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The Strategic JOURNAL of Business & Change MANAGEMENT
ISSN: 2312-9492 www.strategicjournals.com

Vol. 7, Iss. 3, pp 195 – 205. October 12, 2020. www.strategicjournals.com, ©Strategic Journals

INFLUENCE OF PROJECT DESIGN COLLABORATION ON BUILDING SAFETY IN NAIROBI CITY COUNTY, KENYA

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Accepted: September 15, 2020

ABSTRACT

Nairobi City County is currently experiencing a building crisis as the current demand of housing units remains higher than the available supply. The building crisis is associated with limited expertise and fewer experienced building professionals in the industry while the high demand for housing units is attributed to the growing population resulting from rural-urban migration which has been the trend since independence. This has led to influx of uncontrolled developments most of which have not passed any building approvals. This practice is synonymous with structural failures, massive damage of property, serious injuries and loss of lives when buildings under construction or on occupancy collapse. Each participant in the building industry continues to play their individual roles in ensuring safety. However, whenever incidences occur, the heaviest burden of blame falls on the project designers possibly due to inclusions or omissions in the design whose safety implications are experienced at the execution stage as carry-over effects. Investigations have not substantially established the real cause of these incidences. This calls for a broader dimension on active integration and collaboration between parties which could achieve a significant improvement in building safety. The rates of work attendance in construction projects could improve due to reduced absenteeism rates. Accident rates could also reduce drastically when safety is adhered to. This research focused on different levels of collaborations between architects and other building players and how their cooperation can influence building safety. The study was pegged on two objectives namely, the influence of designer-client and designer-designer collaborations on building safety in construction projects. By taking building designers (architects) as key participants, research utilized a descriptive design. It targeted 206 registered architects who were considered as lead designers in the design team of building projects. Selection of the sample followed a purposeful random sampling procedure to obtain participants who had experience in structural designs and who were capable of offering adequate information on the subject matter. For pilot study, twenty one (21) structured questionnaires were administered in both open-ended and closed questions. Raw data was classified, presented in tables and analyzed by use of SPSS software version 20. Both descriptive and correlation results indicated a positive and significant relationship between project design collaborations and building safety. The study concluded that enhancement of design partnerships at all collaboration levels of collaboration improves safety. The study recommended further researches on other levels of collaborations and collaboration with other stakeholders apart from the ones studied.

Keywords: *Designer-Client Collaboration, Designer-Designer Collaboration, Building Safety*

CITATION: Mutiku, J. K., & Mutiso, J. (2020). Influence of project design collaboration on building safety in Nairobi City County, Kenya. *The Strategic Journal of Business & Change Management*, 7(3), 195 – 205.

INTRODUCTION

There has been an increasingly poor H&S performance in the building industry especially in housing developments (Okechukwu & Olele, 2014). Common incidences include but not limited to caving-in of excavation works burying workers beneath, collapse of scaffoldings leading to falls and injuries, workers and passers-by hit by flying objects, falls from heights during roofing and other roof installations, collapse of walling works, electrocution and electric fires, crushes by moving machines and other machine/equipment related injuries just to mention a few (Phoya, 2012). Occupational Safety and Health Administration (OSHA) (2014) reports that world's annual occupational deaths and serious job-related injuries in the construction industry exceed 4500 and 4 million respectively. Moreover, the overall annual financial loss is estimated at 4% in the global Gross Domestic Product (GDP) even though economic losses associated with safety implication are not all accounted for (Uchena, 2016).

Design collaboration in building for safety has significant benefits. Firstly, with reduced accidents rates at work, the organization maintains a healthy workforce. Secondly, by making building safe, work attendance rates increase. Thirdly, it is of financial benefit that the client will not incur costs on treating work related injuries and compensating injured persons evidenced in low costs of work insurance premiums. Lastly but not least, the building profession will meet legal and moral responsibility of protecting humanity from mental, physical harm and possible loss of lives (Stone, 2010).

Though silent on collaborations, Australia performs comparatively better in OHS. This traces back to the numerous safety and design initiatives in the history of her government and also the strong believe that it is cheaper to eliminate and control accidents at design stage than at latter stages of a project. An initiative by the National Standards for Plant (NSP) Australia in the year 2000 sought to investigate the cause of 250 deaths at construction workplace and found that 170 of these were in some way attributable to design omissions and inclusions. This led to the signing of a ten-year National OHS Strategy to serve between the year 2002 & 2012 with an aim of improving safety and decreasing work related deaths by 20% and accidents by 40% through design. In addition, Australia considers supply of safety by design packages for architectural design students useful in facilitating Continuous Professional Development (CPD) Programs (Workplace Health & Safety Queensland, 2012).

In a similar dimension, the United States of America (USA) construction industry encourages project team collaborations. For instance, joint partnerships greatly contributed to the winning of the Chicago Public Library in the Nineteenth Building Team Award of 2015 as the best structure in achieving building excellence in the state of Illinois. The already completed building is capable of offering access to information, knowledge on technology and innovation to the inhabitants of entire Chicago and other 72 branches around the state. This success was significantly enabled by the practice of exemplified partnerships amongst the building teams including the clients, architects, engineers, contractors and the project supervisors (USA Building Design and Construction, 2017). Africa's building safety situation is disturbing and this explains why recent researches show an increasing trend in the number of accidents and fatalities in the building sector (Phoya, 2012). Smallwood and Procedia Engineering (2013) report that 25.5 lives are lost in every 100,000 workers engaged in building works while Phoya (2012) reports between 1.5 and 2.5 deaths in building projects weekly. Vermeulen (2014) argues that safe design in the building industry starts with the project engineer. The architect should be knowledgeable in what exists on the ground before handing over to the executing team a design that would be risky to implement (Stone, 2010). The much needed information can be obtained through active alliances with other participants in the building process (Jerling, 2011).

Kenya's performance in building safety is still at deficient levels. However, significant efforts have been made to improve the state of affairs. For example, the legal framework for OHS in Kenya provides for the right to reasonable working conditions for every worker (OSHA, 2014). This means that every team player in the building sector should consider as priority safety of the worker. The Employment Act Cap 226 clearly defines the rights of employees and also prescribes the basic minimum conditions of work to employers. This Act makes employers in the building industry liable for safety. The Work Injury Benefits Act (WIBA) (2012) provides for compensation to employees for work related injuries and infirmities sustained in line of duty making building contractors and project clients financially accountable for accidents on building sites. Another Act of Parliament, OSHA No. 15 (2007) provides for safety, health and welfare of employees and all other persons legally present at the workplace. Provisions of this Act extend beyond the safety of workers to other building participants.

Statement of the Problem

Incidences of structural failure are prevalent in Nairobi City County. This is evident due to common collapse of buildings and walls under construction (Kemei et al, 2015). A report published by NCA shows that over 30 buildings have collapsed in the period between 2010 and 2015 in Nairobi City County alone (NCA Building Audit Report, 2015). These occurrences mostly lead to a significant number of fatalities and injuries of workers with a 35% monthly likely occurrence (Kemei et al, 2015). A number of serious incidences of structural failure have reportedly occurred in Nairobi City County within a period of 22 years presenting a worrying scenario of 111 fatalities and extremely bad multiple injuries (NCA Building Audit Report, 2015).

Several researches related to safety in building projects have been carried out. A study by Andy (2018) sought to explore project team collaborations between clients and building teams. In this research, it was recognized that when clients connect with building teams, it builds the spirit of commitment and openness and this is a key ingredient to achieving project excellence in most ways. Secondly, Kenneth (2016) undertook a research on assessment on safety management in building sites in Kenya putting more emphasis on initial stages. The study found that employee involvement had a significant effect on safety management. The study recommended employee involvement in setting up safety policies.

Thirdly, Vermeulen (2014) investigated contribution of designers on building safety and established that designers are in a position to spot risky activities on architectural plans and so putting them in a position to eliminate them at that stage. In this study, Vermeulen (2014) admits that most of building designers lack site experience and recommended team work. In another study by Ulang (2012) explored challenges of communicating building safety at design stage and found that minimal mutual relationship existed between project players. Lastly but not least, Goldswain and Smallwood (2015) developed a design oriented model an effort to reduce accidents in building projects. One of the stages in the design model was for the architect to inform the builder of risks not eliminated at design stage. All the above researches were not substantively vocal on project design collaborations and informed the decision to carry out this study.

Objectives of the Study

This study was guided by the following study objectives

- To assess the influence of designer-client collaboration on building safety in Nairobi City County, Kenya
- To establish the influence of designer-designer collaboration on building safety in Nairobi City County, Kenya

LITERATURE REVIEW

Theory of Change

This theory was developed by Kurt Lewin in 1947. It is today as useful as when it was first published. The theory explains why change should happen and

how it should happen. The theory has three elements understood as the three –stage processes. The first stage is the unfreeze stage which means getting ready to change. A fundamental change causes an abrupt transformation or an incremental change which happens over a given timeframe (Lewin, 1947). The designer must be willing to change from the conventional thinking that building safety is the responsibility of the client and the contractor to a modern practice of collaborating with them (Okenda, Thuo & Kithinji, 2017). The second stage is the change stage which is the process of making change happen. This stage causes definite interruptions and distractions on the normal processes. Actual interactions must be seen occurring in site meetings as well as onsite visits at regular occasions. The third stage is the freezing stage which simply means making change stick and stay. Change and its impact should be felt over a sustainably long period (Okenda et al, 2017). The partnerships between the client and the designer must be made a continuous culture.

Project Management Competency Theory

This theory was proposed by McBer and McClelland in 1980. The theory defines competency as the individual characteristics related to criterion performance in a specific job. The theory incorporates capacity and knowledge as its elements which demonstrate the performance of a person in a specific task (Crawford & Nachmias, 2010). The theory also asserts that competency characteristics of an individual can be acquired and assessed through extensive training.

Crawford and Nachmias (2010) attest that professionals involved in projects probably do not have all the required competencies and so may not carry out all the activities required to promote and implement the changes that they are leading as part of their projects. The capacity in human resource incorporates attitudes, knowledge, behaviors and skills that directly relate to superiority in job performance. The professional capability amongst teams involved in projects design, implementation and completion comes from a combination of knowledge, skills and expertise acquired from training and experience developed in course of executing projects works (Crawford & Nachmias, 2010).

In the design process, it is assumed that the project design team possesses all the required capability for the project work attached to them however, this is only an aggregate of several skills put together (Okenda et al, 2017). This theory is relevant to the study as it provides important understanding on professional competency. The theory postulates that if the project team possesses all the required capability in terms of skills and expertise, then the project design will achieve its targeted success. This theory is pegged to the designer- designer collaboration that designers need to come together to bring expert knowledge to earn competency and work excellence collectively (Crawford & Nachmias, 2010).

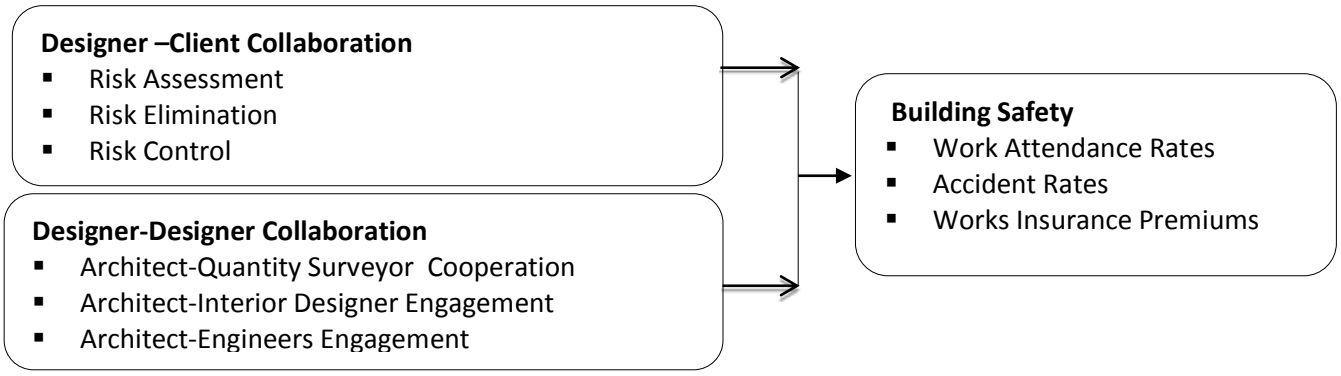

Figure 1: Conceptual Framework

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Empirical Review

Designer- Client Collaboration

Ulang (2012) conducted a research in the United Kingdom (UK) on communication construction H&S information design and sought to understand the challenges of communicating OHS at project's design stage. The research relied on group data where sub-groups of key parties were interviewed on OHS. The studies also reviewed different communication theories and their relevance to H&S information in the building industry. The study finds that communication actually occurs in construction at significant levels. The study recommends focus to be emphasized even on unusual risks and integration of communication technology. Integration of all parties especially at design stage and maintenance of mutual relationship throughout the project is further suggested.

Designer – Designer Collaboration

Lew (2016) sought to examine approaches to designing for safety of workers in the construction sector. The researcher focused on prevention of hazards by design. The study utilized case studies. The study found that utilization of engineering solutions through formation of design partners was of paramount importance. This emphasized on design processes which promoted safety in all the project phases.

Rizal (2011) studied the changing roles of building stakeholders in hospital building facilities in Netherlands through Building Information Modeling (BIM). This study incorporated literature reviews and case studies. In this study, Rizal agrees that health facilities are complex developments and calls for cooperation and coordination throughout the process in order to meet all information needs, environmental requirements and user expectations. This study explored collaboration between architects and engineers in information sharing and technology. In the study, Rizal confronts division of responsibility in the building processes and proposes partnering between architects and engineers.

METHODOLOGY

This research adopted descriptive research design which indeed measured specific characteristics and association between variables. The unit of analysis in this study was the Board of Registration of Architects and Quantity Surveyors (BORAQS-Kenya) while the unit of observation constituted architects currently registered with the BORAQS. This study's population constituted 206 architects captured by BORAQS-Kenya (2019). The sampling frame in this study was the list of all registered architects in Nairobi City County. The study utilized a self-administered questionnaire which constituted both open-ended and closed statements in which respondents were asked to indicate their level of agreement. SPSS (Statistical Package for Social Scientists) Version 20 software was utilized to analyze the data which displayed the interaction of independent variables as well as the linkage between them and the depended variable.

FINDINGS AND DISCUSSION

The study administered 136 questionnaires to respondents randomly sourced from 206 registered architects by BORAQS-Kenya (2019) representing 66% of the target population. Out of the 136 questionnaires distributed, 118 were filled and returned. This represented a response rate of 86.76%.The reasonably high response rate was pegged on constant reminders to respondents by the researcher fill the questionnaire.

Descriptive Statistics

Designer-Client Collaboration

The findings revealed that respondents agreed on the following statements; that it is important for the designer to cooperate with the client throughout the project design process (mean = 4.33), that there is need to consult and compare safety priorities between the designer and the client before the preliminary design (mean = 4.48), that pre-design information about the site provided by the client provides opportunities for safety considerations (mean = 4.52) and that setting safety targets with the client indicates commitment to

designing for safety (mean = 4.14). However, respondents were indifferent on the statement that collaboration with the client dilutes the designer's creativity (mean = 2.76).

On average, respondents agreed on the statements on designer-client collaboration on building safety as shown by an average mean of 4.03 and an average standard deviation 0.57. These results are consistent with Ulang (2012) who agrees that constant communication and sharing of building information between the client and the project designer are significant throughout the project for capturing of usual and unusual risks. These results also concurred with Andy (2018) who supports building collaborative client-team relationships and contends that they provide forums for discussing probable dissatisfying aspects of the design thus empowering building teams. The results were presented in Table 1.

Table 1: Results on Designer-Client Collaboration

Statement	Mean	SD
It is important for the designer to cooperate with the client throughout the project design process	4.33	0.48
There is need to consult and compare safety priorities between the designer and the client before the preliminary design	4.48	0.60
Pre-design information about the site provided by the client provides opportunities for safety considerations.	4.52	0.51
Setting safety targets with the client is an indicator of commitment to designing for safety	4.33	0.57
Designer- client interaction in project risk identification at initial stages enhances building safety	4.14	0.57
Collaboration with the client dilutes the designers creativity	2.76	0.70
Average	**4.03**	**0.57**

Designer-Designer Collaboration

The study findings revealed that respondents agreed on the statements that it is necessary to liaise with the Quantity Surveyor on material specification to ensure safe materials are recommended (mean = 3.95), that cooperation with the interior designer improves on the safety of space decorations (mean = 3.38), that interaction with the interior designer promotes the safety the preliminary design (mean = 3.52) and that design alterations suggested by engineers suggestion on safety should be embraced(mean = 3.80). However, respondents were somehow neutral on the statement that cooperation with the interior designer improves on the safety of space decorations (mean = 3.14).

On average, the respondents agreed on the statements on designer-designer collaboration as shown by an average mean of 3.55 and average standard deviation of 0.51. This concurred with Lew (2016) who agrees on utilization of engineering solutions through design partnerships for purposes of promoting safety and that it is important to design construction project focusing on safety of workers. The study findings were also in agreement with Rizal (2011) who affirms that project designers should cooperate in meeting project user expectations and that information sharing between engineers and architects are of paramount importance to achieving safety efficiency. The findings were presented in Table 2.

Table 2: Results on Designer-Designer Collaboration

Statement	Mean	SD
It is necessary to liaise with the Quantity Surveyor on material specification to ensure safe materials are recommended.	3.95	0.21
Cooperation with the interior designer improves on the safety of space decorations.	3.38	0.49
Interaction with the interior designer improves the safety performance of the preliminary design	3.14	0.35
Collaboration with the engineers adds value to design constructability	3.52	0.67
Design alterations necessitated by engineers suggestion to improve safety should be embraced	3.80	0.81
Average	**3.55**	**0.51**

Correlation Results

The correlation results indicated that the correlation between correlation between Designer-Client Collaboration and building safety in Nairobi City County is .382 with a corresponding p value of .000. The correlation coefficient was therefore positive and significant implying that an increase in Designer-Client Collaboration would result to an increase in building safety. The findings were consistent with Andy (2018) who sought to explore on building collaborative client relationships with project teams and found that such client-team collaborations build trust and empowers teams where the client connects with the designer and together they discuss any dissatisfaction aspects on the design (Andy, 2018).

The study further sought to establish the relationship between designer-designer collaboration and g safety. The correlation results indicated that the correlation between Designer-Designer Collaboration and building Safety in Nairobi City County was .277 with a corresponding p value of .004. The correlation coefficient was therefore positive and significant implying that an increase in Designer-Designer Collaboration would result to an increase safety in building projects. The findings concurred with Rizal (2011) who affirms that information sharing between engineers and architects is of paramount importance to achieving safety efficiency in that design alterations suggested by the project engineer for reasons of enhancing safety would be of great importance when implemented.

Table 3: Correlation Matrix

		Designer-Client	Designer-Designer	Building Safety
Designer- Client	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	118		
Designer-Designer	Pearson Correlation	.476**	1	
	Sig. (2-tailed)	0		
	N	118	118	
Building Safety	Pearson Correlation	**.382****	**.277**	1
	Sig. (2-tailed)	0.000	0.004	
	N	118	118	118

** Correlation is significant at the 0.01 level (2-tailed).

Multiple Regression Analysis

To establish the statistical significance of the hypothesized relationships, the study conducted a

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multiple linear regression analysis at 95 percent confidence level (α = 0.05). The results presented in Table 4 were used to develop a model. The summary revealed R= .719 indicating a strong positive relationship between designer-client collaboration, designer-designer collaboration, designer-contractor collaboration as well as designer-stakeholder collaboration and building safety. R of 0.719 explains the positive relationship between the four levels of collaboration studied i.e designer-client collaboration, designer-designer collaboration, designer-contractor collaboration and designer- stakeholder collaboration. This meant that any change or variation in the independent variables would have a positive influence on building safety. R- Square of 0.516 means that there was 51.6% variation in building safety caused by collaboration practices between the designer and clients/other designers/contractors and stakeholders at 95% confidence interval. The R-squared was 0.516 which indicated that 51.6% of variation in the building safety can be explained by designer-client collaboration, designer-designer collaboration, designer-contractor collaboration as well as designer- stakeholder collaboration.

Table 4: Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.719[a]	**.516**	.497	.20936

a. Predictors: (Constant), Designer-Client Collaboration, Designer-Designer Collaboration.

ANOVA is an inferential statistical method that was applied on data to determine if there exists a significance difference among several population means, ANOVA uses variances to mean differences through the analysis of different forms of variance related with the random samples under study.

The results of ANOVA test as shown in Table 5 indicated F value of 25.505. F test basically compares the model of analysis with underlying predictor variables and in this study the predictor variables are designer-client collaboration and designer-designer collaboration. If P value is less than alpha value then the coefficients included improves the model of fit. F value of 25.505 with a significance of p value = 0.001 which was less than an alpha of 0.05 means that the regression model linking designer-client collaboration and designer-designer collaboration with building safety is positive and statistically significant thus the model of analysis fitted well. The model therefore has a predictive capability. The findings were also confirmed by comparison of a calculated F value of 25.505 against f critical value (4, 114) of 2.313. The F-calculated (25.505) is greater than F-critical (2.313) hence confirming the results.

Table 5: ANOVA (Model Significance)

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	4.718	4	1.796	**25.505**	.001[b]
Residual	3.289	114	.071		
Total	8.007	118			

a. Dependent Variable: Building Safety

b. Predictors: (Constant), Designer-Client Collaboration, Designer-Designer Collaboration

The model coefficients results presented revealed that the coefficient of designer- client collaboration was (β = .378, p = .003,) P value of 0.03 was less than the significance level of 0.05 which showed that the relationship between designer- client collaboration and building safety is statistically significant. The results showed that changes in designer-client collaboration are associated with

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building safety. A Beta of 0.378 implied that a unit increase in designer-client collaboration would result to an increase of 0.378 units in building safety. The findings concurred with Andy (2018) who sought to explore on building collaborative client relationships with project teams. The study found that such client-team collaborations build trust and empowers teams and thus significant influence on building safety.

The model coefficients also revealed that the coefficient of designer-designer collaboration was (β = .243, p = .000). A P value of 0.000 was less than the significant level of 0.05 shows that the correlation between designer-designer collaboration and building safety is statistically significant. This indicated that changes in designer-designer collaboration are associated with building safety.The results revealed a Beta of 0.243 which implies that a unit increase in designer-designer collaboration would result to an increase of 0.243 units in building safety. This was consistent with a study by Ulang (2012) on communication construction H & S information design and which sought to understand the challenges of information sharing at project design stage. The study found that sharing of information with all design team members had significant effect on project success.

Table 6: Model Coefficients

	Unstandardized Coefficients		**Standardized Coefficients**		
	B	**Std. Error**	**Beta**	**T**	**Sig.**
(Constant)	**0.206**	0.336		0.6131	0.003
Designer-client collaboration	**0.378**	0.073	0.544	5.1781	0.000
Designer-designer collaboration	**0.243**	0.042	0.504	5.7857	0.000

CONCLUSIONS AND RECOMMENDATIONS

The findings of the study culminated to conclusions that an emphasis in designer-client collaboration practices such as the designer cooperating with the client throughout the project design process, the designer consulting with the client before producing preliminary design, the designer allowing comparison of safety priorities with the client, the designer encouraging the client to share predesign information about the site, the designer setting safety targets with the client, and the designer and the client participation in project risk identification lead to a significant improvement in building safety in Nairobi City County.

The findings of the study also led to conclusion that an improvement in designer-designer collaboration practices such liaising with Quantity Surveyors to ensure that safe materials are recommended, cooperating with the interior designers to determine safety of space decorations and finishes, incorporating views of interior designers to improve safety preliminary design, collaborating with project engineers to add value to design constructability and allowing design alterations suggested by project engineers to improve building safety lead to a significant improvement in building safety in Nairobi City County.

The study recommended that the Board of Registration of Architects and Quantity Surveyors (BORAQS) should put emphasis for their members on teamwork between designers and clients throughout the project process. This would open avenue for discovery of all kinds of eventualities which might affect safety of the projects. The focus of this project was on the architects as lead designers of building projects. Therefore as concerns the client and the architect, the following should be done:

The design team of the project should make effort to cooperate with the client throughout the project to achieve project success. The architect should actively consult with the client from time to time on matters touching building safety; the architect should compare safety priorities with the client. The architect should consolidate safety priorities together, merge those which are similar and

capture the ones in the clients list and not in the designers list for prior attention. Pre-design information provided by the client on safety targets and expectations should be given serious consideration prior to the preliminary design is unveiled.

The study also recommended that designers should always focus on improving collaboration with other designers for purpose of improving building safety. They should always liaise with the quantity surveyors in ensuring that recommended building materials are safe. For safety of space decorations and finishes, the architect should cooperate with the interior designer for instance to agree on correct floor tiles, sanitary finishes, safe paints etc. emphasis on space safety at preliminary design improves safety in terms of air circulation, natural lighting, ventilation, correct glass and reflection safety. The architect should collaborate with mechanical engineers and accord priority to design alterations made by engineers which implicate on building safety. This is a goal to achieving design constructability.

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