Energy and Environment Research; Vol. 3, No. 1; 2013
ISSN 1927-0569 E-ISSN 1927-0577
Published by Canadian Center of Science and Education

A Literature Review on Analyzing the Architectural Design Process of Post-Disaster Houses

Behnam Ghasemzadeh[1], Atefeh Fathebaghali[2], Kasra Rahbaripour[3] & Hamed Pouyafar[4]

[1,3] Young Researchers and Elite Club, Tabriz Branch, Islamic Azad University, Tabriz, Iran

[2] M.A. in Architectural Engineering, Islamic Azad University of Tabriz, Tabriz, Iran

[4] Department of Art and Architecture, Tabriz Branch, Islamic Azad University, Tabriz, Iran

Correspondence: Behnam Ghasemzadeh, Young Researchers and Elite Club, Tabriz Branch, Islamic Azad University, Tabriz, Iran. Tel: 98-935-574-6603. E-mail: Behnam.Ghasemzadeh@yahoo.com

Received: April 8, 2013 Accepted: May 16, 2013 Online Published: May 25, 2013

doi:10.5539/eer.v3n1p180 URL: http://dx.doi.org/10.5539/eer.v3n1p180

Abstract

This study focused on presenting a secondary source academic analysis on the nature of the architectural design processes used in the creation of post-disaster housing. The specific focus was on sustainability and the extent to which architects have managed to develop sustainable designs, both in terms of economic factors and longevity (including possible experience of future disasters). This study was necessary due to the rise in natural disasters globally over the past two decades as well as the realization that those individuals most affected by the disasters tended to be those poorest in society.

The secondary data analysis found that the existing data supported the hypotheses. The current sustainable architectural designs in disaster-hit areas are linked to high economic expenditure. It is clear though that no current cheap and affordable method of sustainable housing exists apart from one example in Sri Lanka and this needs to be highlighted in the literature. It should also be noted that there are specific political and economic factors that prevent the sustainable development of post-disaster housing. Recommendations are made as to how future studies can use primary data to help discover methods of design that could be used by the wider population in regions hit frequently by natural disaster. By drawing attention to the inequality in housing in these regions through this current study, it is felt that the work has been a success and should lead to further debate and action in the near future.

Keywords: sustainability, natural disaster, economically-viable, longevity

1. Introduction

The recent impact of Hurricane Isaac in the United States has highlighted once again that natural disasters have the ability to impact on every individual in society, regardless of the community that they live in, the developed nature of their education or their location geographically. This study focused on the analysis of the architectural design process of post-disaster houses. The study concerns itself with this topic for a number of reasons but mainly due to the fact that there have been great improvements in architectural design over the past half century and this, coupled with the rise in climate change which has led to a growth in the number and severity of natural disasters on the global scale (Porfiriev, 2010). These two reasons suggest that it was necessary to provide a detailed analysis of how architectural design is adapted for the purpose of post-disaster houses, aiming to strengthen and prevent a similar level of damage and need for reconstruction in the future. Oliver (2006) indicates that there are a number of considerations that need to be met in terms of post-disaster housing in any specific region and that these are cultural and social, as well as political and economic.

The occurrence of natural disasters in a variety of locations around the world have led to the development and increase of knowledge concerning sustainable housing and how architectural designs can be implemented to help prevent future damage, in both the short, medium and long-term period. This research is vital in terms of furthering the knowledge of how certain architectural developments and designs can help to repair the damage caused by natural disasters, as well as helping to prevent future damage through the creation of sustainable housing. It is underlined that 'natural disasters have extensive and violent effects, cause loss of life and property, substantial affect on the communal life. The huge number of damaged and collapsed buildings after the

earthquakes creates a housing problem needing urgent attention' (Limoncu & Celebioglu, 2006, p.2). Moreover, it is assessed that it is those poorest in society that are most likely to feel the highest level of negative impact after a natural disaster.

A work that assessed the impact of an earthquake on the Peruvian coastline stated that 'the poorest households are least prepared when the earthquake hits and most likely to suffer from a lack of funds, rights and access to recover their lives in the aftermath, often falling into a vicious cycle whereby a poor effort to rebuild their homes leaves them even more exposed to the next natural disaster' (Blanco-Lion, Pelsmakers, & Taylor, 2011, p. 435). Through these assessments, it is clear that it is necessary to analyze how effective the architectural design process is for post-disaster housing and this is the main objective of this research study. This study used both qualitative and quantitative research methodologies in a mixed method approach to critically evaluate the current architectural designs for post-disaster housing in terms of its sustainability and cost.

2. Research Objectives

To ensure that the main aim of this study was achieved successfully, it was necessary to present tangible research objectives and clear focus issues that enabled the researcher to remain on task during the longevity of the study. The central research objectives of this study were created to highlight the pressing need to study architectural design in the form of post-disaster housing. Therefore, the objectives were:

1) Conduct a thorough review of the available empirical literature on the subject of architectural design and the creation of sustainable post-disaster housing, allowing the researcher to gain an enhanced knowledge of the current state of the literature.
2) Design a study using both qualitative and quantitative research methodologies to help present recent case studies in the field, providing a secondary source academic analysis of the topic.
3) Ensure that all information was reliable and helped to further the knowledge on the subject so that a conclusive summary could be achieved and that further recommendations of study could be made at the end of the research work.

3. Research Questions

From the research objectives and the focus issues of this study, it was possible to create three main research questions that were answered through the completion of the study. The main research questions were:

1) Have architects been able to ensure sustainability of post-disaster houses?
2) Has the sustainability developed over the past decade?
3) To what extent can this sustainability be maintained in the face of another potential disaster and can it be achieved through limited economic means?

Through these research questions, it was felt that the empirical literature could be studied effectively, allowing a detailed understanding of the architectural design process of post-disaster houses. Moreover, the focus on sustainability within certain economic and cultural limits provided the research with a working context within which to place this current study.

4. Research Hypothesis

Following the creation of the research questions, it was prudent to offer certain research hypotheses. The research hypotheses are two-tailed hypotheses. These are those hypotheses that 'make a prediction that the effect of an independent variable may go in either direction. For a two-tailed hypothesis, there is double the probability in either direction for a positive outcome' (Greene & D'Oliveira, 2005, p.19). The main hypothesis for this work is that successful architectural designs achieving sustainability and protection from disaster are positively related to the economic expenditure used during its creation. Therefore, it is assumed that those houses with greater access to financial support, will be more effective at creating sustainable design in a post-disaster region.

The second hypothesis focuses on the longevity of the sustainability and suggests that the longer the time period that the house exists, the less likely it is to be successful in preventing damage from possible disasters. The conclusions of this study could have a dramatic impact in terms of government support (financial) for regions hit by natural disasters as well as for architectural techniques and designs used in the process.

Table 1. Hypothesis testing in research

Variable	Type of relationship		
	Negative relationship	Positive relationship	Lack of relationship
Sustainable Housing and Economic Expenditure		This is assumed to be a positive relationship, with the higher the expenditure, the more sustainable and protected a house will be against disaster	-
Architectural Design and Time Length	This is viewed as having a negative relationship between these two variables. The longer the time period, the less likely it is that the architectural design would be sufficient in preventing or negating the impact of a disaster.		-

5. Literature Review

The nature of architectural design for post-disaster housing is one that is a 'considerable challenge' (Hayles, 2010, p. 103) for all of those involved in the rebuilding planning process. However, it is evident that the design of post-disaster housing is a central part of the architectural world's agenda, given the increase in natural disasters over the past two decades. An analysis of a brief period of the last decade presents a clear indication of the challenge that is imparted on architects with the view that 'the recent Indonesian Earthquake and Indian Ocean Tsunami (2004), Bam Earthquake (2003) and Gujarat Earthquake (2001)' (Boen & Jigyasu, 2005, p. 1) key examples of how developing countries in particular are impacted by such events. The literature highlights that a large part of the challenge in these particular areas is that cultural and social factors need to be taken into account as well as structural, safety and economic concerns. A 1995 study by Ladinski found that following a 1963 earthquake in Skopje, the 'decision to protect buildings with technology solely based on earthquake engineering principles led to damage of integrity, identity and the originality of the built heritage' (Awotana, 1997, p. 221). To place this viewpoint in context, it is apparent that 'spatial patterns and architectural features of housing are reflection of social order and cultural practices in many societies around the globe' (Vatsa, 2001, p. 6). This highlights that the architectural design process is a vital part of the post-disaster rehabilitation effort and it is necessary for the design to represent both a respect towards the local culture as well as the need to utilize new technologies so that sustainability can be achieved in the design. This is perhaps a difficult balance to achieve and this forms the main research aim of the entire study.

Finally, it has also been found that due to a lack of economic and technological resources, it has often been the case that architectural design processes on post-disaster housing has been unsafe and unsuitable. It was noted by Boen and Jigyasu (2005) that there have been numerous cases, especially in the developing world, where the improper use of technology has led to poorer housing designs and the failure to ensure sustainability in certain disaster-hit areas, with the study noting Guatemala as an extreme case in point. This point clearly indicates the importance of economic assistance, allowing architectural designs to use the needed technology and design to help ensure that safety is guaranteed in the post-disaster housing.

6. Research Structure

This research study relies heavily on existing studies within the architectural literature. Due to the limitations placed on the study, the researcher was not able to conduct any primary research. Therefore, the study relies on existing studies in the field to help analyze sustainability in architectural design and the extent to which various architects and architectural companies around the world have developed certain designs that allow cheap and sustainable housing to be constructed in areas that experience natural disasters. The study is a critical exploration of these designs, providing a discussion of certain innovative designs in the field and assessing them on how far they can sustain future natural disasters.

In this manner, the work aims to assess the followings:

- The techniques employed by architects and;
- How far this has changed in the last decade through the establishment of innovative techniques in industry;
- The ability to use technology to predict the extent of sustainable housing and;
- Whether these designs can be implemented in areas where there are low or limited economic funds, such as in South East Asia and Central America;
- Which are two of the poorest regions on the globe in modern society?

7. Methodology

The research methodology follows a mixed method approach immersed within a secondary source analysis research paradigm. The employment of the mixed methods approach is appropriate for this study because the combination of both qualitative and quantitative methods in one research study is thought to reduce the number of limitations normally associated with single methodology research (Creswell & Clark, 2010). The combination of statistical data and qualitative insights from studies already conducted in this particular research area will therefore be able to add strength to the study and make the findings much more reliable than they would be if a single research methodology was applied (Hesse-Bieber, 2010).

As well as the mixed methods approach, the secondary source analysis form of research is thought to be effective because it allows a researcher to draw together a range of findings from a particular field of study (Gravetter & Forzano, 2011). The definition of the approach is highlighted as a 'form of research in which the data collected and processed by one researcher (or more) is reanalyzed, often for a different purpose, by another' (Rubin & Babbie, 2010, p. 250). In this case, it is possible to collate information relating to architectural design in the world's poorest areas and critically assess the findings to come to conclusions concerning the main research questions in this current study. This is important because of the lack of resources currently held by this researcher and the fact that a primary, on-location study concerning sustainable housing over a long period of time would simply not be possible. However using the secondary approach, results from past studies can be used to help the researcher find the necessary data and to conclude successfully on the subject.

8. Research Tools

The research hypotheses assumed that sustainability was linked to economic expenditure and that longevity of a house life reduced the effectiveness of the sustainability against natural disasters. Therefore, it was deemed necessary to find a research methodology and the research tools that would be able to measure the economic relationship with sustainability as well as the impact of time on certain designs. The research used a search of the architectural literature to find studies relating to sustainability projects, cross-referencing them with the length of the project. Ideally studies were used that had been conducted in the last ten years and had analyzed the effectiveness of certain architectural designs over a period of time, rather than just assuming results in the future. This research method focusing on the key word of sustainability is a common method in recent studies in the architectural field. It is highlighted that 'over the last decade, increased research interest in sustainability has reintroduced many issues such as energy conservation, funding and protection against disaster, but framed within a new conceptual model' (Groat & Wang, 2002, p. 6). Using this search method, appropriate studies were found that could be applied to this current research study. These are highlighted in the results and discussion chapters of this project.

9. Limits and Limitations

At the beginning of this section it is pertinent to point out that limitations of a research study should not be viewed negatively. Kumar (2002) states that by placing limitations on a study, the aims become narrow and realistic. Having said that, there are certain limits placed on this study through a lack of resources that prevented a primary study of the data. The study therefore relies on secondary analysis data and this has limitations. The research study is limited to the data that exists currently, as well as having possible issues with validity (Cargan, 2007). Moreover, the issue of reliability and validity is heightened due to the reliance on other studies that may have used different variables or parameters to that set by this study. Therefore, it is vital that each study used for the analysis is thoroughly checked and critically assessed in terms of its validity before its use is sanctioned for the purposes of the current study.

10. Results and Discussion

This section presents an overview of the findings of the study using both forms of methodology through a case study of regional areas in Central America and South-East Asia. It should be highlighted during this that the

architectural world acknowledges that 'safe, healthy and well-built houses serves a basic human right…unfortunately millions of citizens of marginalized communities around the world are denied this right and struggle to meet the basic needs of daily life through a lack of money and poor government investment' (UN, 2012). Therefore, during this assessment of sustainable housing, it is clear that the knowledge exists that regions of natural disasters need help to strengthen their architectural designs but that this is not necessarily occurring through low investment. Moreover, it is noted by Boano and Hunter (2012) that in each situation when a disaster occurs, 'Spatially speaking, there are massive needs for physical reconstruction of damaged structures, provision of new housing, and the conservation of heritage buildings that challenge faster responses and open up opportunities for incorporating preventive measures in relation to the occurrence of future disasters' (2012, p. 1) but that these decisions also rest on the surrounding political and economic arena that often dictates that preventive methods of architecture cannot be used for the rebuilding effort, due to restrictions placed on the community such as a lack of funding. The study by Boano and Hunter is also critical on the role of architects, stating that to be successful, post-disaster housing efforts requires 'a necessary change in the traditional identity and approach of architects, meaning that they need to understand the complexity of the situation and the community at risk' (2012, p. 10).

The study by Berke (1995) indicated that sustainable development could be achieved through dual planning with local natural disaster commissions and international aid, but that the low economic expenditure on housing, coupled with the desire to rebuild quickly meant that sustainability often was overlooked in the rush to give the local population its housing back. He identified areas of flooding in Bangladesh as a key example of this. The low government spending meant that housing was simply rebuilt in the style prior to the natural disaster, meaning that future sustainability was not guaranteed. This finding was supported by a study by Dikmen (2011) who analyzed post-disaster housing in Turkey. He found that due to economic limitations, the residents rated the traditional housing (pre-disaster) as better than the post-disaster housing in two independent regions in the country and that the residents felt more secure in their old housing, highlighting that through restrictions economically, the post-housing was not viewed as sustainable by the residents.

One study that highlights a successful situation in which sustainability has been increased in post-disaster housing was that of Hidellage and Usoof (2009) who found that in post-tsunami Sri Lanka, the local government and architectural firms worked together to produce a low economic and highly sustainable method of housing for those affected by the tsunami. Although the study highlights that this sustainability has not yet been tested over a long period of time, the fact that economic limitations were not necessarily an issue and that the housing was created relatively cheaply, should be a cause for celebration.

11. Conclusion

In conclusion, the studies analyzed present clear findings that suggest that the most effective methods of architectural design for sustainability in areas of natural disaster are those that are more expensive. It is clear from the study that architects have not been able to ensure sustainability of post-disaster houses, with the literature stating that their fundamental beliefs do not allow for this to happen and that they need to put people and communities first for this to change. As well as this, it is clear that the issue of sustainability has increased over the past decade or so but this has happened slowly, with only a few examples, such as that in Sri Lanka where sustainability has been achieved at an affordable rate. For the most part, sustainability is restricted by economic and political factors and this shows no signs of abating, to the detriment of the majority of the population in disaster-affected regions of the world. Finally, there is little evidence to suggest that longevity reduces the sustainable nature of housing in disaster-hit areas, but this is due to the fact that the issue has only recently been covered by architectural literature and a longer period of time needs to pass before this can be assessed adequately.

12. Further Research

The study concluded in support of the two hypotheses, finding that economic and time factors were important considerations in terms of the ability of housing to remain sustainable throughout its lifetime in areas hit by natural disasters. However, this study relied on secondary data. It would be necessary to conduct (with the appropriate resources) a case study primary analysis of forms of architectural design and how effective they are in terms of sustainability in the face of disasters. This type of study could have a tremendous impact on the living conditions of individuals living in poor areas of the world. It is necessary to discover a cheap and economically viable method of engineering sustainable housing in these regions and this type of future study could help uncover vital data that is needed for this progression to happen. At the current time, those living in natural disaster areas are only able to have sustainable housing if they can afford it and it puts at risk a great majority of

the local populations, especially in areas such as South East Asia and Central America. It is imperative that this subject be further analyzed and through primary study, as recommended in this section.

References

Ary, D., Jacobs, L., Razavieh, A., & Sorenson, C. (2009). *Introduction to research in education*. London: Cengage Learning.

Awotana, A. (1997). *Reconstruction after disaster-issues and practices*. Bristol: Ashgate Publishing.

Berke, P. (1995). Natural-hazard reduction and sustainable development: a global assessment. *Journal of Planning Literature, 9*(4), 370-382. http://dx.doi.org/10.1177/088541229500900404

Blanco-Lion, C., Pelsmakers, S., & Taylor, M. (2011). Sustainable solution for the reconstruction of low income housing in post-disaster zone. In M. Bodart & A. Evrard, *Architecture and sustainable development. 27th International conference on passive and low energy architecture, volume 2.* Belgium: Louvain University Press.

Boano, C., & Hunter, W. (2012). Architecture at risk?: the ambivalent nature of post-disaster practice. *Architectoni, 1*, 1-13. http://dx.doi.org/10.5618/arch.2012.v1.n1.1

Bodart, M., & Evrard, A. (2011). *Architecture and sustainable development. 27th International conference on passive and low energy architecture, volume 2.* Belgium: Louvain University Press.

Boen, T., & Jigyasu, R. (2005). *Cultural considerations for post disaster reconstruction: post-tsunami challenges.* Jakarta: WSSI.

Cargan, L. (2007). *Doing social research*. London: Rowman & Littlefield.

Creswell, J., & Clark, V. (2010). *Designing and conducting mixed methods research*. London: SAGE.

Dikmen, N. (2011). Comparative analysis of permanent post-disaster houses constructed in Cankiri and Dinar. *Disasters, 35*(2), 404-416. http://dx.doi.org/10.1111/j.1467-7717.2010.01220.x

Gravetter, F., & Forzano, L. (2011). *Research methods for the behavioral sciences*. California: Cengage Learning.

Greene, J., & D'Oliveira, M. (2005). *Learning to use statistical tests in psychology.* New York: McGraw-Hill International.

Groat, L., & Wang, D. (2002). *Architectural research methods*. London: John Wiley & Sons.

Hartas, D. (2010). *Educational research and inquiry: qualitative and quantitative approaches.* California: Continuum International Publishing Group.

Hayles, C. (2010). An examination of decision-making in post-disaster housing reconstruction. *International Journal of Disaster Resilience in the Built Environment, 1*(1), 103-122. http://dx.doi.org/10.1108/17595901011026508

Hesse-Bieber, S. (2010). *Mixed methods research: merging theory with practice.* New York: Guilford Press.

Hidellage, V., & Usoof, A. (2009). *Up-scaling owner-driven reconstruction: lessons from post-Tsunami Sri Lanka*. London: South Bank University Press.

Kumar, A. (2002). *Research methodology in social science.* London: Sarup & Sons.

Limoncu, S., & Celebioglu, B. (2006). *Post-disaster sustainable housing system in Turkey.* Turkey: Yildiz Technical University Press.

Oliver, P. (2006). *Built to meet needs: cultural issues in vernacular architecture*. Abingdon: Routledge.

Porfiriev, B. (2010). *Climate change as environmental and economic hazard*. Washington D.C.: Earthscan.

Rubin, A., & Babbie, E. (2009). *Essential research methods for social work.* California: Cengage Learning.

UN. (2012). *United Nations Environment Program.* Retrieved October 1, 2012, from http://www.unep.org/environmentalgovernance/Events/HumanRightsandEnvironment/tabid/2046/language/en-US/Default.aspx

Vatsa, K. (2001). *Rhetoric and reality of post-disaster rehabilitation after the Latur Earthquake of 1993: a rejoinder*. New Delhi: Personal Communication Publishing.