

Framework for Sustainability Assessment of Reconstructed Buildings Post Earthquake in Rural Setting- A Case of Barpak

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Abstract

The post disaster situation at various affected districts is at a regressive state. The historical content and homogeneous vernacular settlement are being converted into a haphazard settlement that doesn't address the needs of the locals. There are major issues in the post disaster reconstruction in terms of housing that are not at all socio-culturally, economically and environmentally sustainable. The reconstruction is affecting the rural areas mostly with economically vulnerable families. Thus, local culture and their lifestyle is in a stage of transformation and that questions the economic, ecological and social sustainability. The built environment there no more represents their intrinsic architecture. The lifestyle is changing and affecting the vernacular character of the place. Government has proposed designs that doesn't address the lifestyle of the people. The aim of making the reconstruction sustainable in the affected areas is a challenge now. The thesis has focused to identify the factors that are crucial to be considered during the reconstruction to be carried out in the rural context. It has tried to focus on developing an approach for the improvements to be made in post disaster recovery framework to make it more context based. A draft structure that can guide to formation of laws and policies for planning has been developed. Recommendations that support the sustainability aspect of reconstruction and in the post disaster recovery framework have been provided.

Keywords

Post-disaster, Reconstruction, Barpak, Sustainability

1. Introduction

Nepal is a landlocked country and lies in one of the most seismically active regions of the world [1]. Therefore, it is ranked as the 11th among 200 countries of the world in terms of its vulnerability to earthquakes [2]. With a lot of history on earthquakes, the recent one that hit Nepal was of 7.6 magnitude on 25th April, 2015. It was one of the most powerful disasters seen in the country bringing a lot of destruction from the loss of lives to infrastructures, damage of ancient neighborhoods and significant heritage sites. It affected 31 districts in total with 14 districts suffering the highest impact. As a result of the earthquake, 8,790 people died and more than 22,300 people were injured. Assessments showed that at least 498,852 private houses and 2,656 government buildings were destroyed. Another 256,697 private houses and 3,622 government buildings were partially damaged. In addition, 19,000 classrooms were

destroyed and 11,000 damaged [3].

The consequences still in the recovery phase even after 3 years of disaster is taking a new shape and setting. The academic field visit to Barpak made me aware about the reconstruction situation. The cluster of heterogeneous natural traditional settlement was being converted into the haphazard RCC buildings changing the visible appearance of the settlement. Some additional understanding of the reconstruction scenario like financial, management and policy issues was observed during study at Chitlang. The impact of these changes on economic, social, environmental and cultural aspects has started to direct it towards unfavorable situations. This change, especially seen in rural areas is a significant one bringing change in lifestyle, sense of space and socio-cultural identity that can be understood as a "SHIFT" of the lives. Imposing a challenge to sustainability, the disaster recovery management of housing reconstruction seems ineffective. Government approach in Post

Disaster Recovery Framework (PDRF) included policies and interventions for finance, recovery and safety but the approach to sustainability for building assessment is missing. Design Catalogue for Reconstruction that includes options for the houses with a blanket approach rather than context base. Different kinds of needs assessment, socio-demographic impact study has been conducted but none have addressed to guide building sustainability aspect.

Therefore, this emphasizes that there is a pressing need of building sustainability assessment criteria during reconstruction. Building sustainability assessment is essential to identify an appropriate strategy that can guide to predict and evaluate the potential impacts of the efforts that have been made. On the other hand, the Post-Disaster Needs Assessment (PDNA) forms a basis for PDRF, thus including building sustainability assessment in PDRF can allow opportunities to incorporate basic needs for building sustainability assessment within PDNA as well. This research tries to understand underlying factors for this shift in the context of Barpak with the help of sustainability assessment framework that can be helpful to control the scale of undesired consequences and future improvement.

Barpak is an area which has cold weather for 12 months with extreme winter from Kartik to Chaitra and remaining months with the mild climate. It is dominant of Ghales, Gurungs and Dalits. The social stratification is from the upper class begins with Ghale followed by Gurung and then Damai/ Kaami. The religion of the locals are among diverse and among Christian, Hindu, Buddhist and Hindu Buddhist. The area has been divided into 9 new wards. Out of 1349 houses that has to be reconstructed, 1193 houses have been completed till December, 2018. RCC houses are being constructed rapidly alongside the Stone Masonry houses. The number of RCC houses are 393 and stone masonry houses are 800.

2. Research Objectives

The research aims to understand the social, cultural, economic and environmental impacts of the housing reconstruction efforts in order to develop a framework for sustainability assessment of reconstructed buildings in Barpak. The research questions that helps to understand the existing problem are mentioned below:

- What are the major factors that have caused the change in the ongoing reconstruction efforts in Barpak?
- What are the necessary strategies to be adopted to protect and promote the well-being of the rural context, especially the Barpak community?

3. Literature Review

Reconstruction, means returning a damaged building to a known earlier state by the introduction of new materials. The Guiding Principles for reconstruction [4] are mentioned below:

1. A good reconstruction policy helps reactivate communities and empower people to rebuild their housing, lives, and their livelihoods.
2. Community members should be partners in policy making and leaders of local implementation. Private sector are as important parts of the solution.
3. Reconstruction policy and plans should be financially realistic but ambitious with respect to disaster risk reduction.
4. Reconstruction is an opportunity to plan for the future and to conserve the past. To contribute to long-term development, reconstruction must be sustainable.
5. Relocation should be kept to a minimum and assessment and monitoring can improve reconstruction outcomes. Every reconstruction project is unique.

3.1 Reconstruction in Rural Context

Jha et al.[4] has differentiated about urban and rural disasters. Rural disaster programs pose their own unique problems such as lower land values, ownership and titling issues. Additional factors that influence the reconstruction approach are the social structure, lack of institutional capacity for planning and regulation. However, it is relatively easier for community participation as housing is usually designed and built by owners themselves. Study on the “3F-in-1” Sustainable Reconstruction of Rural Architecture from Placeality Perspective, Yifu 2017 defines rural placeality -regional culture, way of life , demands on architecture. Combination of “3F-in-1”, functional demands: production functional demands, life functional demands, ecological functional demands.

3.2 Building Sustainability Assessment

A building project can be regarded as sustainable only when all the dimensions of sustainability: environmental, economic, social, and cultural are dealt with. Sood [5] states that Quadruple bottom line (QBL) provides means to measure, value and assess the addition of culture, spirituality, and faith without compromising core values. In order to regulate natural processes and control the scale of human activities, sustainability assessment needs to be integrated. In this context, indicator-based sustainability assessment tools are fundamental instruments that provide information to support policy and decision-making. Indicators and parameters are powerful tool to measure buildings performance environmental, social, cultural and economic criteria [6]. Indicators control the scale of undesired consequences of ongoing aid effort, guide aid policy, improve coordination, situational understanding and decision-making. Sustainability and performance assessment and benchmarking of buildings [7].

3.3 Framework Development

Disaster Recovery Framework guides governments and other implementing stakeholders to defining a strategy and prioritizing actions with guidance on financing [8]. Sustainability Framework is a Conceptual structure works within a local system. It is both a process and its result. Different dimensions have indicators attached to them. Each is then transformed and computed into values to guide analysis and decisions [9]

4. Methodology

4.1 Research Paradigm

This research is based on pragmatic paradigm as it demands a methodology that is suitable particularly to get a comprehensive understanding of the issue with access to extensive information. The ontology of the research is the ongoing reconstruction with a lot of problems and missing sustainability assessment of buildings. To understand this issue, the epistemological areas would be information from locals, organizations, government authorities, documents and data from NRA. It is a qualitative case study research designed with explanatory and descriptive techniques to explain the existing situation of the various issues of reconstruction in Barpak. The

research tries to carry the assessment of RCC and Stone Masonry as stone masonry relates more with the traditional design whereas RCC buildings are contrast to them. To carry out this study, mixed methods with both qualitative and quantitative methods are used. The data collected are used to generalize into a certain meaning, so, the research has inductive approach.

4.2 Research Design

The objective of this research is to understand the impacts for the framework on building sustainability assessment which entails in depth study on what, why and how of the existing reconstruction scenario. Literature and other sources were referred for considering case dependent parameters and indicators for environmental, social, cultural and economic aspects flexible for different building typology. Additionally, criteria for sustainability for each indicator was developed on the basis of ground reality scenario to make it adaptable to the context. On this basis the sustainability matrix was developed for the analysis of the selected buildings for the assessment. It was further structured as questionnaire for site study to understand the needs of the locals. The parameters and the indicators have been mentioned below:

1. ENVIRONMENT

Location - Significant Site, Isolation, Orientation

Resources - Availability of Land, Water, Human Labor, Materials, Equipment

Water - Operational Use of Water-Management, Reuse, Embodied Water Use, Wastewater Generation

Land - Land Use- Existing or New, Change of Land Use- Greenfield / Brownfield, Soil Sealing, Development of Additional Areas, Compensating for The Use of New Land.

Climate Systems - Adaptation to Extremes of Climate, Carbon Footprint

Materials - Use of Local Materials, Reuse of Materials, Use of Foreign Materials, Availability

Energy Demand - Use of Renewable, Use of Non Renewable

Ecological valor of the site - Protection of Trees, Protection of Agricultural Land,

Land Pollution, Water Pollution, Air Pollution- Use of Equipment, Eco Mobility, Waste Management

2. ECONOMY

Building Adaptability - affordable

Long Term Stability - One Time Investment

Maintenance - Items to maintain

Resources Cost - Land, Materials, Labor, Equipments, Transport

Funds - Helpful, Time in Receiving Fund, Difficulty in Receiving Fund, Loans

Source of Income - Rentable Space for Commercial Use

3. SOCIETY

Welfare - Better Services and Facilities

Maintenance - Building Easily Adaptable to Future Changes, Social Status

Health - Indoor Air Quality, Diseases or Illness

Comfort - Illuminance/Sunlight, Daylight, Thermal Comfort-Warm Inside, Heat Insulation, Sound Insulation And Noise Reduction

Satisfaction - Psychosocial Well Being, Construction Satisfaction, Empowerment, Relaxation

Safety and security - New House Stronger than their Traditional House, Resilience of Traditional House, Build Back Better

Human Interactions - Accessible, Easier in Usage, Friendly to all Age Groups and Gender, Inclusiveness in Decision Making, Participation, Awareness

4. CULTURE

Architecture - Local Architectural Style, Functional Planning, Visual Harmony, Building Shape and Size, Design Choices Implementation, Design Choices Preference

Culture and Context - Historical Values Cultural Significance of House, Sense of Identity, Sense of Creation

Spatial Analysis - Production Function with crops, livestock, consumption, Life Function with comfort, development, communication space and Ecological Function with Design-Impact, Time-Communication Space and Clan-Community Space

4.3 Progressive Focusing

On site, the necessary field considerations such as cold climate, ethnic groups like Ghales, Gurungs and Dalits, socio-economic condition, local architecture style, dominant building typology were made. Out of 9 total wards, only six wards (4,5,6,7,8,9) were considered due to the limitation of time and resources.

4.4 Sampling

While selecting the sample from six wards, stratified purposive sampling on the basis of stone masonry and RCC typology within each ward was done. Two houses of each type in every ward(three in Ward 4), was selected by random sampling. The sample size was 13 based of ethnic groups with majority of Ghales, Gurungs and a single Dalit along with diverse economic condition, representative of the population of selected case area. Key informants have also been selected on the basis of their involvement in the community for the validity of the data.

4.5 Methods of Data Collection

Primary Data Collection: In depth interviews, telephonic interviews semi structured questionnaires for survey, focus groups,field observation, photographs and ethnographies are the primary methods.

Secondary data collection: Government publications, internal records of the organization like LUMANTI,JICA, reports, books, journal articles, website and remote sensing imagery are the secondary methods.

The responses from the in depth interviews were documented for four dimensions in broader parameters with sub sections on the basis of four components: Indicators, Criteria for Sustainability, Characteristics and Findings.

4.6 Data Analysis Plan

The similar findings after validity were categorized and then quantified. For easier understanding, percentage representation was used for the findings. For example: 5 out of 13 is 38% of the sample data. For the analysis of data, sustainability criteria of each indicator was categorized in three level as low, medium and high representing unsustainability, partly sustainability and sustainability. Percentage range was

calculated on the basis of percentile out of 13. Perspective, observational, behavioural, Key Informant and Focus Groups were used to develop low, medium and high scenarios for analysis for each indicator. Finally, scope and impact analysis has been done.

5. Findings

After the data collection, the findings of reconstruction scenario for every dimension were both positive and negative.

5.1 Environment

Positive impact: Important sites have not been intervened with houses located within groups. Most of the resources like land, water, human labor are available. Size of the houses have been increased only as per the requirements. Reuse and use of local materials like timber, stone, slate are seen. Walking has been seen as one of the main methods of transport. Land and air pollution is not observed. Degradable wastes have been mainly converted to compost.

Negative Impact: Most of the house have not considered orientation towards the South. Houses are cold on the inside. Resources especially modern materials are not available and use of water resources have increased in the new house. Greenfield sites are being used for construction of the houses and no compensation for the land use was found. Dependence on both firewood and LPG fuel has increased. Use of LPG has increased from hygienic point of view and separate structures have been constructed to use firewood. Use of devices for heating is seen. Connection of drainage and sewerage lines, disposal of wastes into the river has polluted the river. Non degradable wastes are either burnt, reused or sent to brothels.

5.2 Social

Positive impact: Larger rooms, better services and facilities like access of natural daylight with provision of sunlight in rooms. New houses provide barrier from the external noises as compared to the old. Improved health conditions and satisfaction with the building. Strength of the houses have increased. Houses are more easier to use, accessible to all gender and age groups. Participation and inclusiveness of locals in construction and design of the house.

Negative Impact: Houses are not adaptable to the functional change and a lot maintenance is required. The type of residence has started to define the social status, as rich or poor. No considerations of thermal insulation has been made. Locals are less familiar and aware about with the recent design and construction.

5.3 Culture

Positive impact: Locals appreciate the technical and financial help from the government. Larger rooms have addressed the family needs and sufficient for comfort living. Modern facilities added to the houses have made the house easier to use.

Negative Impact: No consideration of local lifestyle, emotional, social, cultural and spiritual significance in the house. The reconstructed houses do not address the local identity of Barpak. Governmental design guidelines have not addressed the needs of the family and size, functional spaces in rural context and have many restrictions. Many one room houses have been constructed who are later planning to make RCC houses. Indigenous skills and ideas for architecture are not considered. Majority have not preferred new designs as compared to the old ones in terms for houses visually suitable to the context of Barpak. Main sources of livelihood transformed. Production and storage of crops adjusted by reducing the amount of dependence on agricultural products, drying is done by using neighbors area due to the lack of space. Animal rearing has been abandoned by majority. Buying items that has increased the family expenses. Spacious and segregated rooms have decreased the communication between the family members. Clan space are being modified and communication space have not been considered in the new houses. More time is spent in the house and socializing with neighbors has decreased.

5.4 Economic

Positive impact: Houses are affordable to the locals and they feel that they have invested for a lifetime. Houses have been used as the source of income by using buildings for commercial purposes. Funds have been helpful to the locals and is observed as the main source of motivation to rebuild houses.

Negative Impact: Price of the materials are expensive for the local to purchase. Expenses of the

houses have increased with increase in resource use and maintenance. Locals have been highly dependent on the loans taken from neighbors and relatives to construct houses. Financial burden has been observed in most of the cases. Funds have been helpful for rebuilding.

5.5 Impact Analysis

The impact analysis has been used to understand the magnitude of the effect in a more broader scenario. Some impact might be large for some and small for the other. Additionally, connections could be observed between various dimensions and interrelationship between the sustainable, partially sustainable and unsustainable indicators of different dimensions. Some of the descriptive analysis of the flowcharts have been mentioned below:

Due to the lack of proper orientation, houses are unable to adapt to extremes of climate. This has increased the use of firewood and active devices ultimately increasing the energy demand, consumption of electricity and challenging affordability. Houses are thermally uncomfortable with no use of insulation that has affected the feeling of relaxation. Ecological function has not been addressed in the design and type of materials used making it less adaptable to the dominantly cold climate of Barpak.

Modern materials are available, preferred, imported and used. This has increased carbon footprint, dependence on tractors, tippers causing air pollution and difficulty in management of non- biodegradable waste. On the other hand, reuse of local materials is seen but not emphasized enough to preserve local architectural style.

The design choices that local prefer is the local architecture due to familiarity which is not practiced in current reconstruction. This has made locals unable to be independent to build their house. Inclusiveness and participation in decision making and needs assessment for preferred design is not seen. The consequences of this is there are less human labor involved with awareness about the preferred design choices that is affecting the resilient reconstruction. No consideration of preferred design choice resulted in the lack of affordability and sense of creation of the houses.

The availability of land has accelerated construction of houses on isolated areas making settlement

haphazard, increasing built-up sprawl and construction debris. Soil sealing of front yard has additionally increased coverage making the land almost irreversible of change. Lack of compensation for consuming agricultural land, has decreased the production of crops.

The houses are equipped with pipelines facilities increasing the use of water and wastewater. There is no provision of septic tanks. Embodied water use is more than old ones. Houses are a one-time investment so new areas are prioritized but increased maintenance like repair of pipelines, electrical bulbs, roof, paintings have added pressure to the affordability of the family.

The design choices that have been implemented by the government has not addressed the family needs, size and distribution making the building difficult to modify to meet the functional requirements. The division of rooms has decreased the interaction between the family members. Additionally, more time is spent in the RCC houses and the interaction is less with neighbors as well. The social connectedness which is the essence of the Barpak community is gradually changing into isolation. Moreover, the lack of storage areas and using neighbors area to dry crops are some other issues. Some of the additional problems have arise with no properly separated spaces for livestock, hence affecting livelihood. New designs have started a social status classification in the community that has affected the psychosocial well-being. Design choices provided has generated a concept that modern construction practices are stronger than traditional ones despite the people realize traditional houses can be made stronger.

The preferred design choice is the traditional house that considers family hierarchy, spaces of spirituality connection with the ancestors, storage and livestock areas. Modern and new houses with no such considerations and increasing demand, thus seem to be an obligation. As the cultural change is in process, the social status defined by the type of house are important rather than cultural significance.

Time taken to receive the full fund is dependent on design options with issues of insufficient grant, has compelled them to take additional loans. Designs provided by government are also not cost effective as for those who built stone masonry houses have used savings and loans. The time for financial recovery is another challenge. The funds are helpful and received

with less difficulty, so most of the houses have been built just to receive fund.

From the impact analysis it has been observed that the cultural dimension has been interrelated the most with other dimensions followed by the economic, environmental and social dimension respectively. Similarly, the major indicators that have been repeatedly connected are mentioned below:

- Local architectural style
- Life , space and production function
- Design choices preference
- Design choice implementation
- Sense of identity
- Maintenance
- Funds
- Affordability
- Cost of Resources
- Thermal Comfort
- Materials
- Change of Land Use
- Social status
- Strength and Stability of House

6. Discussion

After assessing the house typologies in Barpak. It was observed that each typology has its own pros and cons. New houses have facilities but no cultural and functional adaptability. They have healthy indoor environment but do not have thermal comfort as their traditional houses. The houses provide economic burden but are strong to resist disasters. Therefore, proposing a permanent shelter for reconstruction for Barpak requires a deliberate understanding of positive features of the traditional, RCC and stone masonry houses. The impacts of reconstruction have affected from household to neighborhood scale, so it is essential to consider the scale of intervention and emphasize on such strategies. The impact analysis shows that the reconstruction efforts are unsustainable. Therefore, some of the future scenarios that might result with such impacts are that the stone masonry houses might not be used with the need of social status, unplanned settlements are a definite outcome of reconstruction. The cultural shift might create identity crisis and specific focus on buildings can create communal issues in the future. This study can be a reference for future reconstruction programs and a basis for design of context based housing. However, this research is unaccountable for the temperature

data, detail quantity estimate of materials for future research areas that can be used to develop standards to measure quantitative performance of the building. Despite unfavorable situations and many limitations, the country is trying its best to cope up with disaster. Reconstruction has many successful in many areas but it needs wider perspective for efficiency.

7. Conclusion

Sustainability assessment helped to understand the performance of modern stone masonry and RCC buildings through the identification of unsustainable, partly sustainable and unsustainable indicators. This presses the need of context based housing that emphasizes on cold climate, social structure, economic condition, sources of livelihood in Barpak. Therefore, the design of the houses in Barpak cannot be identical with other places. After the analysis from the study, the traditional stone masonry with mud mortar seems to be more appropriate for the context of Barpak with the perspective of reconstruction. It is warmer, affordable, context based, facilitated and functional as per the local needs. However, considerations on facilities in the house, promoting healthy indoor environment and improvements in the strength against disasters have to be made. Culture is the most essential factor in the houses of Barpak that guides other areas of living such as environment, economy and social aspects. This should not be overlooked in need of emergency and relief.

8. Recommendation

SOCIAL

- Houses should encourage social cohesion rather than symbolize social status.
- Locals should be aware and familiar about benefits of local materials for resource sustainability and new construction for resilient reconstruction.
- Design choices preferred by locals should be prioritized to integrate homogeneity, user based design allowing them to become partners in policy making.

ECONOMIC

- Design must be suitable to all income groups within Barpak.

- Economic opportunities must be focused and maintenance should be made economical by creating local markets.
- The sustainable way of providing financial aid is on the basis of affordability so fund would be wisely used and timely provided with additional facilities like low interest loan from financial organizations enough to invest for a secure housing.

CULTURE

- Culture should be emphasized life, ecological and production function restoring livelihoods should be integrated within the proposed shelters.
- Implementation of design choices must ensure need based, permanent, secure housing reconstruction that maintains visual harmony and sense of identity.
- Interaction and understanding of local culture local participation/ consultation during design developments phase that makes technical facilitators, architects, engineers aware about social and cultural context.

ENVIRONMENT

- Bye- laws should be made to enforce proper orientation of the house. It can also include policies of providing overhang, vertical or terrace vegetable garden or certain area of agriculture land within site.
- Ecological considerations like door-window sizes, facade treatment, use of local materials should be made essential to ensure designs are climate responsive, economically affordable and local friendly.
- Preservation of productive land by planning or mapping areas suitable for construction with locals guidance and land owners opinion.

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