Hazards Awareness and Mitigation in Buildings

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Abstract

Buildings in any geographic location are subject to a wide variety of hazards of natural disasters. This research is aimed at identifying the common hazards that buildings are exposed to with the view of coming up with measures that will assist in mitigating the impact of disasters on the buildings and building users at Ahmadu Bello University Zaria. Eighty structured questionnaires were administered to building users and twenty to construction professionals. Results of the research revealed that the adequacy and awareness of protection of buildings against hazards is good but in need of further improvement. It was however recommended that proper and adequate investigation of the location of proposed buildings should be conducted so as to ascertain the type of hazards present and measures should be put in place to mitigate any identified hazard.

Keywords: Buildings, Hazards, Protection, Mitigation, Protective Measures.

Background

Buildings are subject to a wide variety of natural phenomena in any geographic location. While the occurrence of these incidents cannot be precisely predicted, their impacts are as well understood and can be managed effectively through a comprehensive program of hazard mitigation planning (National Institute of Building Sciences, 2011).The fundamental goal of hazard mitigation is to minimize loss of life, property, and function due to disasters. In addition, designers should anticipate conditions that may exist in buildings in emergencies and provide refuge for occupants or safe evacuation routes (Frederick and Jonathan, 2001).
Mitigation efforts are long-term measures that attempt to prevent hazards from developing into disasters altogether, or to reduce the effects of disasters when they occur. Designing to resist these hazards should always begin with a comparative risk assessment (Smith, 2001). This process includes identification of the hazards present in the location and an assessment of their potential impacts and effects on the built environment based on existing or anticipated vulnerabilities and potential losses.

According to Nezih and Green (2006), disasters are large intractable problems that test the ability of communities and nations to effectively protect their populations and infrastructure, to reduce both human and property loss, and to rapidly recover. The seeming randomness of impacts and problems and uniqueness of incidents demand dynamic, real-time, effective and cost efficient solutions. Disasters also refer to natural catastrophic events caused by natural forces, such as earthquakes, floods, large landslides, and spontaneous wild fires (Songer, 2011). These events normally involve massive destruction of property, eventual loss of human lives, displacement of populations and loss of services and livelihood. Leroy (2006) also asserts that a disaster is a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope with using its own resources, so

external aids are needed. As such, a disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk.

Building designers should also use judgments in determining the degree of protection to be provided against specific disasters. Cost of protection should be commensurate with probable losses from an incident (Dorfman, 2007). In many cases, for example, it is uneconomical to construct a building that will be immune to extreme winds, bombs, burst dams or professional burglars. Full protection of buildings to hazards like fire, vandals etc should however always be provided because the probability of occurrence is accompanied by personal injuries or high property losses.

Problem Statement

Disaster management has been attracting a lot of attention by many research communities. According to Smith (2001), many buildings are erected without paying serious attention to the conditions and requirements to ensure that they are adequately protected against these natural phenomena (hazards). In such a situation, problems eventually arise which both affect the serviceability and functionality and in severe cases, the stability of the building.

All buildings are subject to hazards such as wind, water, fire, lightning, and burglars etc therefore, preventive and control measures should be provided by ensuring design is to standard, building designers and contractors being guided by building-code and professionals exercising their best judgment so as to ensure optimum performance and usage of the building.The risk associated with these hazards should be assessed. And after the risk of a hazard has been assessed, the building designers and contractors should decide on an acceptable level for the risk. With this done, they should then select a cost-effective way of avoiding the hazard, if possible, or protecting against it so as to reduce the risk of the hazard's occurring to within the acceptable level.

Aim And Objectives

The aim of the study is to identify the hazards to which our buildings are exposed to with the view of coming up with measures that will assist in reducing the impact of such hazards on buildings and building users.
The objectives of this study are:

i. To identify the common hazards that buildings are exposed to;
ii. To assess the characteristics of these hazards;
iii. To evaluate the effects of the hazards on the buildings and building users;
iv. To make recommendations on mitigating the hazards identified.

Scope

The scope of this research is mainly to identify hazards present within the academic and residential areas of Ahmadu Bello University, Zaria (Samaru Campus).

Field Survey

The survey is designed to assess buildings within the academic and residential areas of Ahmadu Bello University, Zaria with regards to the level of protection incorporated into the buildings against hazards. The opinions of built environment professionals as well as those of building users were sought.

Population

The population of this study consists of three (3) selected faculties and two (2) selected students' hostels within the Samaru campus of the University. These are:

i. Faculty of Environmental Design
ii. Faculty of Engineering
iii. Faculty of Science
iv. Danfodio Hall
v. Suleiman Hall

Data Collection Instrument

The study is conducted through the use of a structured questionnaire administered to building construction professionals and users of buildings to obtain information about the way and manner buildings are protected against hazards.

Administration of Data Collection Instrument

According to Creative Research System (2007), in selecting a study sample, one has to consider the following; deciding what kind of people to interview (target population), and how many of them needed to be interviewed (The larger the sample, the more precisely it reflects the target group). In respect to this, a total number of 100 structured questionnaires were administered for this study, twenty (20) to professionals and eighty (80) to users.

Scales Adopted

A well-structured questionnaire was used as the instrument for data collection with suggested answers measured on a Likert scale. A Likert scale is a psychometric response scale primarily used in questionnaires to obtain participant's preferences or degree of agreement with a statement or set of statements (Bertram, 2012). Likert scale is concerned with determining the respondents' degree of agreement or disagreement with a statement; it enables the ranking of the attitudes of the respondents on the statement (Malhotra, 2012). Four and Five point scales of the Likert were adopted in this research. Most of the data for this research fall under the ordinal scale since they involve rating which normally uses integers in ascending or descending order. Others fall under the nominal scale which tends to classify the data having a particular property but does not imply any idea of rank or priority. The scales were characterized as follows;

5=strongly agree, 4=agree, 3=undecided, 2=disagree, 1=strongly disagree.
4=very important, 3=important; 2=less important, 1=not important.
4=very frequent, 3=frequent, 2=rare, 1=never.

Question Format

The questionnaire used as the instrument for data collection contained closed ended questions. Closed format questions are questions that include multiple choice answers. By including closed format questions in questionnaire design, it enables easy calculation of statistical data and percentages. Preliminary analysis can also be performed with ease. Closed format questions can be asked to different groups at different intervals. This helps to efficiently track opinion over time.

Method of Data Analysis

Descriptive, percentage as well as simple statistical analysis was performed on the data generated from this study and the results are presented in tables.

Data Presentation and Analysis

The data collected was analyzed with the aid of descriptive statistics and percentages to show the extent of dispersion within the variables of the study.

Table 1. Distribution of Questionnaires

Target Group	Distributed	Returned	Percentage (%)
Building professionals	20	20	100
Building users	80	75	93.75
Total	100	95	95

Source: Field Survey, 2012.

Of a total of 100 questionnaires administered, 20 were administered to building professionals and was properly completed and returned (100%), 80 were administered to building users and 75 was properly completed and returned (93.75%) and this was used in the analysis.

Responses from Built Environment Professionals

Table 2. Profession of the Respondent

Profession	Frequency	Percentage %
Building	6	30
Architecture	4	20
Civil Engineering	3	15
Quantity Surveying	3	15
Elect/Mech. Engineering	4	20
Urban and Regional Planning	0	0
Total	20	100

Source: Field Survey, 2012.

of the questionnaires received, 6 were returned by Builders (30%), 4 each by Architects and Services Engineers (20%), 3 were returned by Civil Engineers (15%), 3 were returned by Quantity Surveyors (15%).

Table 3. Type of Projects Normally Handled

Types of project	Frequency	Percentage (%)
Building construction	20	100
Civil engineering	0	0
Total	20	100

Source: Field Survey, 2012.

All the professionals that responded declared that it is only building construction projects that they participate in handling.

Table 4. Common types of Hazards

Types of hazard	Frequency	Percentage (%)
Wind	20	100
Fire	19	95
Lightning	10	50
Intruder	20	100
Water	15	75

Source: Field Survey, 2012.

All the respondents (100%) signified that wind and intruders are hazards that buildings should be protected against while 95%, 75% and 50% of respondents respectively pointed out that buildings should be protected against the hazards of fire, water and lightning. This has shown that less importance is attached to provision of lightning protection even by experts. This might not be unconnected with the fact that most of them are engaged in construction of not so tall buildings.

Table 5. Manageability of Hazards

Response	Frequency	Percentage (%)
Strongly agree	17	85
Agree	3	15
Undecided	0	0
Disagree	0	0
Strongly disagree	0	0
Total	20	100

Source: Field Survey, 2012.

It can be observed from these responses that even though the threats posed by different types of hazards cannot be eliminated totally, the respondents are all of the view that they can be managed properly to reduce their effects on the people and environment.

Table 6. Protective Measures against Hazards

Types of hazards	Protective measures	Frequency	Percentage (%)
Wind	1) Shear walls	18	90
	2) Diagonal bracings	18	90
	3) Rigid frames	19	95
	4) Trees as wind breaks	20	100
Fire	1) Limit potential fire load	18	90
	2) Means of prompt detection of fire	20	100
	3) Means of early extinguishment	20	100
	4) Adequate means of egress	20	100
Lightning	1) Installation of lightning conductors	20	100
Intruder	1) Controlled access to property	20	100
	2) Protection at the boundary of the property with fence and gate	20	100
	3) Guard patrol	20	100
	4) Security lights	20	100
	5) Installations of sounding devices such as bells and alarms	20	100
	6) Security locks and latches on doors and windows	20	100
Water	1) Incorporation of DPC and DPM during construction	20	100
	2) Adequate drainage of ground water	20	100
		20	100
	3) Adequate roof drainage	20	100
	4) Raising structures above flood levels		

Source: Field Survey, 2012.

From the above data, it is shown clearly that the respondents are aware of the protective measures put in place to reduce or eliminate the impact of the hazards identified.

Table 7. Other Measures for Protecting Buildings against Hazards

S/N	Consideration	Frequency				ΣF	ΣFX	Mean(X')
		4	3	2	1			
1.	Adherence to Codes, Standards & Spec.	20	0	0	0	20	80	4.0
2.	Give qualitative supervision of the project.	20	0	0	0	20	80	4.0
3.	Use of high quality materials	20	0	0	0	20	80	4.0
4.	Use best judgement to decide acceptable risk.	16	4	0	0	20	76	3.8

Source: Field Survey, 2012.

4 = very important, 3 = important, 2 = less important, 1 = not important.

Table 7 presents the responses of the Professionals on the measures they will adopt to ensure proper protection is provided to buildings when there are insufficient funds to provide all that are needed. The results pointed out that adherence to Codes, Standards and Specifications as well as qualitative supervision of projects and the use of quality materials are very important measures that can contribute significantly to protecting buildings properly against hazards. Exercise of best judgement is also important in some situations.

Table 8. Frequency of occurrence of Risks Associated with Inadequate Protection of Buildings

S/N	Consideration	Frequency				ΣF	ΣFX	Mean(X')
		4	3	2	1			
1.	Loss of lives and properties	3	15	1	1	20	60	3.0
2.	Loss of functionality of the building.	18	2	0	0	20	78	3.9
3.	*Discomfort to occupants.*	5	13	2	0	20	63	3.15
4.	Depreciation in aesthetics of buildings	18	2	0	0	20	78	3.9
5.	Environmental degradation	0	5	15	0	20	45	2.25
6.	*Health and safety risk to the occupants*	5	15	0	0	20	65	3.25

Source: Field Survey, 2012.
4 = very frequent, 3 = frequent, 2 = rare, 1 = never.

With a scale ranging from 4 to 1 for very frequent to never, Loss of lives and properties average 3.0 (frequent), Loss of functionality of the building average 3.9 (very frequent), Discomfort to occupants average 3.15 (frequent), Depreciation in the aesthetics value average 3.9 (very frequent), Environmental degradation average 2.25 (rare) and Health and safety risk to the occupants average 3.25 (frequent). It can be deduced from Table 8 that the listed risks occur frequently with a mean of 3.24.

Table 9. Procedures for Designing to Resist Hazards

S/N	Consideration	Frequency					ΣF	ΣFX	Mean(X')
		5	4	3	2	1			
1.	*Identification of the hazards present*	19	1	0	0	0	20	99	4.95
2.	An assessment of their potential impacts	19	1	0	0	0	20	99	4.95
3.	An assessment of the effects on the built environment	19	0	1	0	0	20	98	4.90

Source: Field Survey, 2012.
5 = strongly agree, 4 = agree, 3 = undecided, 2 = disagree, 1 = strongly disagree.

Using a scale of 5 to 1 to represent a range from strongly agree to strongly disagree about the procedures for designing and constructing buildings to resist hazards, Identification of the hazards present in the location average 4.95 (strongly agree), assessment of their potential impacts average 4.95 (strongly agree), assessment of the effects on the built environment based on existing or anticipated vulnerabilities and potential losses average 4.9 (strongly

agree). It can be seen from Table 9 that the procedures involved in comparative risk analysis are strongly agreed with a mean of 4.93.

Responses from Building Users

Table 10. Level of awareness of Building users to presence of Hazards

Types of hazard	Frequency	Percentage (%)
Wind	47	62.67
Fire	59	78.67
Lightning	20	26.67
Intruder	50	66.67
Water	47	62.67

Source: Field Survey, 2012.

The table shows that 62.67% of the respondents are aware of dangers posed by wind to buildings, 78.67% of the respondents indicated fire to be a potential hazard, 26.67% pointed to lightning as a hazard while 66.67% and 62.67% respectively signified that intruders and water are hazards that buildings are exposed to. This figures showed that the greatest threats to building users are fire and intruders.

Table 11. Manageability of hazards

Response	Frequency	Percentage (%)
Strongly agree	30	40
Agree	35	46.67
Undecided	10	13.33
Disagree	0	0
Strongly disagree	0	0
Total	75	100

Source: Field Survey, 2012.

Table 11 reveals that 86.67% of the users of buildings interviewed agreed that even though hazards cannot be eliminated completely, they can be managed effectively to minimise their effects whenever they occur and 13.33% are undecided about the possibility of managing hazards.

Table 12. Risks Associated with Inadequate Protection of Buildings against Hazards

S/N	Consideration	Frequency				ΣF	ΣFX	Mean(X)
		4	3	2	1			
1.	Loss of lives and properties	15	52	8	0	75	232	3.09
2.	Loss of functionality of the building.	30	35	10	0	75	245	3.26
3.	Discomfort to occupants.	20	45	10	0	75	235	3.13
4.	Depreciation in the aesthetics value	42	30	3	0	75	264	3.52
5.	Environmental degradation	10	35	30	0	75	205	2.73
6.	Health and safety hazard to occupants	28	42	5	0	75	248	3.30

Source: Field Survey, 2012.

4 = very frequent, 3 = frequent, 2 = rare, 1 = never.

With a scale ranging from 4 to 1 for very frequent to never, Loss of lives and properties average 3.09 (frequent), Loss of functionality of the building average 3.26 (frequent), Discomfort to occupants average 3.13 (frequent), Depreciation in the aesthetics value average 3.52 (very frequent), Environmental degradation average 2.73 (frequent) and Depreciation in the health and safety of the occupants average 3.30 (frequent). It can be observed from Table 12 that based on the judgment of those interviewed the listed risks occur frequently with a mean of 3.17.

Table 13. Cost of Protecting Buildings against Hazards

Response	Frequency	Percentage (%)
Not expensive	1	5
Expensive	11	55
Very expensive	8	40
Total	20	100

Source: Field Survey, 2012.

40% and 55% respectively of the respondents signified that it is very expensive and expensive to protect buildings against hazards with 5 % of the respondents indicating it is not expensive to protect buildings against hazards. This is a misconception as preventing hazards is not likely to be as expensive as remedying its effects when one eventually happens.

Conclusions

The conclusions that have been drawn from this study are as follows:

The majority of the respondents which include both the professionals and the building users are quite aware of the hazards buildings are exposed to and they also demonstrate an understanding of the effects of these dangers. Some of respondents are unsure as to whether the buildings in which they live in have adequate protection against hazards. The commonest of these risks are wind and intruders even though the others as listed are also sources of concern. The respondents (the professionals) are also conversant with the protective measures usually incorporated into buildings to mitigate the consequences of hazards but sometimes ignore giving them the proper attention. Among the risks associated with inadequate protection of buildings against hazards such as loss of lives and properties, loss of functionality of the building, discomfort to occupants etc, it is reduction in aesthetic value that occurs more frequently according to building users' opinion followed by health and safety hazard to users and loss of functionality. Most of the building users are also of the view that it is expensive to protect buildings against hazards and managing them is also difficult.

Recommendations

Based on results obtained from the research, the following recommendations have been put forward as measures to drastically reduce the effects of identified hazards on buildings and users:

Adequate investigation of the location of proposed buildings should be conducted so as to ascertain the type of hazards present and incorporate protective measures into the construction to mitigate the effects of any identified hazards. Enforcement of the relevant Codes should be done to ensure that buildings are constructed to standards and proper supervision and inspection of the works should be carried out. All defaulters of hazard

mitigation measures should be penalized and more awareness should be created among the members of the public about the importance of protecting buildings against hazards.

Reference

Bertram, D. (2012). *Likert Scales.* Retrieved September 24, 2012, from http://poincare.matf.bg.ac.rs/~kristina//topic-dane-likert.pdf

Creative Research System (2007).*The Survey System – How to Begin your Survey Design Project.* www.google.com

Dorfman, M. S. (2007). *Introduction to Risk Management and Insurance.*Published by Prentice Hall, Englewood Cliffs

Frederick, S. M. and Jonathan, T. R. (2001).*Building Design and Construction Handbook.* McGraw-Hills Publishing Company, New York, USA.

Leroy, S.A.G. (2006). *From Natural Hazard to Environmental Catastrophe: Past and Present.*Quaternary International 158 (1) 4e12

Malhotra, N. K. (2012). *Questionnaire Design and Scale Development.* Retrieved September 24, 2012 from http://www.terry.uga.edu/~rgrover/chapter_5.pdf

National Institute of Building Sciences (2011).*Whole Building Design Guide – Natural Hazards.*Washington DC, USA.

Nezih, A. And Green, W. G. (2006). OR/MS research in disaster operations management. *European Journal of Operational Research* 175(1): 475-493.

Smith, K. (2001): "Environmental Hazards – Assessing Risk and Reducing Disaster," Published by Routledge, New York, USA.

Songer, T. (2011).*The Epidemiology of Disasters.* Lectures Series, University of Pittsburgh. Retrieved September 24, 2012, from http://www.pitt.edu/wepi2170/lecture15/sld007.htm.