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Effect of Post-Earthquake Rural Housing Reconstruction on Housing Types and Family Debt

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Abstract

This research investigates the impact of post-earthquake rural housing reconstruction in Nepal, focusing on changes in housing sizes, typologies, and financial debt among affected families. It highlights a significant reduction (i.e. 61% of respondents have two-room houses after earthquake) in average house size from pre- to post-earthquake periods, driven by constraints related to time, resources, and financial capacities. The study reveals that reconstructed homes are notably smaller and often do not meet the spatial needs of households compared to their pre-disaster counterparts. The quantitative analysis, which involved random sampling of household data complemented by secondary data from literature reviews and project reports, uncovers several key findings: The average reconstruction cost per house is NRs 6,14,600 significantly exceeds the government grants provided, leading to increased household debt and financial strain. Changes in construction materials and housing typologies, 75% of respondents with SMM typology decreased to 9% after the earthquake and the BMC had increased to 61% from 2% which reflect that beneficiaries are more likely to have BCM typology. The study finds that the lack of consideration for settlement-level dynamics in reconstruction efforts has resulted in incomplete recovery, indicating the need for a more integrated approach.

The research also assesses the applicability of Central Place Theory in the housing reconstruction process, suggesting that incorporating this theory could improve planning and contribute to more

sustainable outcomes. Overall, the research provides valuable evidence for refining policies and strategies related to rural housing reconstruction. It advocates for a revised approach that considers settlement dynamics and aligns with the spatial needs of affected communities, aiming to enhance the effectiveness and sustainability of future reconstruction efforts both within Nepal and in similar contexts worldwide.

Keywords: housing reconstruction, housing trends, recovery, housing finance, lessons learned, settlement approach.

1. Introduction

Nepal faces a complex and recurring challenges of multi-hazard disasters due to its diverse geography and climatic conditions from sea level to Himalayan terrain. Earthquake is one of the major hazards causing huge impact in terms of casualties, fatalities and economic loss as it is located between two tectonic plates: Indian plate and Tibetan plate. As per observed earthquake history of Nepal, there is possibility of earthquake with magnitude of 7 and above in every forty years and magnitude of 8 plus in every eighty years.

Following the devastating earthquakes that struck Nepal in April 2015, the nation faced unprecedented challenges in addressing the extensive damages to private and public house, infrastructure in 31 districts. Major impact of the earthquake is detected in rural area of affected districts. Two consecutive earthquakes with magnitudes of 7.8 and aftershock 7.3, resulted in intensive destruction, causing loss of lives, dislocation of societies, and sizable damage to homes, infrastructure, and livelihoods. In the aftermath, the Nepalese government, along with various international organizations and NGOs, initiated the emergency response followed by extensive reconstruction efforts to address the housing crisis and support affected families. The reconstruction efforts were focused not only on restoring homes but also on promoting resilient and culturally appropriate housing designs. The initiatives considered the socio-economic conditions of the affected families, ensuring that the new structures were both sustainable and reflective of local traditions. By prioritizing resilience and cultural relevance, the reconstruction aimed to provide long-lasting, suitable housing solutions that would support the communities' recovery and strengthen their ability to withstand future challenges. The reconstruction process involved various strategies, including technical support, financial aid, and housing design guidelines, to facilitate the rebuilding of homes in affected areas. Government had deployed the

numbers of engineers for the technical support in reconstructing the house of affected families along with the various earthquake resilience design in the affected district. Financial aid came in the form of grants from government and loans provided to affected families to support their reconstruction efforts.

The financial burden on affected families increased significantly during the reconstruction period. Government subsidy is not enough for reconstruction and many households were compelled to take loans or incur debts to supplement the government grants, raising concerns about the long-term financial sustainability of these households. Despite the assistance provided, the post-earthquake reconstruction process encountered several challenges. Delays in disbursing financial assistance, bureaucratic obstacles, geographical challenges in accessing remote areas, and complexities related to land ownership and documentation significantly impeded the speed and effectiveness of the reconstruction efforts. The reconstruction efforts resulted in changes to housing typologies, where traditional architectural designs were adapted to incorporate earthquake-resistant features and to meet the evolving cultural and social needs of the communities. Consequently, the new housing structures and layouts differed from those of the pre-earthquake homes.

Following guiding principles should form the basis of strategy and planning of recovery and reconstruction as per PDNA (Commission, 2015).

- Facilitate community engagement by empowering residents to take charge of their home reconstruction projects.
- A comprehensive view of housing reconstruction should include holistic habitat development, with basic services and community infrastructure. The principle of build back better (BBB) should translate into a concept of safer settlements.
- Reconstruction should be viewed as an opportunity to enhance long-term community resilience by addressing vulnerabilities and bolstering community capacities. This involves adopting improved construction practices to strengthen the majority of the building stock and better prepare for future disasters.
- Enhance the local economy through reconstruction initiatives that specifically support the poor and marginalized, especially those in the informal sector. This approach should

provide these communities with opportunities to upgrade their living conditions and achieve greater economic advancement.

- Ensure that the reconstruction process is sustainable and environmentally friendly by considering climate change, managing natural resources responsibly, and incorporating scientific risk assessments.
- Ensure that rehabilitation is equitable and inclusive.

2. Materials and Methods

Tanahun district is in the Gandaki Province with the area of 1,546 km². Tanahun District share boarders with Grokha in east, Kaski in west, Lamjung and Kaski in North and Chitwan and

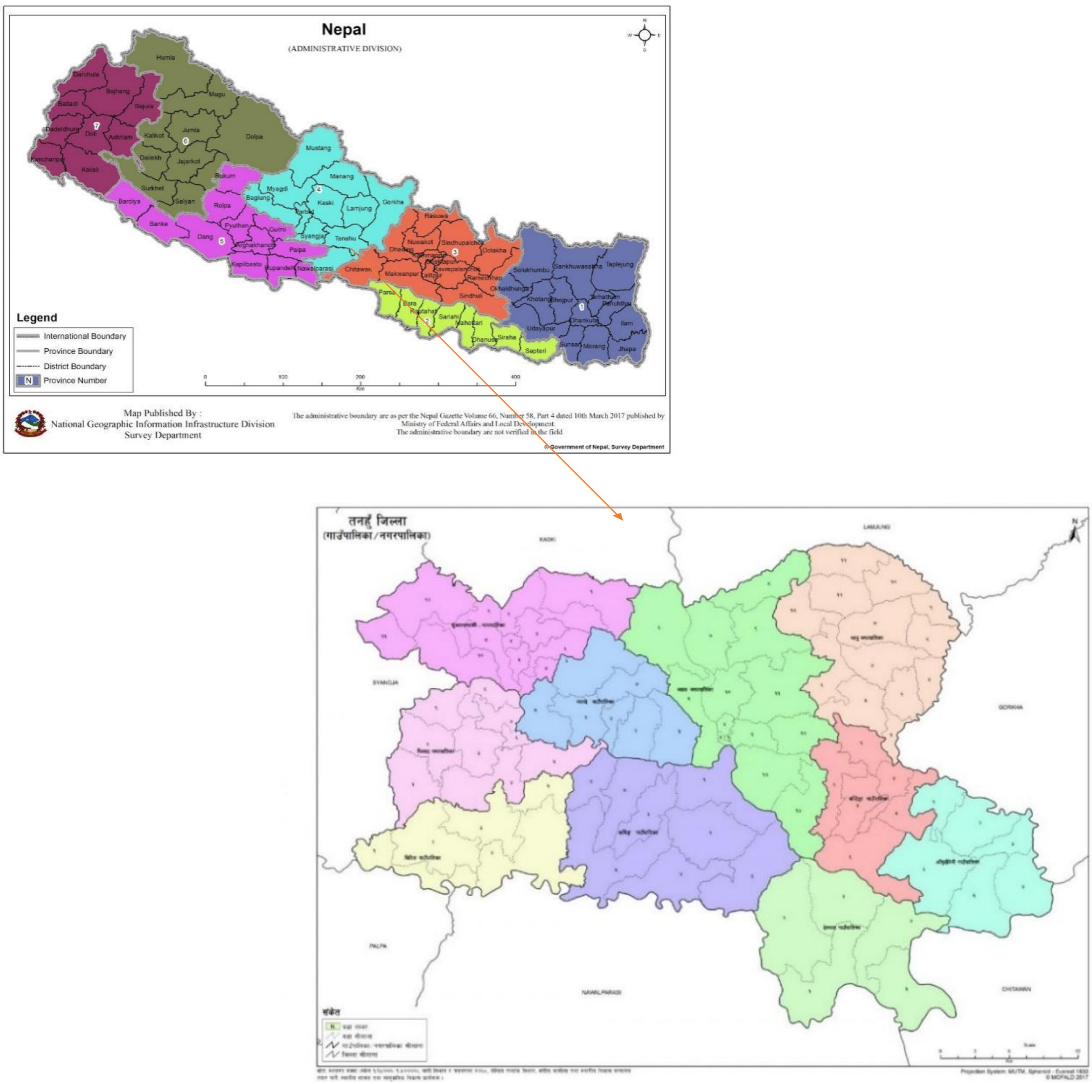

Fig. 1: Topographic map of Tanahun District Source: Nepal Census 2068

Nawalparasi in south. It consists of total 10 local level where 4 are urban municipalities and 6 are rural municipalities where Bhanu, Bhimd, Shuklagandaki and Vyas are municipalities and remaining Aabukhaireni, Bandipur, Devghat, Ghiring, Myagde and Rhishing, Ghiring are rural municipalities. Tanhun district has been taken as study area of the research as this district was least affected district among the major affected fourteen districts. According to the national census 2078 BS, total population of the Palika is 321,153.

2.1 Data Collection

2.1.1 Nature of data

To assess the effectiveness of shelters reconstructed by the National Reconstruction Authority (NRA) across various Palikas within Tanahun District, a comprehensive methodology will be adopted. This study will involve the utilization of both primary and secondary data sources. Primary data will be gathered through field visits, while secondary data will be acquired from reputable sources including Palika Offices, district Offices, the National Reconstruction Authority (NRA), the Department of Urban Development and Building Construction (DUDBC), Non-Governmental Organizations (NGOs), and relevant publications and periodicals to ensure a thorough analysis.

2.1.2 Data collection technique

The main purpose of the study is to determine the "Impact of Rural Housing Reconstruction Post Earthquake on Housing Typologies and Financial Debt Status of Affected Families." Thus, both quantitative and qualitative method will be applied. Key informant interview (IDI), questionnaire survey and field observation were the major tools for this study.

I. **Field observation**

In this method observations will be made in field where reconstructed house is located. Visualization of house site is carried out and measurement of plinth area of house along with typology of house is recorded. Number of rooms in house and storey of house is recorded. Status of earthquake affected house is observed along with other facilities in house. Availability of latrine throughout the kitchen is also observed during the field visit.

II. **Key informant interview**

KII is carried out with those who have specific knowledge or expertise relevant to the reconstruction in different municipalities of Tanahun District. It helps to provide insights, perspectives, and context that can enhance understanding or validate finding of assessment. Also, the key person who have been engaged with the specific activities and have experience on the scenario.

III. **Questionnaire survey**

Questionnaire survey will be held in each household of selected sample size according to the structured questions.

2.2 Sample size

According to the profile of Tanahun district, there are 88,583 houses (National Population and Housing Census 2021). As per latest list of Nepal Reconstruction Authority (NRA), there is 16,168 households listed under NRA beneficiaries where 15,129 household had received first tranche, and 14,880 household had received third government tranche. So, 14,880 beneficiaries had been considered for the study. A total sampling frame was prepared. Simple random sampling technique was used for identifying the sample. Hence, a total of 201 respondents were interviewed who were residing in Tanhaun district. Married, unmarried, male and female, rich and poor who live within a study area were considered eligible for a study population. The sample size was calculated by using Slovin's formula (n=N/ (1+Ne2). Where n is the sample size, N is the population size and error are margin of error which is taken as 7%. (Here N=14880).

Calculation:

Total populations (N)	=	14880
Margin of (e)	=	7% (Provision range: 5-10%)
Sample Size (n)	=	?
Using Slovin's formula	n =	N/ (1+N e2)
	n =	14880/ (1+14880 x 0.07 x 0.07)
	n =	201.3 nos.

Hence, taking sample size as 201 numbers of the study from NRA listed beneficiaries.

3. Result and discussion

The reconstruction efforts following the earthquake in moderately affected districts are influenced by a multitude of factors, affecting both housing trends. This complex situation emerges from a variety of contributing factors. A thorough analysis of measurable parameter is analyzed based on the information received. Understanding the financial aspects of households, including income and expenditure, was crucial for a comprehensive debt analysis among respondents.

Furthermore, we consulted secondary data sources to explore additional factors that shape individuals' decision-making regarding housing trends and debt management. Our study conclusively shows a significant shift in housing patterns, evident in changes in house size, typologies, living areas, and patterns observed before and after the earthquake. Notably, the data reveals that many individuals continue to struggle with underlying debt, posing potential challenges to both economic development and the overall well-being of families and the nation.

3.1 Tranche received from NRA

Out total number of households surveyed, 96% of respondents surveyed received the third tranche whereas 0.5% and 3.5% received first and second tranche only respectively as shown in figure 2. Despite constructing new house, 3.5% and 0.5% of households were unable to receive all the government tranche due to non-compliance issue.

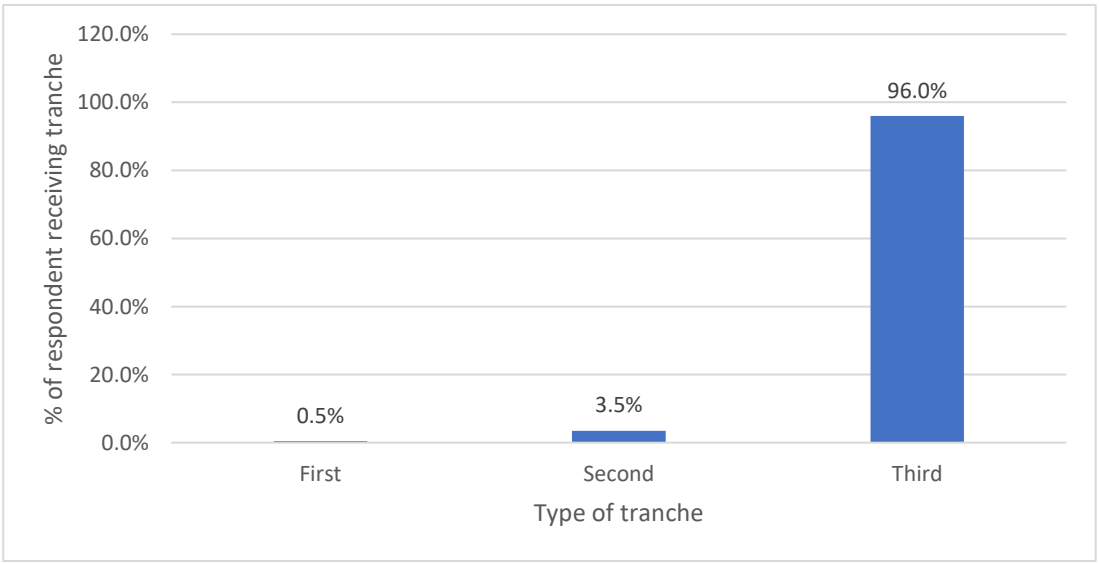

Fig. 2 % of sample surveyed participants with tranche status

3.2 Comparison of housing area

There is not much difference in the plinth area after the earthquake. The plinth area range between 147 to 270 is 68% which is increased from 43% as shown in figure 3. Though NRA didn't promote the single room house for reconstruction, vulnerable single headed family use to reconstruct the one room house and 16% respondents belongs to it. It is observed that higher plinth area more the 541 square feet is usually made up of RCC typology and also of two storey house.

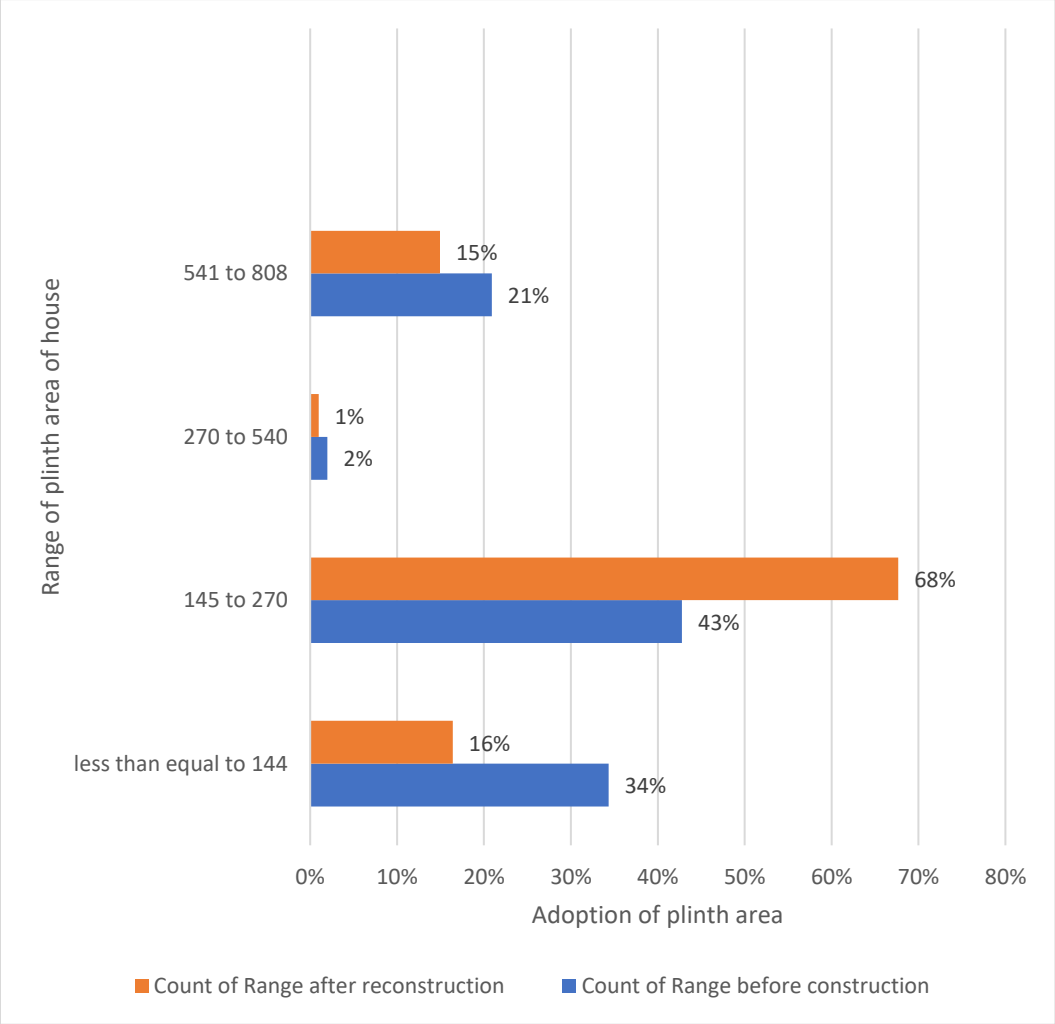

Fig. 3 Comparison of plinth area of house before and after earthquake

The comparison between Central Bureau of Statistics (CBS) damage grade assessment survey and house size data was collected from HRRP analyzed on 15 April 2019 clearly indicates that house sizes have significantly reduced after reconstruction. The analysis of the change in house size showed decreased in housing area from 51-75 m2 to 26-50 m2 from pre- to post-earthquake (HRRP, 2019, p.27).

3.3 Comparison of House storey

There is significant difference in storey of house before and after earthquake as shown in figure 4. 38% of respondents surveyed used to live in two storey houses before earthquake which is decreased to 3% and 21% of surveyed respondents used to live in one storey house which increased to 84%. Only 2% and 3% have their house story two or more. It indicates that majority of people choose to build small and limited to one story houses which may be because of the misunderstanding as NRA norms to receive the tranche is only one storey building. And even NRA deployed engineers used to prioritize for one storey house.

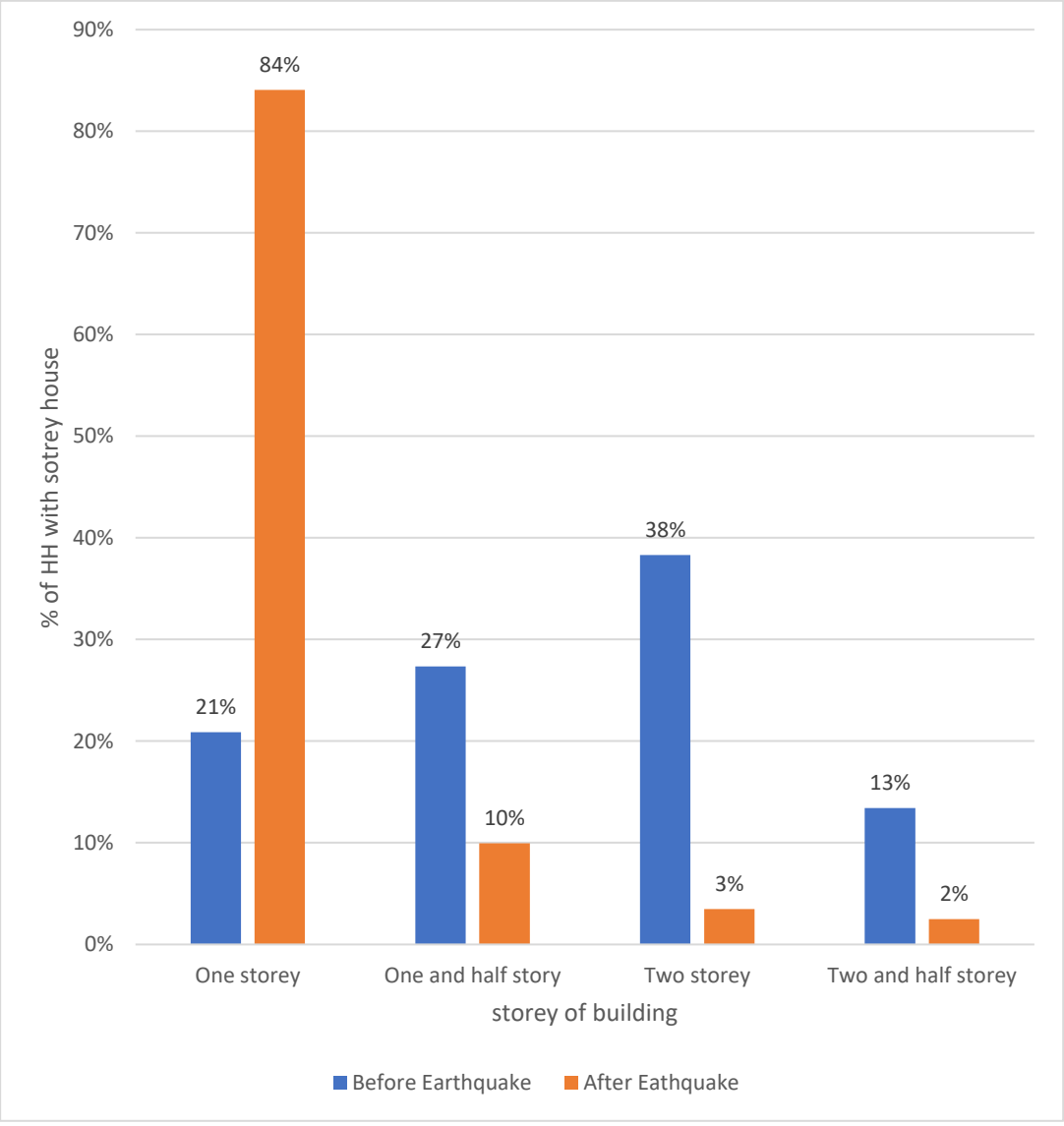

Fig. 4 Comparison of Storey of house before and after earthquake

Table 1 Comparison of storey of house before and after house

Storey of House	Before Earthquake	After Earthquake
One storey	42	169
One and half story	55	20
Two storey	77	7
Two and half storey	27	5

3.4 Earthquake resilient element in house

Only limited houses had horizontal bands before earthquake. Those houses which are built earlier had not earthquake resilient element. The survey reflects that after the earthquake; beneficiaries

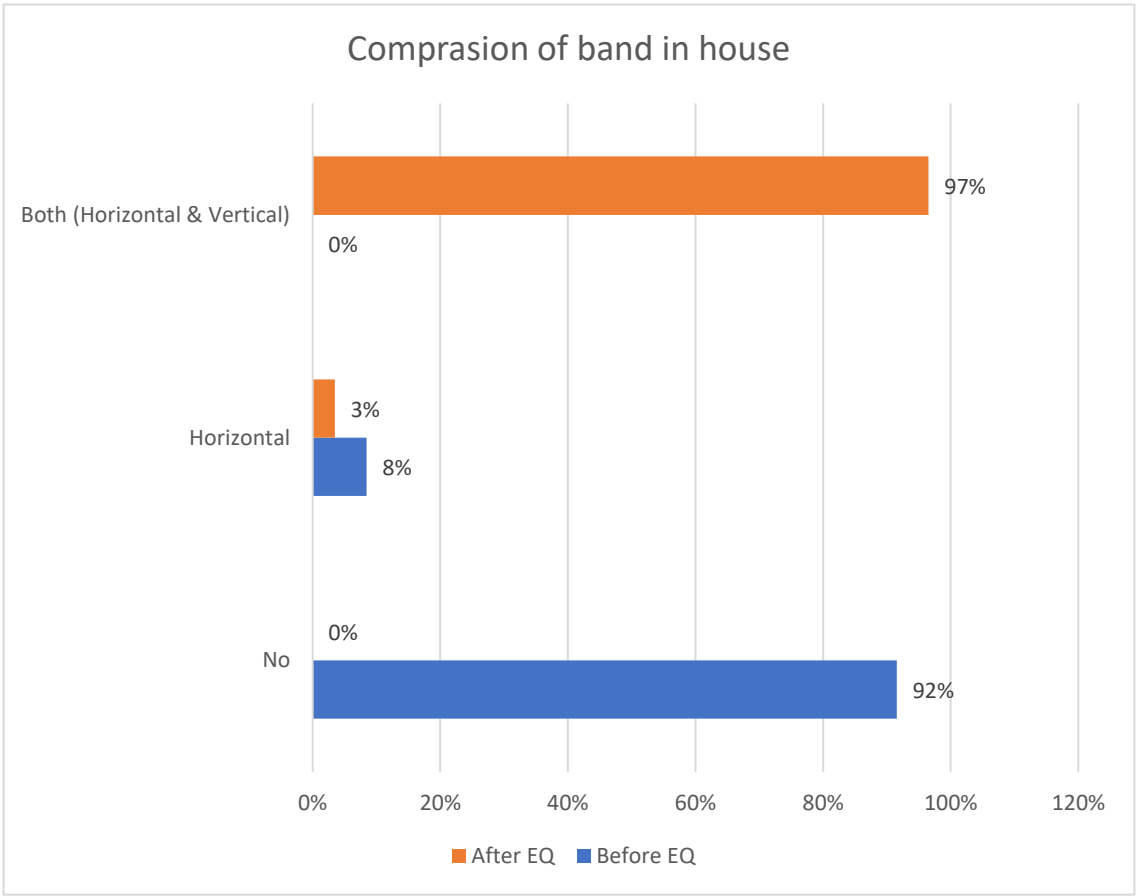

Fig. 5 Comparison of EQ resilient element per and post-earthquake in house

are more concerned to reconstruct the safer/stronger house. Also, the government requirement for the tranche is earthquake resilient element which is horizontal band (plinth level, sill level, lintel level and roof level) and vertical band at corner and opening is mandatory. According to the data surveyed, most families didn't have bands in their house before earthquake. Only 8% of respondents reported to have horizontal band before earthquake. Only 3% of respondents reported to have horizontal bands whereas 92% of respondents shared to have both horizontal and vertical band in their house after earthquake as shown in figure 5.

3.5 Number of rooms in house

The change in number of rooms was not significantly different before and after the earthquake as more than 50% of people used to have two room houses and still maintain similar ratio in new

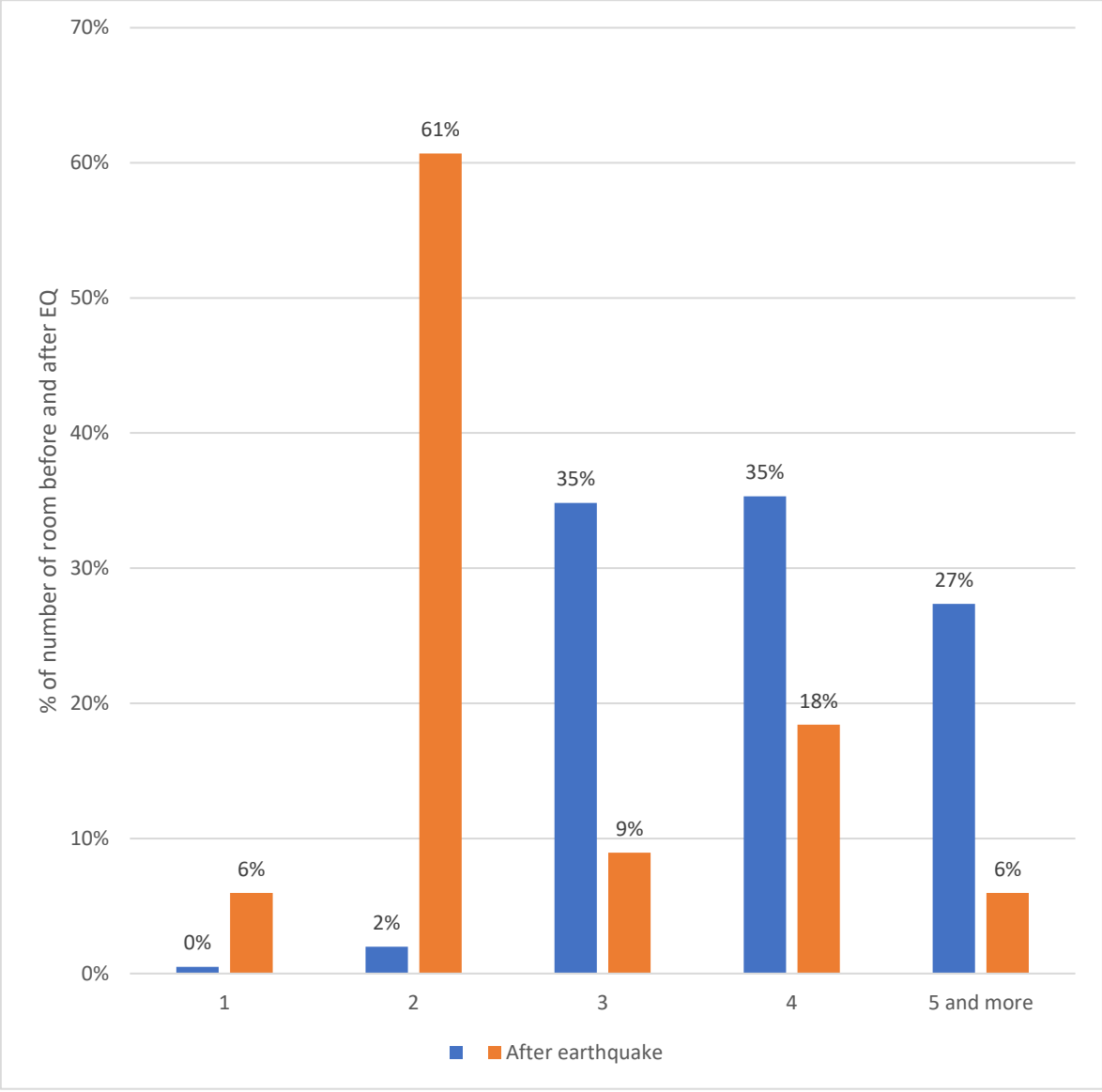

Fig. 6 Comparison of rooms in house before and after EQ

construction. 61% of survey respondents have two room house which increased from 2% after earthquake as shown in figure 6. Reconstruction of house with more than two room is decreasing in percentage after the earthquake. According to surveyed data, numbers of room after earthquake has been limited to two room.

3.6 Housing Typology

Following significant changes, the architectural landscape often undergoes transformations. In Tanahun district, prior to the earthquake, the prevalent construction method was stone and mud mortar masonry, constituting over 75% of the buildings as illustrated in figure 7. Conversely, alternative typologies only accounted for a quarter of the structures, with Reinforced Cement

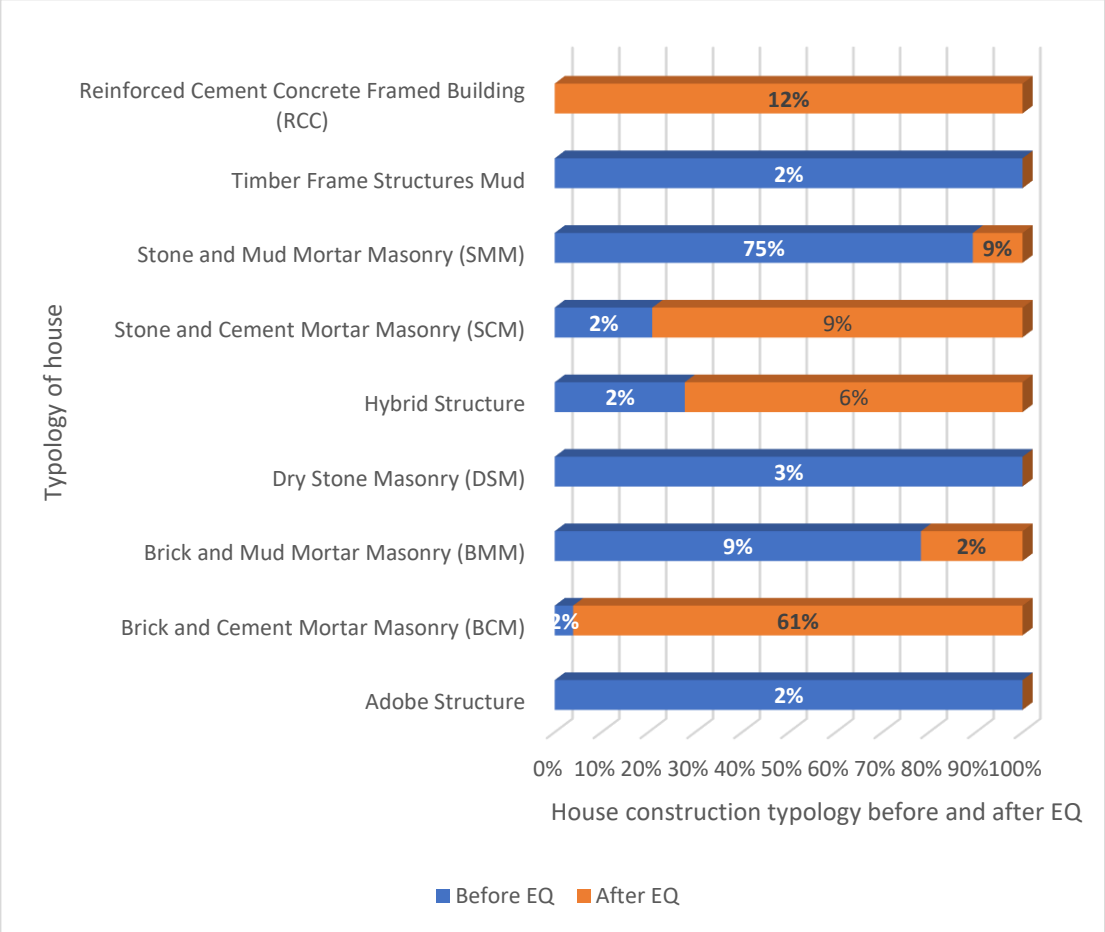

Fig. 7 Comparison of typologies of houses built before and after the earthquake

Concrete Framed Buildings (RCC) being the least popular. However, in the aftermath of the earthquake, there has been a notable shift in preferences towards Brick Cement Mortar Masonry

(BMC) and RCC structures. Despite this shift, a substantial portion of the populace still favors traditional methods, perhaps influenced by perceptions of strength, communication channels, government regulations, material scarcities, economic factors like inflation, or aspirations for modernization.

75% of surveyed respondents with SMM typology decreased to 9% after the earthquake. 12% of surveyed respondents built RCC after earthquake which is null before EQ. The Brick and cement mortar Masonry had increased to 61% from 2% which reflects that beneficiaries are more likely to have BCM typology. Earthquake affected beneficiaries from Tanahun district are most likely to reconstruct the two room BCM model 1.1 typology of house shown in figure 3.7 as it is easier to construct and consume less time and NRA deployed engineer also recommend and is approving for the further tranche.

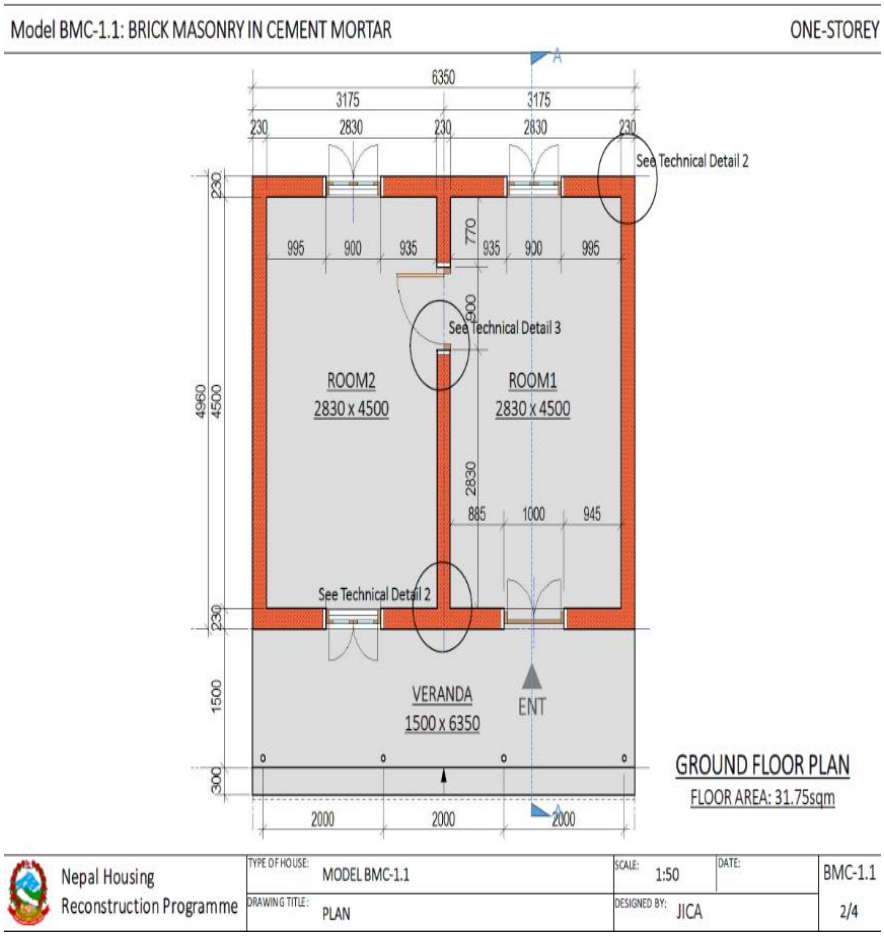

Fig. 8 NRA approved BCM building from Volume I catalogue. Source: NRA

3.7 Family additional need

When we investigate the housing needs, it is not just living or sleeping area, but it consists of at minimum toilet and cooking area. Except 10.2%, all 89.8% families have functional toilets available inside or outside of their house shown in figure 8. But when we ask about the availability

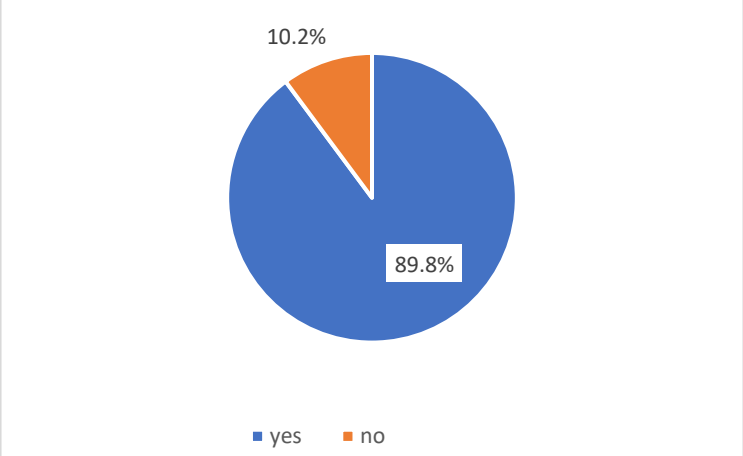

Fig. 8 % of status of latrine in reconstructed house

of separate kitchen, 42% of families didn't have kitchen in their newly reconstructed houses as illustrated in figure 9. This indicates either the families must cook outside the room or construct additional space. The family will gradually plan for extension to existing structures either vertically or horizontally in various ways.

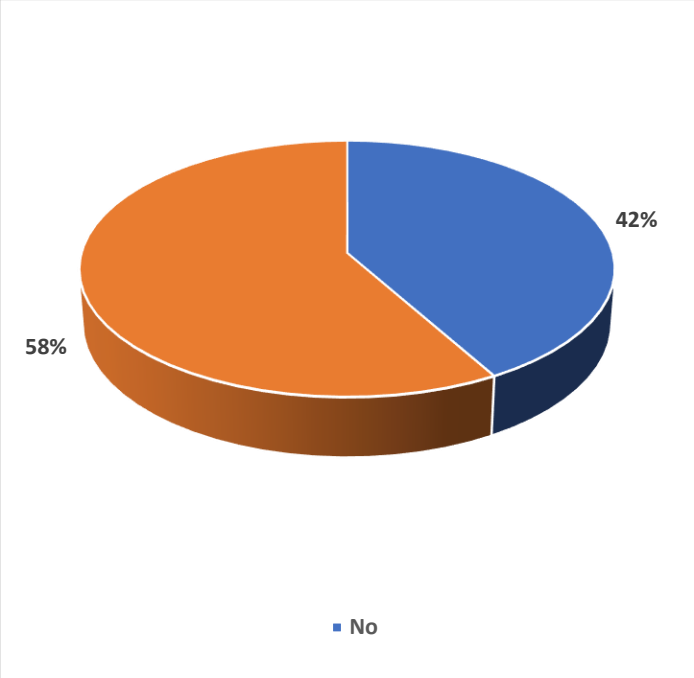

Fig. 9 Availability of separated kitchen in newly reconstructed houses

As Nepal is 'Open Defecation Free (ODF)', it is observed that 18.7% population still have no toilet where 9.8% in urban and 25.0% in rural area. Also, poorest family is the one who don't have toilet It indicates that there is strong association of prosperity with available toilet facility. However, the proportion of no toilet household has declined from 2014/15 when it was 22.0% (CBS & UNDP, 2015/16). There are limited families who didn't have toilet in their house and used to share with other. Most of the families are waiting for other to extend their house so that they too can extend their house for the kitchen and other purpose.

3.8 Building design adopted during reconstruction

After the earthquake, most families are concerned with the design of building as it directly affects the government tranche. It is observed that 81% of surveyed families had rebuilt their house following the NRA building catalogue so that there won't be any difficulty in receiving the government all tranche and only 5% have rebuilt following own traditional design incorporating the earthquake resilient element in consultation with NRA engineers as illustrated in the figure 10. 13% of surveyed families rebuild their house as per municipal engineer design as most of them

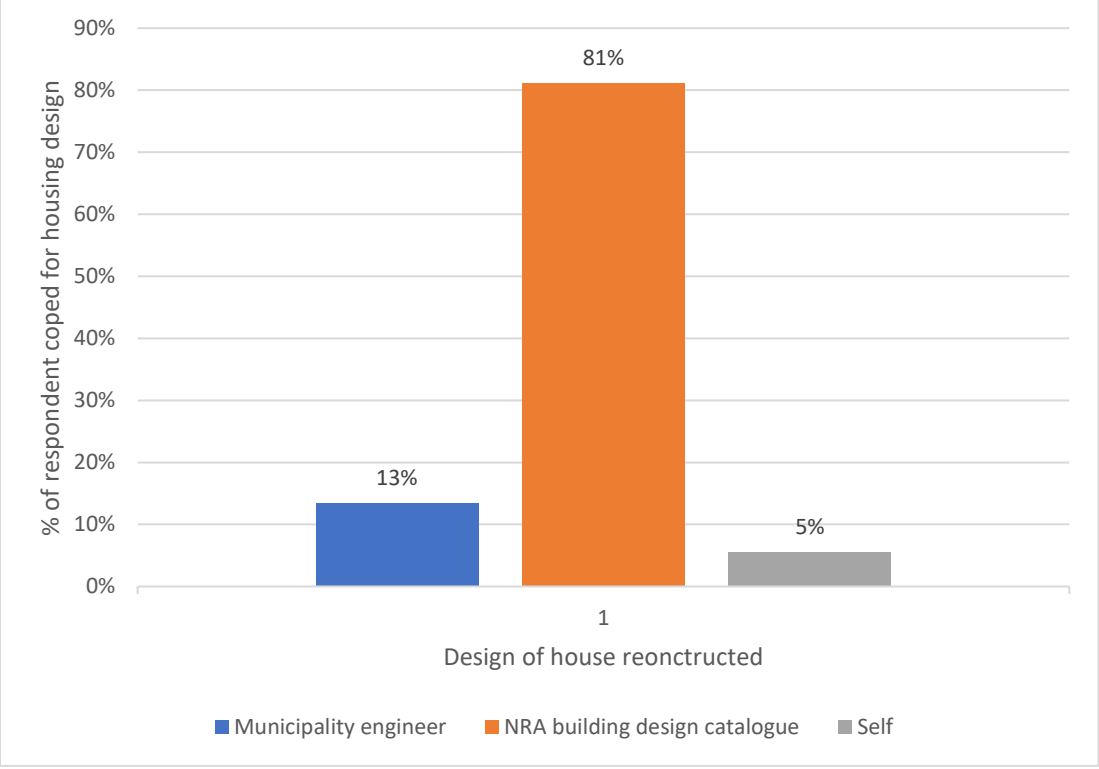

Fig. 10 Design adaptation for reconstruction

had already reconstructed house just after the earthquake where are remaining want more space and follow the traditional design for the reconstruction.

5.9 Extension of house

As most of the houses are one storey with 2 room houses, the need of extension of house is

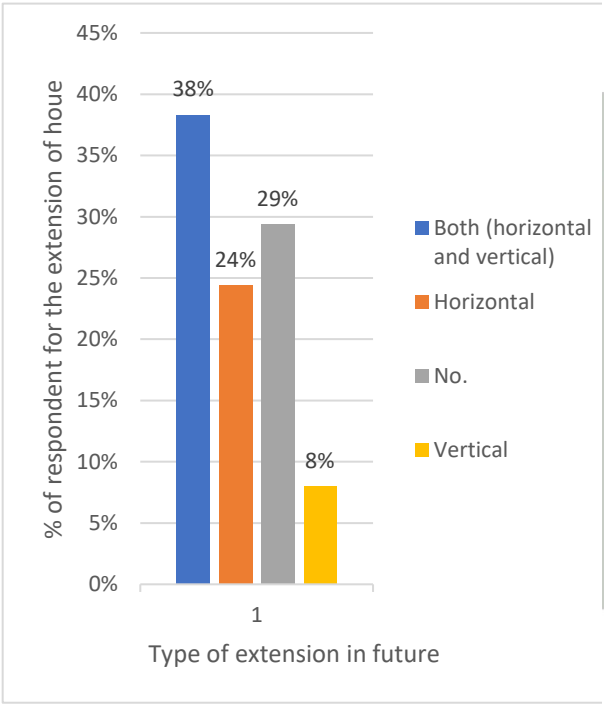

Fig. 11 % of respondent for future f extension of house

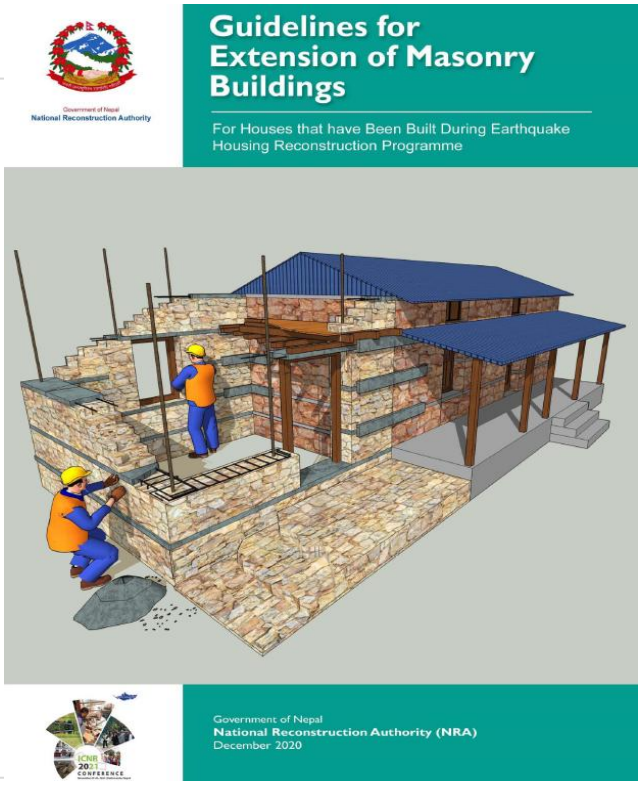

Fig. 12 NRA house extension guideline Source NRA

explored. According to surveyed families' 38% respondent want to extend both horizontal and vertical, 29% respondent want to extend horizontal and 8% vertically as shown in fig. 11. Also, 29% respondent don't want to extend their house as they feel safe during disaster.

Nepal Reconstruction Authority had published the Guidelines for Extension of Masonry Buildings for houses that have been built under Housing Reconstruction Program on December 2020 as shown in figure 12. The guideline consists of extension procedure in both horizontal and vertical way for single and double room house. It provides the minimum requirement for the element at the junction of the new and the existing walls, connection of roof members along will construction

steps. The guideline also focusses on the addition of floor in the case of cement mortar and mud mortar and replacement of light roof with reinforced concrete roofing for the vertical expansion.

4. Conclusion:

- Significant Changes in Housing Size and Conditions:

  The earthquake-induced rural housing reconstruction process has led to significant changes in housing size and living conditions, deviating notably form pre-earthquake norms. This shift has impacted not only the physical dimensions of homes but also raised concerns about the potential loss of traditional architectural styles and vernacular building practices. The departure from these established methods poses a threat to cultural heritage, which once characterized the rural environment.

- Number of house reconstructed verse quality of house

  The reduction in living space has presented practical challenges for families, who often try to address their spatial needs by expanding their homes. However, such expansions can potentially undermine the structural integrity of the buildings, raising concerns about long-term safety and stability. Despite the success in the number of houses rebuilt, there are significant concerns regarding the quality of these structures. The emphasis on quantity rather than quality has led to mixed outcomes, particularly in terms of spatial adequacy, socio-economic effects, and settlement integration.

- Increase the financial debt of families

  The financial burden on households has greatly increased due to the reconstruction efforts. Many families have had to cover over half of the reconstruction costs themselves, exacerbating their debt and financial stress. This issue is further compounded by inadequate subsidized loans and limited access to formal financial support, forcing households to manage substantial costs without sufficient financial assistance. Consequently, national debt projections have become alarmingly high, reflecting the extensive economic impact of the reconstruction process.

- Need for the further research

Addressing these challenges requires further research. It is crucial to investigate the decision-making processes of individuals affected by the earthquake, beyond financial, technical, and governance factors. Future research should focus on how families are adapting their homes post-reconstruction and the strategies employed by households, communities, and local governments. Additionally, employing a detailed settlement approach, such as Central Place Theory, in housing reconstruction models could provide valuable insights into the socio-economic impacts of the reconstruction process. This approach would improve our understanding of the broader effects and inform future housing and settlement strategies.

5. References

1. Bhawan, H., 2020. The NHRI Nepal Joint Submission for The Third Cycle Universal Periodic Review of Nepal.

2. Documents, K. R. (2017) 'Nepal Earthquake 2015 – Housing Reconstruction " Briefing Pack "', (November 2016), pp. 2015–2017.

3. Hendriks E, Opdyke A. Adoption of seismic-resistant techniques in reconstructed housing in the aftermath of Nepal's 2015 Gorkha earthquake. Earthquake Spectra. 2021;37(4), pp. 2662-2686

4. Khanala, R., Subedib, S., Panthic, G.K. and Bajracharyad, A.R., Household Level Construction Cost and its Management in Rural Housing Reconstruction in Nepal. VIKAS.

5. Kotani, H., Honda, R., Imoto, S., Shakya, L. and Shrestha, B.K., 2020. Transition of post-disaster housing of rural households: A case study of the 2015 Gorkha earthquake in Nepal. International Journal of Disaster Risk Reduction, 44, p.101443.

6. Pamidimukkala, A., Kermanshachi, S. and Safapour, E., 2020. Challenges in post-disaster housing reconstruction: analysis of urban vs. rural communities. In Creative Construction e-Conference 2020 (pp. 103-110). Budapest, Hungary: Budapest University of Technology and Economics

7. Platt, S., 2018. Factors affecting the speed and quality of post-disaster recovery and resilience. Earthquake engineering and structural dynamics in memory of ragnar sigbjörnsson: Selected topics, pp.369-403.

8. Shieh, S., Chow, L., Huang, Z. and Yue, J., 2021. Understanding and mitigating social risks to sustainable development in China's BRI: Evidence from Nepal and Zambia. ODI Report.

9. Shrestha, C.B., Parajuli, B. and Malani, S., 2021. Unravelling constraints of urban housing reconstruction. Progress in Disaster Science, 11, p.100178.

10. Shrestha, R.K., Parajuli, H.R. and Poudel, B., 2021. Building typologies and code compliance issues of reconstructed houses after 2015 Mw 7.8 Gorkha, Nepal earthquake: Experience from Dhading District earthquake. Progress in Disaster Science, 10, p.100155.

11. Singh Thing, S. and Bahadur Bajracharya, S. (2020) 'Proceedings of 8 th IOE Graduate Conference Socio-Economic Impacts of Post-Earthquake of Nepal: A case of Owner Driven Approach in Rural Housing Reconstruction of Nepal', 8914, pp. 303–311.

12. Stephenson, M. (2020) 'Lessons learnt from the 2015 Nepal Earthquake housing recovery', (April), p. 54. Available at: https://www.habitat.org/sites/default/files/documents/Four-Lessons-from-Earthquake.pdf.

13. Thing, S.S. and Bajracharya, S.B., 2020. Socio-Economic Impacts of Post-Earthquake of Nepal: A case of Owner Driven Approach in Rural Housing Reconstruction of Nepal.

14. Vahanvati, M. and Mulligan, M., 2017. A new model for effective post-disaster housing reconstruction: Lessons from Gujarat and Bihar in India. International Journal of Project Management, 35(5), pp.802-817.

15. Wang, J. and Ng, Y.Y.E., 2023. Post-earthquake housing recovery with traditional construction: A preliminary review. Progress in Disaster Science, 18, p.100283.