

# An Evaluation of the Impact of Defects in Public Residential Buildings in Ghana

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## Abstract

Public housing in Ghana is a social responsibility of government by accommodating its employees. Due to inadequate or lack of thorough maintenance, a considerable number of these public residential buildings have developed various forms of defects internally, externally or both of which some are either minor or major in terms of their stages of severity. Whereas, some of these defects have seriously affected the structural integrity other defects are mild. This paper was therefore undertaken to evaluate the impact of these defects in some of these public housing or residential buildings. In arriving at the set objectives, data was gathered using the following instruments; questionnaire, personal observation and face to face interview with the occupants of these public buildings. Different types of major defects were identified of which the top twenty of the most common ones found in the buildings were listed and made part of a questionnaire where respondents ranked these defects by considering their impact of severity in terms of function and user requirements. It was realized that majority of these defects or failures can be attributed to design of the buildings, usage of buildings and lack of adequate maintenance on the buildings, also majority of the identified defects were in the low severity range.

**Keywords:** Public, Residential Buildings, Defects

## 1. Introduction

The rapid growth in population and technological advancement in all facets of life has made man to adapt to the environmental changes and secure a better form of housing to accommodate himself and his family. Man presently is not only after the provision of just any housing facility but is reliant on the provision of quality housing facilities for both aesthetics and function. The functionality of building and its envelopes is dependent on their ability to act as a weather barrier, air barrier and thermal barrier (Wilson 2013). This also includes the safety from fire and security as well as appearance and structural stability (Wong 1998).

Public housing in Ghana is necessarily a political product. The country's social structure reflects the inequalities in affordability and this has led to uneven distribution and consumption of housing facilities, although they are essential to the market economy. The failures of the Ghanaian market to provide adequate housing for all its employees have made state provision necessary (Beng-Huat 1996).

In Ghana, there is a difference between the total demands for houses to their supply creating a housing gap. There is therefore an indication of additional houses to be built to address such a necessity. However, what exists even has not been maintained to serve both their functionality and aesthetic requirements to the full. Low income and less government subvention leading to inadequate maintenance have rendered majority of the existing public housing stock to develop faults or defects either on the building fabric, fittings or fitments. Several cases of defects occurring in most of these public houses have arisen due to low quality materials being used for maintenance in the event of reducing maintenance cost compromising the quality and aesthetics of the public buildings.

Defects of various type and condition are identified in most of these residential buildings rendering the fabric to be less appealing. Their causes range from many underlining reasons right from physical agents, biological, chemical and mechanical agents. Defects can also occur when buildings age or not used in accordance to design requirements as well as lack of adequate maintenance. These normally have negative impact not only on occupants of these public buildings but society at large due to possible danger posed. The functionality of the buildings if not urgently considered might not fulfil their anticipated life span.

The findings of this paper intend to help unveil the actual causes of defects or faults on these public residential buildings and provide measures of avoiding them in order to promote cost effectiveness of housing design and construction and also to ensure a first rate living conditions. The source of the problems identified and alternative means of performance suggests solutions to the user and public as a whole. The significant factors identified regarding the occurrence of these defects or faults helps in tackling the housing need and also promote safer, cleaner and greener areas of communities and cities where people are able to develop their lives comfortably and interact with each other.

## 2.0 Problem Statement

The condition of public residential buildings leaves much to be desired. The satisfaction derived from buildings in fulfilling the function and aesthetics properties is somehow missing in most public residential buildings in

Ghana. Most of these buildings have developed various forms of defects that might have resulted either through design deficiency or lack of adequate maintenance. The design problems have occurred through specification wrongly or difficult to understand by the constructors or designers forgetting about maintenance of such facilities in the future date culminating in expensive maintenance works which government is feeling reluctant to execute. Also, different types of building materials used mainly for maintenance works are not fitting with existing materials (Baiden and Tuuli, 2004). Other sources of defects have occurred from poor workmanship or unsuitable construction detailing, or inappropriate usage of the completed buildings or attack by pollutants and various agents

The defects and faults identified include; structural defects e.g. cracks in floors, walls and some structural elements, etc, plumbing defects e.g. leakages in most pipe works, toilet seats not firmly fixed to the ground, cross thread on valves, etc., carpentry defects e.g. broken door handles, improper function of door locks, leakage from roof, kitchen cabinet been rotten, etc., electrical defects e.g. poor functioning of light switches, ceiling fan, etc. These defects can be attributed to some or all of the following; how the building was designed and constructed; performance of the contractors selected for the project at stake; and quality of materials used for the construction. Other forms of these faults identified include: inadequate parking space for the occupants; green plants growing on paved floors; cracks in structural members; and no recreational space for kids.

### **3.0 Objectives of the Study**

The main aim of this paper is to evaluate the impact of defects in public residential buildings in Ghana, and to identify the extent of defect ranges in terms of severity. Specific objectives were:

- 1.To identify the nature and condition of public residential buildings in Ghana
- 2.To identify possible causes of defects and faults in public residential buildings
- 3.To determine the extent of faults or defects on these public residential facilities
- 4.To determine the severity range of the defects in terms of their impact on the building fabric

The study will provide an in-depth understanding to the fact that it is not the number of buildings that determines whether its operation can be disrupted but rather the severity of the identified defects. The paper will inform all maintenance professionals the need to prepare severity investigation for prioritization of remedial measures.

### **4.0 Literature Review**

An extensive literature on investigation into public residential buildings failures and their avoidance have been published by different scholars in most parts of the developed world and can readily be assessed. However, there seems to be scant information of this literature in Ghana. Much of what exists is specific in nature and tailored towards the researcher's interest. This literature therefore considers what a public residential building is; by identifying their current condition. The need to identify possible causes of defects, if any becomes pressing, by further determining the extent of these defects by also considering the impact of the defects on both the occupants and the buildings.

#### *4.1 Public Residential Housing*

Public housing is a form of government provision for accommodation for its employees as a rental facility. Financial arrangements are done either centrally or locally depending on the condition of service or governmental agency the employee is under. Management of such facilities is in the hands of the state institution of the employee. Public housing comes in all sizes and types, from single family bungalows, semi-detached houses, medium and high-rise apartments. The inception of this provision was mandated by government through the State Housing Corporation in 1956 which was then known as the Gold Coast Housing Corporations. It functioned as government's main housing development agency. Most of these public residential houses have been constructed in the form of an estate. They have been built of only a few styles or design and thus, are uniform in function and aesthetics.

They were designed, constructed and to be maintained to live to their required life span normally of an average of about fifty years or more. Their supply or provision increased the building stock of the country as well as made towns, cities and rural areas better places to live and work. These encouraged harmony within and between communities and also worked to meet sustainable developmental goals. The successful operation or usage of these facilities after completion required adequate balance to be struck between a range of factors such as accessibility, security, safety, privacy, community interaction, availability of appropriate services and the provision of adequate space to give a standard comfort.

The absence of a single or most of these factors leads to the building failing to perform some of or all of its functions leading to defects or failure to elements within the buildings or fittings or fitments. The causes of these defects or failures are given the primary consideration bearing in mind that only public residential buildings are investigated. These defects affect society at large due to possible danger or discomfort posed.

Direct and indirect cost in repairs also arises leading to high maintenance, disputes and possible loss of the usage of the buildings.

#### 4.2 Defects

A building defect is any characteristics exhibited which hinders the usability of the building for the purpose for which it was designed and constructed. Defects is defined as ‘frailty or shortcoming that prevents an item from being complete, desirable, effective, safe, or of merit, or makes it to malfunction or fail in its purpose (Business Dictionary.com)’. It is the non-conformity of an element or fittings with respect to a standard or specific feature. It is to indicate only a deviation from standard that may, but will not necessarily, result in failure (Kasim 2009). Defects or faults are regular problems in any residential buildings. Several defects arise as buildings age (Ransom, 1981).

#### 4.3 Causes of defects

Defects are caused by underlying problems and not necessarily from a single effect e.g. a crack in a concrete floor could be a symptom of maybe foundation movement or inefficient workmanship or poor design of concrete mix. Defects occur when the building structure experiences an improper condition leading to failures or low performance and utilization of the building. As a result it does not only affect the building aesthetically but users safety may sometimes be required (Che-Ani et al., 2011).

There are four main causes of building defects. These are inadequacies in design, construction, inappropriate operational or usage not in accordance to design and lack of or incorrect maintenance. However, defects that are identified in existing public residential buildings have arisen through wear and tear because of lack of adequate maintenance (Gatlin, 2013). These resulted from either latent or patent defects. Four main classifications of defects are shown in Table 1 below;

Table 1: Classification of defects and their implication (Business Dictionary.com)

Classification	Implication
Class 1	Very serious, directly causes severe injury or catastrophic loss
Class 2	Serious, directly causes significant injury or economic loss
Class 3	Major, related to significant problems with respect to intended normal or reasonable use
Class 4	Minor, related to minor problems with intended normal or reasonable use

In the process of inspection or monitoring of the condition of buildings, defects in materials and or workmanship that are discovered that may cause failure or malfunction of buildings, such defects are known as patent defects. Whilst hidden or latent defects are realized in the process of inspection or monitoring of the condition of buildings, but are not easily discovered. The major contributors to these latent defects are design deficiencies and this can be prevented or overcome by improving design (Low and Chong, 2004).

#### 4.4 Defect rate and severity index

The defect rate was used to provide information on the number of identified defects that have occurred on public residential buildings in Ghana. It measures the volume of defects recorded from the field research observation. The rate is simply the count of all necessary defects or faults identified divided by the population of interest. Each defect identified, regardless of the type or seriousness of the defect counts the same in the rate, e.g. one structural defect counts the same as a hair line crack on the public residential buildings.

Percentage evaluation of the defects in this case may seem vague as the buildings may continue to perform in terms of function and useability. Hence, there is also need of evaluation using the severity index to assess the true extent of the defect occurrence on the various buildings in terms of both function and useability.

The principle behind the defect severity index was to have more serious defects carry a higher weight than less serious defects. As a result, changes in more serious defects would have a great impact on the index than the defect rate.

Table 2: Average index evaluation metric

SCALE	Evaluation
1.00-1.50	Not urgent at all
1.51-2.50	Not very urgent
2.51-3.50	Urgent
3.51-4.50	Very urgent
4.51-5.00	Extremely urgent

### 5.0 Research Methodology

The data provided were a combination of questionnaire administration and personal observations and interviews. The questionnaire was developed for content validity based on detailed literature and analysis of the prescriptive, theoretical practitioner. It was also distributed to building construction professionals comprising construction

consultants, contractors and academicians after briefing them about the objective and scope for face validity. Their comments regarding the relevance and content were considered.

Generally, identifying the type and causes of defects are achieved by simple techniques and sensitive surveying. However, for this particular research quantitative analysis was employed to establish the efficacy of severity index and also to inform the relevant authorities in charge of the need for repairs.

Occupants and building construction professionals were asked to enumerate the major defects found in the case study area. A list which has already been prepared did have all that the respondents listed.

20 different types of defects (factors) were ranked by these respondents to determine the severity of these defects on a scale of 1 to 5. Respondents were instructed to rate these defects accordingly, with 1 being defects which are mild and 5 being the serious ones that might need urgent attention. In between other assessment is to be made from low, medium and high.

The impact factor was then calculated by the formula

$$\text{Impact} = \frac{\sum (f_i * i)}{n}$$

Where: i = is the severity score from 1 to 5

f = the frequency of defect/factor getting score i

n = number of responses

The resultant impact ranking of defects found in public residential buildings were divided into three regions, namely;

Range of 1.00 – 2.50 (neglected on the severity impact axis, this is due to insignificance)

Range or impact score of 2.51 – 3.50 (low severity range)

Range or impact score of 3.51 – 4.50 (medium severity range)

Range or impact score of 4.51 – 5.00 (high severity range)

Table 3: Type and number of Public Residential buildings

S/No.	Type of Public Residential Building	Total Number
1	detached bungalow	45
2	semi-detached bungalow	38
3	apartments on blocks of flats	62
	TOTAL	145

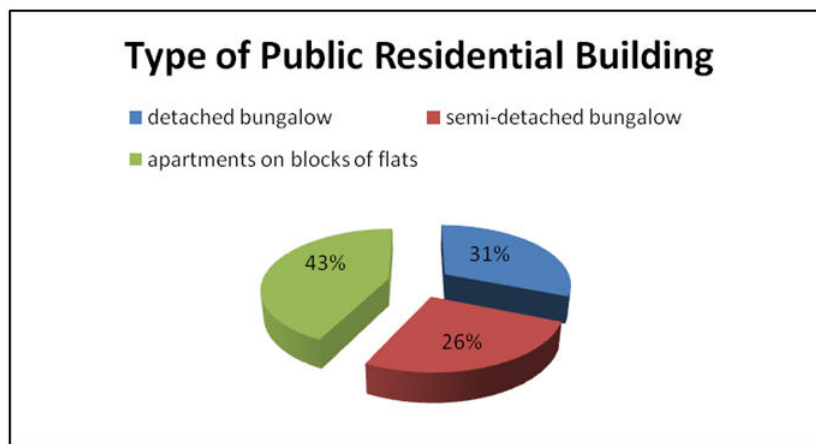


Figure 2: Percentage representation of public residential buildings

The public residential buildings used for the study is represented in figure 1 above. 43% of the buildings used for the study consisted of apartments on block of flats, whilst 31% represented that of detached bungalow and 26% representing that of semi-detached buildings.

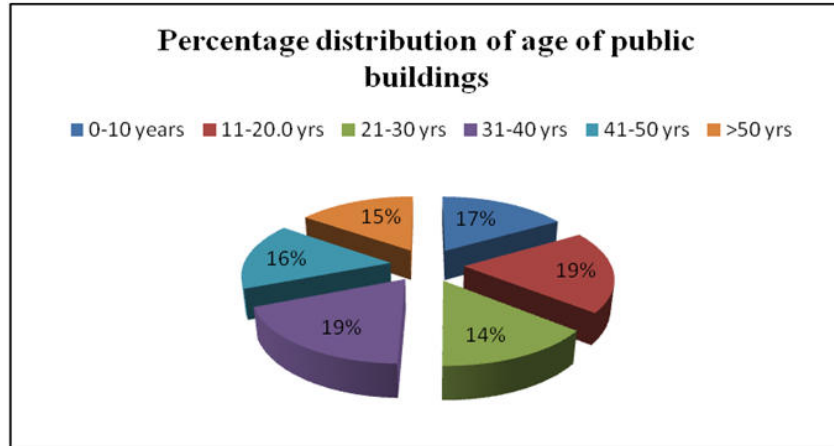


Figure 2: Percentage distribution of age of public buildings

The percentage distribution of the various ages of the public buildings also revealed that those that are under 10 years represented 17%, those between 11-20 years are about 19%, and 21-30 years are represented by 14%. Whilst, 31-40 years are also 19%, 41-50 years are about 16% and finally, those over 50 years are about 15%.

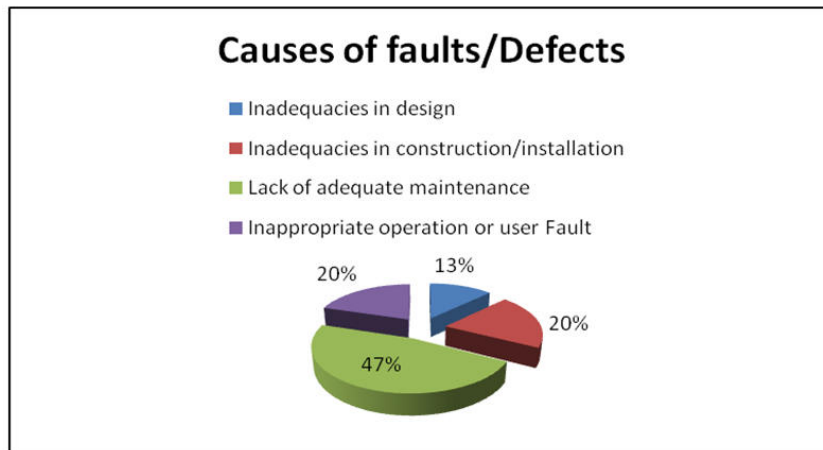


Figure 3: Causes of faults/Defects

From the field study it reveals that most of the defects or faults found in the public residential buildings are as a result of inadequacies in design, inadequacies in construction/ installation, lack of adequate maintenance and inappropriate operation or user fault in the public buildings. The survey revealed that 20%, 13%, 20% and 47% are the causes of defects/faults for inadequacies in design, inadequacies in construction/installation, lack of adequate maintenance and inappropriate operation or user fault respectively.

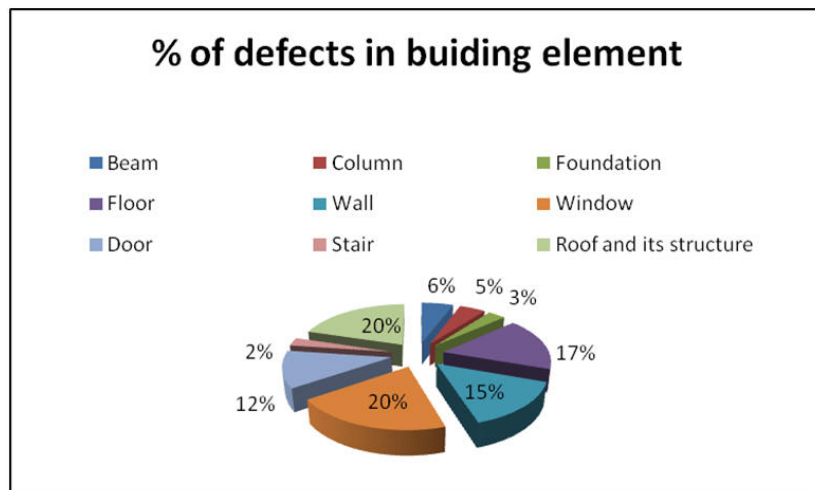


Figure 4: Percentage of defects in various elements within the public buildings

The field study revealed the percentage of defects in various elements within the public buildings. It shows that a percentage of defects within the structural components of the public buildings have the windows and the roof and its structure to be having the highest number of defects that represents about 20% each, followed by the floor 17%, wall 15%, door 12%, beam 6%, column 5%, foundation 3% and stair 2%.

Table 4: Top twenty defect factors

S/No.	Factor ID	Factor Description	Impact Factor	Rating
1	11	Painting defects	4.61	High
2	2	Damaged or deteriorated masonry walls	4.52	High
3	16	Rusted wire mesh regulator	3.66	Medium
4	8	Spalling of masonry	3.65	Medium
5	10	Structural damage to timber	3.60	Medium
6	12	Dry rot	3.58	Medium
7	4	Dampness	3.52	Medium
8	18	Socket outlet	3.07	Low
9	15	Malfunction fan regulator	3.07	Low
10	14	Faulty ceiling fan	3.07	Low
11	19	Faulty light switch	3.04	Low
12	9	Ill fitting windows and doors	3.03	Low
13	1	Cracks	3.01	Low
14	7	Spalling of concrete beams and columns	2.79	Low
15	20	Broken tiles	2.76	Low
16	17	Damaged Louvre blade carriers	2.72	Low
17	3	Leaking showers	2.67	Low
18	5	Excessive sagging of roof	2.59	Low
19	6	Excessive sagging of ceiling	2.47	Insignificant
20	13	Wet rot	2.33	Insignificant

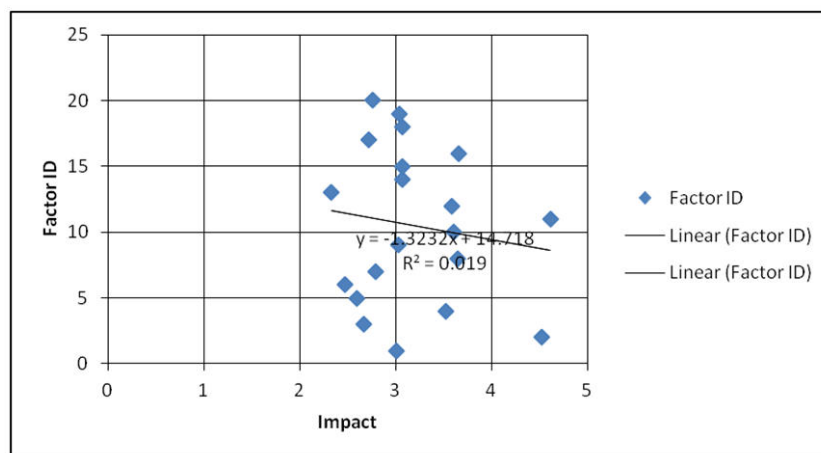


Figure 5: Factor Severity Range

Figure 5 above shows the factor severity identification against the impact ranges. Most of these defects lie within the low severity range. The slope of the scattered points indicates a negative one and most of the points are far off indicating that they are outliers. However, seven of the factors are medium or high severity range.

## 6. Conclusion

The following major observations have been concluded:

1. The defects identified in most these public residential buildings are found on the building components or elements, fittings and fitments. These include; the walls, floors, beams, columns, stairs, roofs and foundations. The defects spread from finishes, metal work, glazing, joinery, services and ironmongery.
2. The survey results indicated that majority of defects about 55% lie in the low severity impact range. It implies consideration should be emphasized on those factors that lie within the medium and high severity range which constitute about 35%, as those defects can cause considerable increase in maintenance cost and should be promptly attended to.

Future research will examine the extent and nature of implementation of defect impact mapping as a turnkey for

maintenance officers in the various severity ranges of buildings for prioritization and rectification of such facilities. Also a research into the identification of quality problems in the supply chain in the Ghanaian construction industry using the quality filter mapping approach will be considered.

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