arazi (2010), who demonstrated that design defects were responsible for inaccessibility of some parts of public university buildings; as the stairways had been poorly constructed and the buildings had exhibited poor functionality as most doors and windows were loosely fitted and had unpleasant aesthetics in form of cracking floor tiles and poorly done paint work. In a bid to find the causes of latent defects in government funded buildings in Singapore, Low and Chong, (2006) observed that design errors did adversely influence the durability of paint work and interiors such as ceilings and pillars in these buildings. They therefore advised that quality can only be enhanced through the identification of design defects and dealing with them before project completion (Low & Chong, 2006).

Zou, Zhang and Wang, (2007) did demonstrate errors in design as one of the major key risk in the durability of government funded building construction projects in China. They did emphasize that these do have a negative influence on the aesthetics of the buildings as they expose paint work and vanish on door frames to climatic conditions which adversely affects their appearance (Zou et. al., 2007). In a Pakistani study Saqib, (2008) did observe that design errors arising from lapses in supervision and incompetence of building artisans were positively correlated with cracks in beams and pillars in government funded building projects. This they observed did compromise the durability of these buildings forcing the Pakistani government to fund reworks on these buildings which resulted to schedule and cost overruns (Saqib, 2008).

Supervision lapses and artisan incompetence were found to be responsible for the many design errors in public universities in Iran forcing government to incur rework costs (Lateef,2009). Further, he argues that this involved redoing paint work, refilling of cracks on pillars and beams and replacing hanging ceiling parts (Lateef, 2009). However, in a study in Israel Shohet, Lavy-Leibovich, and Bar-On, (2010) postulated that excellence in supervision and the contracting of competent artisans did minimize design errors during construction which positively influenced the quality of public hospitals buildings thereby reducing government costs incurred during maintenance. Further, they observed minimal design defects during construction were positively correlated to the installation of high quality building interiors such as ventilation which enhanced the air circulation in these buildings (Shohet, et. al., 2010). Al Rubaiey, Ulanga and Baharum (2014) in their study on 15 public buildings in Oman found out that that poor design on public buildings coupled with supervisions lapses and artisan incompetence did result to numerous errors in design during the construction of these buildings which negatively influenced the quality of these buildings. Further, they contend that errors in design during construction presented numerous challenges for the maintenance of these public buildings thereby leaving most of them with poor ventilation, roofs, facades and the substructure of the buildings (Al Rubaiey, et. al., 2014).

Oyewobi and Ogunsemi, (2010) in their study on several government funded buildings projects in Nigeria demonstrated that design errors contributed to the poor inaccessibility of some of the buildings characterized

by poorly installed doors and poorly constructed stairways, unpleasant aesthetics in paint work coupled with poor finishing of rough walls and ceilings. Further, they contend that to bring these buildings to quality standards, the government is forced to fund reworks in most of these buildings resulting to cost overruns for these buildings projects (Oyewobi & Ogunsemi, 2010). These findings were echoed in study by Shittu, Adamu, Mohammed, Sulieman, Isa, Ibrahim and Shehu (2013), who observed that most public buildings projects had building defects arising from poor workmanship which had a positive relationship, with defects in design during construction.

In a South African study Rhodes and Smallwood, (2003) found out that the quality of most government funded buildings was compromised by design defects which had resulted to fragile walls that placed these buildings in the vulnerability of collapse. Further they argued that the government was forced to fund reworks in these buildings contributing to cost overruns of most of these projects (Rhodes & Smallwood, 2003). Similarly in a separate study Zunguzane, Smallwood and Emuze (2012), did demonstrate that most government funded low-income houses in the country were delivered at poor quality and most buildings were at the verge of collapse due evidenced from numerous cracks on walls and pillars. Further, they contend that errors in design were responsible for the loss of the allure of paint work on the walls arising from exposure to the abrasive climatic conditions (Zunguzane et. al., 2012).

Studies in East Africa also emphasize on the adverse influence of design defects on the quality of government funded buildings and facilities. Kakitahi, Alinaitwe, Landin and Rodgriues (2014), found that numerous design errors in government funded buildings in Uganda did lead to numerous reworks on cracked walls, beams and pillars resulting to cost overruns. They also pointed out that design defects had also resulted to hanging ceiling panels and poorly fitted windows and doors which in some buildings were left like that during reworks as a result of limited funding (Kakitahi et al., 2014). Kimani and Kimwele, (2014) also demonstrated the link between supervision lapses and incompetent artisans had resulted to numerous design defects on housing buildings funded by the National Housing Corporation (NHC). They also argued that it is such defects that had resulted to reworks leading to delays in the construction process leading to most buildings being delivered with already decayed door frames, clogged ventilation and unpleasant façade due to poorly done paint work (Kimani & Kimwele, 2014).

## **5.0 Theoretical Foundation**

This study is guided by one theory: The Bad Apple Theory of human error. According to Reason, (1990) the Bad Apple Theory of human error fundamentally assumes that complex systems such as construction projects fail due to the unpredictable behavior of people; human errors cause accidents and failures are unexpected. The Bad Apple Theory of Human Error therefore puts its forward that failures come as unpleasant surprises. They are unexpected and do not belong in the system. Failures are introduced to the

system only through the inherent unreliability of people. Another proponent of the theory argues that error is either the result of a bad apple, where disastrous outcomes could have been avoided if somebody had paid a bit more attention or made a little more effort. It is the result of people's poor inaccurate assessments, wrong decisions and bad judgments (Dekker, 2006). However, Love, Edwards and Han, (2011) proponents of the Bad Apple Theory of Human Error contend that errors are not a cause of an event but a symptom of a much deeper problem within a system. Human error is not a cause of failure. Human error is the effect, or symptom, of deeper trouble. Human error is not random. It is systematically connected to features of people's tools, tasks and operating environment. Human error is not the conclusion of an investigation. It is the starting point (Love, et al., 2011).

This theory seeks to unpack the influence of design defects on the quality of government funded building projects, the theory will explain the important role that; contractors and consultants (architects, structural engineers and quantity surveyors) play in the implementation of these projects as part of the overall system that makes up the environment they operate in.

## **6.0 Research Methodology**

This study adopted descriptive survey research design to investigate the relationship between design defects and quality of government funded buildings projects in Isiolo County. Survey research design made it possible for the researcher to gather both qualitative and quantitative data on the influence of design defects and quality of government funded building projects in the study locale. The link between the study variables and the problem under study was also developed through the research design of choice. This was made possible by the inherent characteristics of survey design which provides researchers with an opportunity to interrogate on study respondents' understanding, perspectives and values relating to problem under study. Descriptive Survey design is also very convenient when researchers are collecting of data from samples representing large populations. This study used a sample size of 149 respondents made of; project clients, contractors and Consultants (Architects and Structural Engineers). Final study subjects were selected making use of stratified and simple random sampling techniques. Research questionnaires were self-administered to the sampled respondents. Primary data was edited, its integrity evaluated and then coded. Statistical Package for Social Sciences (SPSS) version 21.0 was used through the application of descriptive statistics to analyze quantitative data. Findings for this study were presented making use of frequency and percentage tables to make valid conclusions. Content analysis involving the categorization of collected data into themes, structure and sub-topics modeled by the objectives of the study was employed for analysis of qualitative data.

## **7.0 Findings and Interpretations**

The study sought to establish the relationship between design defects and the quality of government funded building projects.

### Reports of Design Defects on Government Funded Buildings Projects

The research sought to determine whether there were reports of design defects on government funded buildings projects. Results are shown in Table 1.

**Table 1: Reports of design defects on government funded Buildings projects**

Opinion	Clients		Contractors		Consultants	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	56	81.2	42	84.0	6	66.7
No	13	18.8	8	16.0	3	33.3
<b>Total</b>	<b>69</b>	<b>100.0</b>	<b>50</b>	<b>100.0</b>	<b>9</b>	<b>100.0</b>

From the study results, majority of the clients as shown by 81.2% agreed that there were reports of design defects of government funded buildings projects, the same was also reported by majority of contractors (84.0%) and consultants as shown by 66.7% as well. This signifies that there were reports on design defects of government funded buildings projects. From the findings all the respondents acknowledge that defects in a project design have been escalating in the recent in the recent past. Most of the design defects were reported led to inadequate provision for movement, ignoring changing environmental weather condition, ignoring the impacts of load on the building stability, poor dimensions, overlooking the changes in soil conditions and poor structural design.

### Influence of design defects on quality of Government Funded Building Projects

The research sought to determine whether design defects on government funded building projects influence the functionality of some building parts. Results are shown in Table 2.

**Table 2: Influence of design defects on quality of Government Funded Building Projects**

Opinion	Clients		Contractors		Consultants	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	63	91.3	42	84.0	7	77.8
No	6	8.7	8	16.0	2	22.2
<b>Total</b>	<b>69</b>	<b>100.0</b>	<b>50</b>	<b>100.0</b>	<b>9</b>	<b>100.0</b>

From the study results, majority of the clients as shown by 91.3% agreed that design defects on government funded building projects influence the functionality of some building parts, the same was also reported by majority of contractors (84.0%) and consultants as shown by 77.8% as well. This signifies that design defects on government funded building projects influence the functionality of some building parts.

Respondents also explained that design defects compromised the project implementation time frame and project cost and sometimes leading to high maintenance costs.

### Statements relating to effect of Design defects on quality of Government Funded Building Projects

The study sought to determine the extent to which respondents agreed with the following statements relating to design changes. Results are shown in Table 3.

**Table 3: Statements relating to effect of Design defects on quality of GFBP**

Statement						Mean	Std Deviation
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree		
Design defects make government funded buildings fragile thereby influencing the quality of these buildings.	2.3%	5.5%	4.7%	42.2%	45.3%	4.34	0.53
Number of enquiries emanating from design defects does influence the quality of government funded building projects.	3.9%	4.7%	6.3%	53.9	31.3%	4.26	0.50
Design defects influence the functionality of buildings' parts of government funded building projects.	1.6%	2.3%	9.4%	50.0%	36.7%	4.36	0.53
Design defects do influence the occurrence of unpleasant aesthetics in government funded building projects.	3.1%	3.1%	4.7	60.2%	28.9%	4.28	0.50
<b>Average mean</b>						<b>4.31</b>	<b>0.52</b>

Results obtained on effect of design defects on government funded buildings projects, showed that majority of the respondents agreed that; design defects influence the functionality of buildings' parts of government funded building projects as shown by a mean of 4.36, design defects make government funded buildings fragile thereby influencing the quality of these buildings as shown by a mean of 4.34, design defects do influence the occurrence of unpleasant aesthetics in government funded building projects as shown by a



mean of 4.28 and that the number of enquiries emanating from design defects does influence the quality of government funded buildings as shown by a mean of 4.26.

The average mean for sub measure assessing the effect of design defects on quality of government funded building projects was 4.31 and STD deviation 0.5. This translates to agree as per the measurement scale. In other words this means that design defects had a significant influence on quality of government funded buildings projects in Isiolo County.

### Regression Analysis Results

For this study a multiple regression analysis was used to test the influence of independent variable under study (design defects) on quality of government funded buildings projects. The findings are presented in the Table 4.

**Table 4: Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.864 <sup>a</sup>	.746	.741	1.45642
Predictor: (constant)	Design Defects			
Dependent: Variable.	Quality of government funded Buildings Projects			

The study used the Adjusted R squared as the coefficient of determination to provide information on the variation in the dependent variable due to changes in the predictor variable. Based on the results in table 4, the value of adjusted R squared was 0.741 implying that there was variation of 74.1 percent on quality of government funded building projects emanating from design defects at 95 percent confidence interval. From these findings the researcher inferred 74.1% changes in quality of government funded building projects emanates from design defects.

### Regression Coefficients

The coefficient table was used in this study to determine the study model. The findings are presented in the Table 5.

**Table 5: Coefficients<sup>a</sup>**

Model	Unstandardized		Standardized	t	Sig.
	Coefficients		Coefficients		
	B	Std. Error	Beta		
1 (Constant)	-4.273	1.266		-3.375	0.023
Design Defects	-0.416	0.121	0.391	3.438	0.010

From the data in table 5, the established regression equation was:

$$Y = - 4.273 + (-0.416)$$

Based on results from the regression equation above the study noted that, a unit increase in design defects would lead to decrease in quality of government funded building projects by a factor of - 0.416, in other words this means that that increase in design defects will adversely or lower the quality of government funded building projects, in other words this means that increase in design defects would negatively influence the quality of government funded building projects. The researcher also observed that this was at a significance value of 0.010 which is < 0.05 leading to the conclusion that design defects to a greater degree influence the quality of government funded buildings projects in the study locale. Therefore the Null hypothesis that design defects do not have a significant relationship with the quality of government funded buildings projects is rejected and the Alternative hypothesis; design defects have a significant relationships with the quality of government funded buildings projects is accepted.

### Conclusion

The study also concludes that design defects leading to; structural instability of buildings, unpleasant aesthetics and buildings' parts poor functionality adversely influenced the quality government funded building projects in Isiolo County.

### Research Recommendations

The study recommends that, as a measure to deal with defects in government funded buildings projects structural design, a design review (involving project clients and consultants) prior to the final design for construction is approved should be undertaken.

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