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A STUDY ON NON-COMPLIANCE WITH NATIONAL BUIILDING CODE IN PRIVATE HOUSING RECONSTRUCTION AT INDRAWATI RURAL MUNICIPALITY OF SINDHUPALCHOK DISTRICT

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ABSTRACT

Non-compliance with the Building Standards compromised the National Reconstruction Authority's objective of ensuring earthquake resistant housing construction. Identical to all earthquake affected municipalities, the Indrawati Rural Municipality has some cases of non-compliant households with the building codes. Against this backdrop, this study examined factors behind non-compliance with the Nepal National Building Code and its magnitude in the given context of technical assistance and economic condition. For achieving the stated objectives, this study collected primary data from house owners, contractors, consultants, municipality and NRA technicians. The secondary data was collected from various different sources.

It was found that there were four hundred twenty-two non-compliant houses. Among them the highest caseloads were concentrated in wards number 7 (16.7%) whereas ward number 1 had less than 1%. The higher construction cost and inadequacy of housing grant were the major contributing factors. None of the non-compliant households could secure concessional loan which forced them to rely on cooperatives, private lenders or other informal lenders which exposed them to exorbitantly high interest rate.A number of caveats were also identified in technical assistance: non-motivated, ill-trained and inadequate number of technicians was another contributing factor. In the federal context, all municipalities have to adopt the building permit system for ensuring compliance with the building code. In addition, intensive hand holding is required for planning and designing the house and supervising the construction for which adequate provision of technicians in the municipality is indispensable. Households' access to finance has to be enhanced employing various instruments such as initiating rural housing insurance could be one of them.

Abbreviation/Acronyms

BF	Bank and Financial Institution
BM	Brick masonry
BMM	Brick Masonry in Mud Mortar
CBS	Central Board of Statistics
CGI	Corrugated Iron Sheet
CLPIU	Central Level Project Implementation Unit
CSEB	Compressed Stabilized Earth Bricks
DLPIU	District Level Project Implementation Unit
DSE	District Support Engineer
EB	Earthen Building
EERI	Earthquake Engineering Research Institute
EHRP	Emergency Housing Reconstruction Project
GDP	Gross Domestic Product
GNP	Gross National Product
GoN	Government of Nepal
HH	Household
IRM	Indrawati Rural Municipality
KII	Key Informant Interview
KMC	Kathmandu Metropolitan City
LDC	Least Developed Country
LSMC	Lalitpur Sub-Metropolitan City
MIS	Management Information System
MoUD	Ministry of Urban Development
MR	Minimum Requirements
MRT	Mandatory Rule of Thumb
NBC	National Building Code
NBCDP	National Building Code Development Project
NGO	Non-Governmental Organization
NLSS	Nepal Life Standard Survey
NPC	National Planning Commission
NRA	National Reconstruction Authority
OJT	On Job Training
PDNA	Post Disaster Needs Assessment
RC	Reinforced Concrete
RCC	Reinforced Cement Concrete
RII	Relative Importance Index
SMC	Stone Masonry in Cement Mortar
SMM	Stone Masonry in Mud Mortar
TOT	Training of Trainers
UNDP	United Nations Development Programme
URM	Un-reinforced masonry

CHAPTER 1
INTRODUCTION

1.1 Background

Population of Nepal was 29,192,480 in 2021(Housing census survey, 2021) and population growth rate of 0.93 % per annum during the inter-censual period between 2011 and 2021. In addition, there were 4,005 institutional buildings (Barracks, Hostels, and Monasteriesetc.). Altogether, 85.26 percent of the households reside in their own house whereas 12.81 percent in rented, 0.63 percent in institutional and 1.30 percent in other arrangements. In urban areas, 40.22 percent live in rented house. The Kathmandu district has the highest percentage (58.65) of households living in rented house. The census report further reveals that nearly ten percent of total households live in houses with the foundation having RCC pillar, 17.57 percent households in house with foundation made up of cement-bonded bricks, 24.9 percent in wooden pillar, 44.21 percent in mud-bonded bricks and 2.33 in other type of foundations. In urban areas, 28.42 percent of the households live in houses with the foundation having RCC pillars. The Highest number of households (41.38 percent) live in houses which has outer wall made of mud bonded bricks or stone followed by outer wall made of cement bonded bricks or stone (28.74 percent), bamboo wall (20.23 percent) and wood/planks (5.31 percent).28.26 percent of the total households live in houses roofed with galvanized sheet followed by tile/slate (26.68 percent), RCC (22.48 percent) and thatched/straw roof (19.03 percent) (Housing census survey, 2011).

The article 37 of Constitution of Nepal 2072 has provisioned the right to appropriate housing to every citizen.No citizen shall be evicted from the residence owned by him or her nor shall his or her residence be infringed except in accordance with law. The National Shelter Policy, 1996 was revised in 2012, to address the new challenges of slums, rental housing and housing for internally displaced and that of the Economically Weaker Section. Adequate housing for all continues to remain one of the human rights and development challenges in Nepal(Amnesty International, 2018). As estimated in the National Census, 49% of Nepal's population lives in substandard housing. Less than 30% of people's houses are considered structurally safe(Amnesty International, 2018).Further, as revealed by UN-Habitat's Nepal: Urban housing sector profile, about 10% of urban dwellers in Nepal are "squatters" or people who do not currently have a legally recognized right to the house or land they occupy(Amnesty International, 2018). Soaring land prices and increasing rural-urban migration has made it difficult for those living in poverty to afford adequate housing, especially in the fast-growing urban areas. The proposed targets for 2030 set by the Government of Nepal include doubling the proportion of households living in safe houses to 60% (NPC, 2017). There is a huge demand for structurally safe houses in urban areas. The private sector is emerging as an active player in urban housing. But housing is inadequate and expensive. As housing finance offered by banks and financial institutions carries high interest rates, affordable housing is challenging for people living in poverty and with low income(Amnesty International, 2018). Also, banks and financial institutions often require a house or land as collateral to provide a housing loan. Currently, there is a lack of appropriate housing finance or subsidized loans available to those living in poverty.

The 2015 Nepal earthquake caused widespread destruction of housing and humansettlements. Nearly 500,000 houses were destroyed and more than 250,000 houses were partially damaged (NPC, 2015). The effects of the disasters were visible among a diverse range of communities and settlements, including remote mountain villages, roadside market towns, heritage settlements,peri-urban neighbour hoods and emerging cities, and several dense neighbour hoods in the Kathmandu Valley (PDNA, 2015). The large-scale destruction of housing resulted primarily from the seismic vulnerability of un-reinforced masonry houses that predominate throughout the country. Most houses (58 percent of all housing construction) are low strengthmasonry stone or brick masonry with mud mortar, without seismic-resilient features. These intrinsically weak and brittle buildings suffered widespread damage and collapse throughoutthe 31 districts that experienced intense ground shaking. Other common building types such as cement-mortared masonry and RC frame buildings were somewhat better off but still suffered significantly due to deficiencies in material, design, detailing and craftsmanship (PDNA, 2015).

Table 1.1: Number of houses damaged

	Low Strength Masonry	Cement Mortared Masonry	Reinforced Concrete	Total
Fully Damaged	474,025	18,214	6,613	498,852
Partially Damaged	173,867	65,859	16,971	256,697

(Source: PDNA, 2015)

In the absence of an appropriate building code of its own, most buildings in Nepal were, and are still being, planned and constructed with little or no regard for seismic safety (Parajuli, 2000). The need for change and improvement in the prevailing building design and construction methods was recognized. Accordingly, a Building Code Development Project was launched in 1992(Parajuli et.al, 2000). The objectives of the project, among others, included the development of regulations and design documents for use by the planners and engineers in order to improve the seismic safety aspects of the existing buildings and to suggest safer building design and construction practices being introduced/enforced gradually in Nepal. Nepal drafted the NBC in 1994 based upon a scientific assessment of seismic hazard and risk, the existing practice of building construction including the usage of different construction typology and technologies in the different climatic regions, and considering the socioeconomic realities (Guragain et.al, 2018). The Government of Nepal, through Nepal Building Act 1998 made the NBC mandatory for all municipalities and urbanizing settlements in the country.

The NBC document was drafted by the National Building Code Development Project (NBCDP) in 1994. However, it remained a technical document with no legal force until 2003. Nepal's government enacted the Building Act in 1998, followed by the Local Self-Governance Act in 1999 and the Local Self-Governance Regulations in 2000. None of these actions compelled compliance with the NBC.Then Lalitpur sub-metrodecided independently to enforce the NBC in all new buildings in its jurisdiction in 2004. Encouraged by Lalitpur's initiative, a couple of other municipal governments followed suit. In 2004, Nepal's national government issued an executive order for all municipalities to implement the NBC code for new buildings(Arendt *et al.*, 2017). However, it remained up to the municipal governments to set up the code implementation mechanism and enforce the code. Because of lack of technical capacity and supporting resources, most municipal governments have not yet completely followed it (Arendt, 2017).

1.2 Statement of Problems

Indrawati is a rural municipality located in Sindhupalchok District of Bagmati Province of Nepal. Itcover area of 105 km2 with 25,518 populations (Census Survey, 2021). Gorkha Earthquake 2015 almost destroyed 90% of households in Sindhupalchok district and generating 90,242 initial potential beneficiaries (NRA, 2015). 8,584 potential beneficiaries are identified in Indrawati Rural Municipality after the Gorkha earthquake 2015 (DLPIU Sindhupalchok). Among 9,000 deaths, 3,532 people had been killed only in Sindhupalchok which was the highest fatality among another district. Thousands of houses, public and private school buildings, and government office buildings, historical, cultural and archaeological heritages had been seriously damaged and many people rendered homeless. As far as number of infrastructure destruction is concern, Sindhupalchok comes again in number one position (Dangi, 2018).

The National Reconstruction Authority (NRA) is responsible for leading and managing earthquake recovery and reconstruction initiative in Nepal. According to NRA, reconstruction grant agreements have been signed with 86186 households in Sindhupalchok district out of total identified beneficiary as 90242 households until 9th September 2020(NRA, 2020). The first instalment of Rs 50000 has been distributed to 85891 households until the end of Bhadra 2020. The Second instalment Rs 150000 and third instalment Rs 100000 distributed till 9th September 2020 was 83831 and 76215 households respectively. Only 86264 houses are under construction and construction of 70097 houses has been completed until 9th September 2020 (NRA, 2020). This data

suggests that large numbers of beneficiaries are still prohibited from getting their third tranche and many beneficiaries are still prohibited from getting their completion certificates.

The private housing reconstruction undertaken by NRA in Indrawati rural municipality has raised a question regarding its effective compliance. The significant number of private housing reconstruction undertaken by NRA does not comply with building code. Out of the total 8567 beneficiaries in municipality, a considerable number of houses were non-compliant. Many of the non-compliance cases are resolved but there are still existing numbers of non-compliance cases in municipality consequently, prohibiting the beneficiaries from receiving the tranche for the further construction and completion certificates (DLPIU, Sindhupalchok). Identifying the non-compliance cases and resolving it will speed up the reconstruction process and ultimately aware the people and local government itself about the effective implementation of building code.
In context of Nepal, most of the buildings constructed are generally owner-driven. They are constructed without the technical assistance of engineers/architects. But after the recent earthquakes, there seems to be increased level of awareness among the people regarding the construction of earthquake resistant buildings, but this awareness level is still not enough (Khadka, 2017). There are several pitfalls in the effective implementation of building code and bye-laws.

There were single engineer, sub-engineer and assistant sub-engineer in every ward of municipality but at present due to the reduction of work and loads, there are 18 technical persons out of which 7 are engineer, 3 are sub-engineer and 8 are Assistant sub-engineer (DLPIU and Indrawati Rural Municipality). These all-technical persons are responsible for the inspection, supervision and monitoring of houses during and after construction since it is mandatory for the effective implementation and compliance of building code. Anecdotal evidence suggests that due to the difficult terrain and geographical structures and lack of vehicle resources, there are lots of problems in technical monitoring and supervision of houses (DLPIU, Sindhupalchok)

Nepal government has never provided the cash grants for the total reconstruction of building but has provided in the form of leverage and motivational factor to beneficiaries but in the reality and beneficiaries perception, most of them pointed out the insufficiency of grant, the major challenges for post disaster reconstruction (Dangi, 2018). The amount provided by government is less than half to build the house because most of the beneficiaries have been invested more than the seven lakhs for reconstruction of their house(Dangi, 2018). A rough estimate has indicated that construction of even a 300sqft (which is much smaller than the average house size in Nepal) house constructed of stone in mud where stones are locally available would require at least Rs400k (including cost of earthquake resistant features) (Bothara *et al.*, 2016).Sindhupalchowk is basically agriculturally based district where approximately 77.3% of the active populations are involved in agricultural sector. Subsistence agriculture farming, mainly small-scale livestock is the main source of occupation and livelihood of the majority of the population, with 79% of the population active in this sector (Source: Rural access phase 3).

1.3 Research Questions

The study has been undertaken to seek the answers to the following research questions:

1) What is the magnitude of non-compliance in private housing reconstruction of Indrawati Rural Municipality?

2) What are the contributing factors for the non-compliance and which contributing factor is more responsible for boosting the non-compliance of private housing reconstruction of Indrawati Rural Municipality?

3) What are the source and level of household's income and their level of access to bank loan?
4) What are the available technical support provisions towards building code compliance in the private housing reconstruction?

1.4 Research Objectives

The general objective of this study is to assess earthquake resilience of the reconstructed private housing in theIndrawati rural municipality of the Sindhupalchok district. In the given context of technical assistance and economic condition, policy and operational responses will be also outlined.

Specific objectives of the study are:

1) To ascertain the magnitude of non-compliance in private housing reconstruction of Indrawati Rural Municipality.

2) To identify the contributing factors and to identify the more responsible causal factors for non-compliance of private housing reconstruction.

3) To identify the source and level of household's income and their level of access to bank loan.

4) To assess the available technical support provisions for private housing reconstruction.

1.5 Significance of the Research

As this research will portray the compliance status of NBC , it can be supportive document to track down the effectiveness of building code and bye-laws undertaken by NRA in Indrawati Rural Municipality. This research includes conclusion drawn on basis of practical approach made in the reconstruction activities and analyse the level of awareness of concerned stakeholders. Furthermore, this research addresses the status of building code compliance and ensures the compliance status of NBC in local government and urges the earthquake engineering community to pay more attention to the enforcement of building code. Thus, this research can be the strength to NRA, local government and DUDBC itself to overcome the prevailing weakness in implementation of building code and to revise the policies regarding building code.

1.6. Scope and Limitation of the Study

This study is carried out in order to analyse the compliance status of building code and bye-laws in Indrawati Rural Municipality. Research is carried out only among the private housing reconstruction undertaken by NRA which is constructed after earthquake. Survey is carried out only among the limited sample size of each ward of municipality. Thus, the results may not be generalized and reliable. Only concerned stake holders were interviewed for conducting the research.

CHAPTER 2
LITERATURE REVIEW

The overall goal of this chapter is to identify the research gap. This chapter deals with the National Building Code for private housing reconstruction. This chapter evaluates different housing methodologies critically. In

addition to analysing the National Building Code, this chapter also elaborates traditional building typologies, 2015 Gorkha Earthquake induced major building failures status of code compliance. Additionally, elaborated issues are: Nepal's rural poverty, general housing construction cost and technology, access to housing credit and are also deliberated.

2.1 Traditional Building typologies

The distribution of the buildings in Nepal is also similar to the distribution of the population (Chaulagain *et al.*, 2015). Chaulagain further elaborates that the data obtained from National Population and Housing Census indicates that mud bonded brick/stone buildings are more common in Nepal for all the geographical regions, occupying about 44.21% of the total number of houses. Chaulagain further explains that the wooden houses are more popular in rural area of Terai region which occupied as around 24.90% and the cement bounded brick/ stone and cement concrete with pillar buildings are highly popular in urban area in most of the Terai region, Kathmandu Valley and some district headquarter of mountainous region and occupy 17.57% and 9.94 % building stock in Nepal. Chaulagain further added that Reinforced concrete (RC) building construction in Nepal begun from late 1970 and in the last 3-4 decades, RC building construction increased rapidly, replacing other construction materials and solutions like adobe, stone and brick masonry in Kathmandu Valley as well as in other parts of the country. Another category includes combination of two or more than two different building materials. These are the mixed buildings like stone and adobe, stone and brick in mud, brick in mud and brick in cement, wooden and brick cement mortar.

The adobe construction, wooden framed houses and rubble stone masonry constructions are more popular in villages of Nepal, meanwhile most of the urban and suburbs constitute majority fraction of stone or brick masonry buildings constituting around 20 % of RC construction (Gautam *et al.*, 2016). Gautam further explains that 80 % of the buildings are non-engineered to poorly engineered stone or brick masonry constructions even in urban areas of Nepal and moreover, majority fraction of RC construction is also covered by non-engineered to pre-engineered construction as owner-built houses. Gautam further elaborates that after 1980s RC construction in Nepal has been mushrooming and surpassed any other construction types after 2000 in urban areas however, in rural Nepal stone masonry, adobe and wooden framed structures are still being dominant construction type. The construction technology, construction materials, binding materials are not significantly changing in rural settlements of Nepal. Along with this, on the most likely scenario it is also clear that the adobe construction, wooden framed houses and rubble stone masonry constructions are more popular in villages and rural area of Nepal and stone or brick masonry buildings and RC construction in urban areas of Nepal.

2.2 Major Building failures due to 2015 earthquake

The Gorkha earthquake of 25 April 2015 reflected the performance of various types of buildings. The majority of damage is found to be consisted by un-reinforced masonry, rubble stone and adobe buildings and moreover, RC damage is found to be localized so many reasons except structural and construction deficiencies like liquefaction, local site effects, ground amplification, among others may have contributed in building damage (Gautam *et al.*, 2016). Gautam further elaborates that the common types of failures in RC construction were identified as the soft storey, pounding, shear failure, and other failures associated with construction as well as structural deficiencies like building symmetry, detailing and others and moreover, for URM constructions, the structural integrity, heavy load accumulation, age, lack of bracing and pounding were the major cause of complete collapse or out of plane failure. Similarly, binding and structural integrity, lack of tying members, heavy gable and roof construction were the leading cause of damage in random rubble construction and adobe constructions. Gautam further explains that about 95 % damage is shared by URM, random rubble and adobe buildings, so this earthquake was more devastating towards such buildings in comparison to the performance of RC buildings in affected districts and the wooden framed houses were the most survived structures that performed very well during 2015 Gorkha earthquake.

Unreinforced stone masonry was affected severely by the 2015 Gorkha earthquake and aftershocks (Dizhur *et al.*, 2016). Dizhur further elaborates that wall delamination, out-of-plane failure mechanisms, and in-plane failure mechanisms were observed andclay brick URM was observed to commonly suffer damage due to

deficient lateral capacity, lack of integrity between walls, and lack of connection between the walls and floor/roof diaphragms.Dizhur further explains that out-of-plane wall collapse was the most commonly observed failure mode and movement of floor diaphragms relative to the loadbearing URM walls was commonly observed in all types of URM buildings. The primary mechanism of collapse in reinforced concrete buildings was shear failure caused by the wide spacing of the stirrups, buckling of longitudinal rebar, and the poor confinement of the core concrete(Sharma et al., 2016). Sharma further explains that inadequate embedded hook length, cross-sectional area of columns and longitudinal reinforcement (less than 1.0 %) in columns, short lap splices contributed to the severe damages or collapses of buildings. Sharma further elaborates that failures and damages of reinforced concrete buildings due to the soft stories were observed because of elimination of infill wall due to social, public or commercial needs and damage and failures related to strong beam weak columns mechanism were observed and the causes of the damage of masonry buildings were observed to be poor construction detailing, poor masonry material properties, irregularly shaped stones having smooth surfaces, weak structural walls, unconfined gable walls, and cracks at the corners of windows and doors.

RC buildings were partially damaged, and many masonry buildings were severely damaged(Ohsumi et al., 2016). Ohsumi posits that the building damage might be caused by the soft ground conditions near the river branch as well as inappropriate construction methods and BM buildings survived in urban and rural areas and these buildings have very poor horizontal rigidity because of low bond strength and strong moisture absorption in mud joints, wooden floors and roofs. From the above research reviewed, on the most likely scenario it is clear that the many masonry buildings were severely damaged in comparison to RC buildings. Soft storey, pounding, shear failure were the reasons for the RC buildings failure whereas wall delamination, out-of-plane failure mechanisms, in-plane failure mechanisms, poor horizontal rigidity were found to be the reasons for the failures of masonry buildings.

2.3 Characteristics of Nepalese Building code

Building code regulation was promulgated as a measure to reduce the impact of a disaster such as an earthquake causing destruction to buildings and infrastructure in the human environment. Building code exists in most countries that are prone to earthquake; however, building collapse still causes deaths and economic losses during an earthquake. Deficiency in compliance with code regulations has been attributed as the primary root of large-scale deaths and property loss in recent disaster (Burby and May, 2000). Burby and May further elaborate that recent disasters in the United States brought to light evidence of more than incidental violations of building code standards, which have contributed significantly to the toll of property damages and shortfalls in compliance with building code standards are national in scope in the United States and they can be attributed to a variety of factors, including inadequate staffing of local enforcement agencies, inadequate technical expertise, inadequate legal support, inadequate leadership and effort in undertaking enforcement functions, and failure to work in a facilitative way with building designers and the construction industry and in addition, many local governments do not place a high priority on enforcement of the earthquake-related provisions of building codes. Thus, deficiencies in building code enforcement present a significant barrier to effective management of earthquake hazards.

The NBC document was drafted by the National Building Code Development Project (NBCDP) in 1994. However, it remained a technical document with no legal force until 2003(Arendt *et al.*, 2017). Arendt further elaborates that Nepal's government enacted the Building Act in 1998, followed by the Local Self-Governance Act in 1999 and the Local Self-Governance Regulations in 2000 but none of these actions compelled compliance with the NBC and the Lalitpur Sub-Metropolitan City decided independently to enforce the NBC in all new buildings in its jurisdiction in 2004 and encouraged by Lalitpur's initiative, a couple of other municipal governments followed the suit. Arendt further explains that Nepal's national government issued an executive order for all municipalities to implement the NBC code for new buildings in 2004 and however, it remained up to the municipal governments to set up the code implementation mechanism and enforce the code because of lack of technical capacity and supporting resources, most municipal governments have not yet completely followed it. Nepal National Building Code (NBC) was first drafted in 1994 following the lessons

learned from the 1988 M6.8 earthquake which killed more than 700 people in the eastern Nepal and The NBC was approved by the government in 2004 and is a legally binding document in all 130 municipalities (Khadka, 2017). Khadka further elaborates that no such regulation is applied to every municipality because of the lack of resources, monitoring of implementation of the code has been a big challenge since it was first legally enforced in 2004.

The code includes four levels of building practices, all of which are informed either directly or indirectly by professional engineering expertise: (1) international state-of the-art design, (2) professionally engineered design, (3) construction from standard templates of designs derived from engineering calculations for semi urban and urban residential houses [addressed by the Mandatory Rules of Thumb (MRT)], and (4) the Guidelines for non-engineered construction or remote rural buildings(Arendt *et al.*, 2017). Arendt further elaborates that in each MRT document, the basis of engineering analysis and detailed procedures are presented so that recommended design dimensions and details can be independently derived from engineering calculations and the NBC covers the most common building types in Nepal. Table 2.1 displays the main types of structures included in the NBC and their purpose. The NBC is designed to act as a standard for the construction of new buildings; it does not provide guidance on retrofitting of existing structures (EERI, 2016).

Table 2.1 Key elements of Nepal's NBC (EERI 2016)

Type of building code	Purpose
International state-of-the-art Applicable code: NBC 000	Applicable to large building structures. The structures must comply with existing international state-of-the-art building codes
Professionally engineered buildings Applicable codes: NBC 101, NBC 102, NBC 103, NBC 104, NBC 105, NBC 106, NBC 107, NBC 108, NBC 109, NBC 110, NBC 111, NBC 112, NBC 113, NBC 114, NBC 206, NBC 207, NBC 208	Buildings designed and constructed under supervision of engineers, buildings with plinth area more than 1,000 sq. ft., buildings having more than 3 stories, buildings with span more than 4.5 m and buildings with irregular shapes.
Mandatory Rules of Thumb (MRT) Applicable codes: NBC 201, NBC 202, NBC 205	Buildings of plinth area less than 1,000 sq. ft., less than 3 stories, buildings having span less than 4.5 m and regular buildings designed and constructed by technicians in the areas where professional engineers' service is not available.
Guidelines for remote rural buildings (low-strength masonry/earthen buildings) Applicable codes: NBC 203, NBC 204	Buildings constructed by local masons in Remote areas and not more than 2 stories.

Based on design and construction of buildings as per Nepal National Building Code 2004 and Building (First amendment) act 2007, following four different level of design parameters and construction are addressed in the building code:

Category I: International State-of-the-Art

The buildings which are designed by the sophisticated design philosophies and analytical techniques considering the studies carried out by Nepal and other developed countries on earthquake safety fall under this category. Additionally, the building which are designed by contemplating the Building Codes of other countries where seismic safety is given significance but also the Nepalese requirement with respect to the Nepal National Building Code's for seismic resistance are fall under this category. Special utility buildings such as cinema hall, public buildings, school buildings, hospitals are some of the examples of these kind of buildings. Similarly, buildings of national importance and buildings used for sensitive purposes such as buildings for telecommunication, petroleum product collection, airport management and control, buildings of cultural importance and other important buildings used by government fall under this category (NBC, 1994). This code is applicable for modern and sophisticated buildings such as International Convention Centre that

are constructed based on compliance with international building codes. NBC 000 lies within this (NBC, 1994).

Category II: Professionally Engineered Structures

This contains the standard code requirements that all professionally qualified engineers will recognize and must meet as a minimum when designing structures in Nepal. It covers all usual structures such as hospitals, meeting halls, factories, warehouses, multi-story buildings and residential buildings. Materials, analysis and design, construction safety and site considerations are all covered. This standard code provisions include the buildings with plinth area greater than 1000 Square Feet, storey more than 3 numbers and structural span greater than 4.5 meters. If any other design criteria exceed the code provisions of category III and category IV, they fall on this category. The related codes are as follows:

1. NBC 101: Materials Specifications
2. NBC 102: Unit Weight of Material
3. NBC 103: Occupancy Load (Imposed Load)
4. NBC 104: Wind Load
5. NBC 105: Seismic Design of Buildings in Nepal
6. NBC 106: Snow Load
7. NBC 107: Provisional Recommendation on Fire Safety
8. NBC 108: Site Consideration for Seismic Hazards.
9. NBC 109: Masonry: Unreinforced
10. NBC 110: Plain & Reinforced Concrete
11. NBC 111: Steel
12. NBC 112: Timber
13. NBC 113: Aluminium
14. NBC 114: Construction Safety
15. NBC 206: Architectural Design Requirement.
16. NBC 207: Electrical Design Requirements for (Public Buildings)
17. NBC 208: Sanitary and Plumbing Design Requirements

Department of Urban Development and Building Construction (DUDBC) made revisions
&updated the codes and also prepared additional three codes in 2003. The additional codes were NBC 206, NBC 207 and NBC 208 (NBC, 1994).

Category III: Mandatory Rule of Thumb-MRT

This part recognizes that it is not practical in Nepal at present to insist that all small buildings be designed for strength by a professional adviser. Therefore, for classes of buildings not exceeding certain simple criteria as to height, number of stories and floor area, mandatory rules of thumb are provided. The explanatory documents are such that an experienced overseer will be able to understand them and present sufficient details at the time of permit application to prove to a skilled appraiser at the Local Authority that the requirements have been met. The requirements are in terms of limits on spans and heights, minimum reinforcing and member sizes, positioning of earthquake resisting elements and other such rules (NBC, 1994). The building with plinth area less than 1000 Square Feet, storey less than 3 numbers and structural

span less than 4.5 meters can be designed following the provisions of mandatory rule of thumb as defined by this code (NBC, 1994).

The documents consist of:

1. NBC 201: Mandatory Rules of Thumb: Reinforced Concrete Building with Masonry Infill
2. NBC 202: Mandatory Rules of Thumb: Load Bearing Masonry
3. NBC 205: Mandatory Rules of Thumb: Reinforced Concrete Building without Masonry Infill

Category IV: Guidelines for Rural Buildings

These guidelines address about a dozen typical building styles that have been condensed from an inventory of approximately fifty-five surveyed intensively during 1993. In the form of diagrams and descriptions aimed at the technical advisers to owner/builders in villages, these guidelines emphasized those changes that should be made to current practices to improve the seismic resistance of these building which are not subject to modern quantitative analysis and rational design consideration. These structures are normally of earthen construction (unfired masonry, mud mortar, rubble, dry stone, wattle and daub, etc.) (NBC, 1994).

It consists of

1. NBC 203: Guidelines for Earthquake Resistance Building Construction: Low Strength Masonry
2. NBC 204: Guidelines for Earthquake Resistance Building Construction: Earthen Building (EB)

2.4 Implementation mechanism of code compliance

Nepal is located in a seismically active zone and the history shows the occurrence of various larger and smaller intensity earthquakes every year, safer and stronger construction is the utmost requirement. After the Gorkha earthquake, peoples are aware of the safer construction to a limited extent. The implementation of building code has been the part of concern for every stakeholder.

On the occasion of Earthquake Safety Day on January 16, 2003, LSMC announced its plan to implement NBC in all of its building permit process and became the first municipality in Nepal to implement NBC and it was done before the implementation was made mandatory (Subedi and Mishima, 2008). Subedi and Mishra further elaborates that the decision was historic in the sense that it not only awakened the government to enforce NBC but also encouraged other municipalities on the necessity of building code implementation and it also proved that implementation of NBC can be done by determination irrespective of legal constraints. Subedi and Mishra further explains that the building permit process is designed in three stages in LSMC in which first stage starts with application by owner and ends with Temporary Permit for construction up to Plinth Level.

In the second stage, the house owner applies for permanent permit and field checking is done jointly by the Building Permit Section and Earthquake Safety Section. If the construction is in conformity with by-laws and NBC, permanent building permit is issued. Finally, field checking is conducted at different stages of construction and the Completion Certificate is issued to the owner. Subedi and Mishra further explains that the three-stage implementation process is a standard approach for the effective implementation of NBC and however, LSMC had to drop the three-stage process to two stage for certain duration due to complaints of house owners on lengthy permit process.

Currently, LSMC has been taking different strategy i.e., to minimize the circle of controlling system and increase the circle of compliance on building code. So LSMC has been carrying mass awareness campaign to general public, orientation classes to house owners and series of technical training programs to masons, engineers/designers. LSMC expects the house owners, masons and designers/supervisors themselves to follow building code and carry constructions according to the approved structural designs and drawings.

However, technical persons from the Earthquake Safety Section often visit the construction sites for inspection and to provide advices to masons, supervisors and owners on earthquake safety measures for houses.

In Nepal, municipalities are the responsible agencies to issue building permits and the current municipal building permit process does not ensure the compliance of NBC (Giri, 2013). Giri further elaborates that only 3 out of 58 municipalities in Nepal have tried to incorporate NBC into their building permit process; but these attempts have been too limited and lack the necessary verification to ensure compliance and these three municipalities are Kathmandu and Lalitpur in the capital region and Dharan which is in the far eastern region of Nepal. However, Dharan Municipality has limited enforcement of NBC compliance to the pre-engineered design category such as Mandatory Rules of Thumb (MRT). Giri further explains that the de facto building permits process in Kathmandu and Lalitpur is very superficial and subjective even though both municipalities enforce NBC compliance in theory and few generalized checklists have been developed and the questionnaires in checklists are overlooked and easily manipulated and there is no effective mechanism for field verification of approved drawings. Even the concerned authorities of Kathmandu Metropolitan City (KMC) and Lalitpur Sub-Metropolitan City (LSMC) realize that they have ineffective code compliance tools in their building permit system. Such a haphazard implementation of NBC in Kathmandu is dampening any effort and/or enthusiasm of the rest of the municipalities to emulate the Capital City's building permit system.

Research analysis of interviews with multiple stakeholders revealed several reasons for non-compliance with building permit regulations in Accra-Tema city-region and the reasons include administrative bureaucracy and inefficiency, cumbersome planning regulations, scepticism about the building permit system, indiscipline and lawlessness, ignorance of legal steps, land litigation, and the lack of institutional co-ordination (Arku *et al.*, 2016). Arku further elaborates that that participants in the study have generalized knowledge of building permit regulations in terms of awareness, although they may not be aware of the specific details of the legal requirements for building permit regulations prior to commencement and subsequent adherence to various stages of construction. Specifically, all housing developers and artisans were aware of the issuance of building permits by the Town and Country Planning Department and MDAs, and 19 out of the 21 residents were similarly aware of the existence of building permits as a legal requirement for land development. They were aware that the regulations are legal requirements to be fulfilled prior to land development or alteration to existing property.

The municipal's current institutional mechanism for the implementation of Building code is guided by various legal provisions and documents(Bhattarai and Mishra, 2017). Bhattarai and Mishra further elaborate the adopted Sequential Steps for building permits process in Nagarjuna municipality which are mentioned below.

Step 1: Submission of application letter and building drawings both architectural and structural along with other required documents like copy of citizenship, blue-print, land owner's certificate, trace map, 4-corners details.

Step 2: Registering the application

Step 3: Checking for required documents and finding out whether the submitted drawings fulfil architectural design requirements and building bye-laws or not. If ok go to step 4 if not go to step 1

Step 4: Checking for structural design requirements and finding whether MRT has been adopted or not. If no go to step 5 if not inform applicant to re draw

Step 5: Forward the drawings and application to respective ward office for 15 days' notice publication to adjacent neighbour. If ok go to step 6

Step 6: Field check by technical manpower of respective ward and completion of other administrative job. If ok go to step 7 if not report to municipality.

Step 7: Collection of Taxes

Step 8: Permission granted up to plinth level (temporary permit) after constructing up to plinth level, owner again apply for permanent permit.

Step 9: Application by owner to check plinth level

Step 10:Plinth level check by technical manpower of municipality. If ok go to step 11. If not inform applicant for design alternation up to possible extent

Step 11:Permission granted for permanent construction after constructing and completion of building as per drawings, owner again applies for building completion report.

Step 12:Application by owner for building completion report

Step 13:Field check by technical manpower. If ok go to step 14. If not inform applicant for design alternation to the possible extent

Step 14**:** Building completion report issuance.

After the devastating earthquake of April 25, 2015 GoN has legally enforced the National Building Code (NBC) and Byelaws in all the municipalities (Khadka, 2017). National Reconstruction Authority (NRA) was established under the act relating to reconstruction of earthquake affected structures, 2015 to support the earthquake victims in reconstruction of earthquake safer buildings. To address the housing reconstruction needs and to build a more resilient Nepal, the GoN is leading the overall housing reconstruction efforts nationally through a housing reconstruction program meant to encompass all of the housing stock to be rebuilt and the program will also serve as a coordinating framework to standardize housing reconstruction policy (Nepal Rural Housing Reconstruction Program, 2016). Nepal Rural Housing Reconstruction Program further elaborates thatbeneficiary will be supported with socio-technical assistance; training and market facilitation; and cash-based assistance, provided in tranches, upon certification of earthquake-safer techniques guided by Nepal's National Building Code (NBC) and inspection will be conducted to ensure that the housing reconstruction follows the NBC and is in compliance with the necessary conditions for the cash transfer. Inspection will be done upon signing of the Participation Agreement, upon completion of the foundation up to the lintel/wall, and upon completion of the roof.Each VDC will have a mobile team composed of technicians and social mobilizers. The team's main responsibility will be to conduct awareness campaigns and orientations for homeowners, provide on-the-job assistance to workers on site, and organize social gatherings and meetings to discuss problems and difficulties faced during the reconstruction phase in order to help identify solutions. Nepal Rural Housing Reconstruction Program further explainsan effective reporting, monitoring and evaluation system will be in place to gather, standardize and measure all data streams related to reconstruction, earthquake-safer compliance and technical support activities.

Following the Gorkha Earthquake, people have become aware of the need for resilient construction, and there are today trained masons in the community but all the municipalities may not have a full system. Even after the reconstruction is over, any construction in those cities must be made resilient (Guragain, 2019). Guragain further explains that implementing a building code implementation section in the municipality are important to establish that system, registering trained masons and trained engineers, creating disaster risk management.

2.5 Nepal's poverty in rural areas

The absolute poverty ratio in Nepal has been gradually decreasing and in fiscal year 2017/18 it has fallen to 18.7 percent of the total household / population and multidimensional poverty has declined to 28.6 percent (Economic survey, 2019). Economic survey further elaborates that poverty and unemployment have been reduced in recent years due to high economic growth rate of the country, employment policies to involve the citizen in work, effective social security and protection programs, concessional loan programs and remittance income from foreign employment and according to the latest estimates of the National Planning Commission, absolute poverty is estimated to be around 16.67 percent in the fiscal year 2019/20. Economic survey further

explains that the long-term vision of Fifteenth Plan has targeted to drop the population living below the poverty line to 5 percent by 2030, and below zero percent by 2043, by reducing income inequality. Nepal's Human Development Index is 0.579 according to the 2019 report of the United Nations Development Program (UNDP). Although absolute poverty is low in urban areas, the concentration of poverty is high. Absolute poverty is high in rural areas. As the poverty alleviation has been recognized as a national strategy in Fifteenth Plan, targeted programs have been carried out by the federal, state and local levels.

The connection of macroeconomic growth of the country is directly associated with the welfare level of any citizen in the country and ultimately reflects the situation of poverty (Khanal, 2012). Khanal further elaborates that six decades have already been completed for the implementation of the systematic fiscal budget, but Nepal still suffers from poverty coupled with low economic growth, unemployment, inequality and political instability. The Constitution of Nepal created a federal structure with seven provinces, with significant socioeconomic differences among them. Bagmati Province contributes 41.4 percent of GDP, while the share of Karnali Province is 3.4 percent (Human development report, 2020). Human development report further elaborates that in fiscal year 2018-19, Lumbini province achieved economic growth of 7.1 percent, but Karnali Province lagged at 5.7 percent and the population below the absolute poverty line is 33.9 percent in SudurpaschimProvince, but 12.4 percent in Province 1 and unemployment rate is 20.1 percent in Province 2 compared to 7 percent in Bagmati province. Human development report further explains that the country's resource endowments, competitive strengths and future potential in several spheres, together with progress on various socioeconomic fronts and improved growth performance in recent years, suggest a bright future and improving human development level has been notable at the aggregate level, with Nepal's score reaching 0.579 in 2018, higher than the LDC average and this is largely due to successes in education and health and the average multidimensional and consumption poverty levels have fallen considerably, to 28.6 and 18.7 percent respectively in 2018, while in the last three fiscal years, the average economic growth rate has been around 7.3 percent, a rate far higher than the average growth rate of about 4 percent over the last four decades.

Nepal is geographically divided into three major topographical areas- Mountain, Hill and Terai. The mountain region is the northern high elevated land which covers approximately 15 percent of total land. This region has difficult and rocky terrain and holds world's eight of ten tallest peaks. Despite having opportunities, this region is economically backward and always isolated from national mainstream(Pokharel, 2015). This region holds only 6.73 percentage of total population (CBS, 2013). The NLSS 2010/11 affirms 42.27 percentage of population in this area live in absolute poverty which is 17 percent points higher than that of national average. Hill stretches between mountain and southern plain (Terai) and holds 68 percent of total land and 43 percent of total population (Central Bureau of Statistics [CBS], 2013). This region has many well-developed urban centres including the capital city Kathmandu(Pokharel, 2015). Pokharel further elaborates that around 24 percent people in this area live below absolute poverty which is little less than national average and however, the proportion of people living under human poverty is around 5 percent points higher than absolute poverty. Pokharel further explains that the terai (southern plain) borders with north India and holds 17 percent of total land against 50.27 percent population implying that unequal distribution of population to land size. This region has fertile and industrial land and it has some well-developed infrastructure and considered to be developed area than other regions. The NLSS 2010/11 shows 23.44 percentage of population in this region survive under absolute poverty. The incidence of poverty is more severe in the rural (44 percent) and mountain (56 percent) areas.

Agriculture still remains the prime occupation for majority (80 percent) of the population in Nepal. The majority of the population (88 percent) still live in the rural areas where agriculture remains the major source of employment and livelihood. But the overall performance of this sector could not remain strong. It is quite noteworthy that the agricultural sector share to GDP over the last 10 years has significantly declined from 26.7 percent. However, the number of labours engaged in agriculture and allied activities has changed little over this period (about 80 percent of employment). This has denoted the low productivity of labour indicating poverty increment in future.

2.6 General Housing Construction Cost and Technology

The housing sector is one of the backbone sectors in the construction industry and determines the success and failure of this industry and plays a major role in the economy of many developed countries and twenty six percent of EU's construction activities were from housing building (Warsame, 2006). Housing construction was normally used as an economic stabilizer in many countries. Warsame further elaborates that Swedish housing construction costs have risen more than the rate of inflation during the last decade and increasing construction costs affect household's welfare in terms of housing affordability, weaken the relationship between developers and contractors, and destabilize the housing markets as well as the whole economy. Warsame further explains that the effect of the construction costs escalation was not evenly felt in all regions and there was also an imbalance of housing stocks in various regions and the supply of new residential apartments stagnated at the same time as the construction costs were high particularly in the metropolitan regions where the housing demands were stronger. Higher construction costs reduce residential construction and thus affect movement's in house prices and rent levels (Somervile, 1999).

Construction costs and activities in Yemen and other low-income countries are unaffordable (Sultan et.al, 2003).Sultan further elaborates that the building construction costs registered an increase in rates every year at scales much faster than inflation and it is seen that in view of the increase in cost for basic input materials like steel, cement brick timber and other materials as well as the cost of construction labour, buildings cost increase at around 20% to 30% annually even when inflation is in single digit. Even though income levels of people are by and large brought in line with the levels of inflation through inflation indexed rise in salaries, year after year, housing is moving beyond the reach of the majority of the people. The reducing housing size for various categories in consecutive years in respect of the plinth areas, nature of specifications even with increased income levels would indicate the rapid increase in cost of construction. Sultan further explains that in less than two decades, the construction costs have increased from around 4,000 YR/m2 (15.94 US $/m2) to as high as 45,000 YR/m2 (179.32 US $/m2). This is in respect of the normal types of housing construction. Still higher levels of costs are registered for using better finishes and amenities. Sultan further explains that since 1979/80 to 1999/2000 wages in local currency have increased 10 times and the exchange rate and equally, most construction prices by nearly 40 times (GNP and PPP per capita (in US$) stayed the same or changed insignificantly, which meant the construction cost is growing faster than the average income.

Building a residential house now costs approximately three times more than what it did five years ago due to substantial rise in labour costs and price of other construction materials and construction cost per square feet now hovers around Rs 2,400 as against Rs 850 five years ago, with labour charges going through the roof due to scarcity of workers here and skilled masons, for instance, now charge around Rs 1,000 per day, as against Rs 450 five years ago (Poudel, 2014). Poudel further elaborates that even general unskilled labourers demand at least Rs 330 per day now, as against Rs 220 half a decade ago, while helpers and general masons do not agree to render services for less than Rs 425 and Rs 550 per day, respectively, as against Rs 300 and Rs 350 five years ago andpeople working at construction sites are demanding more money every day due to shortage of labourers in the domestic market which is the prime cause that is pushing up the cost of building a house. A rough estimate has indicated that construction of even a 300sqft (which is much smaller than the average house size in Nepal) house constructed of stone in mud where stones are locally available would require at least Rs 4,00,000 (3383.03 US$) (including cost of earthquake resistant features)(Bothara et al., 2016).

A basic, traditional-style Newari house for a family of four costs between US$ 30,000 and US$ 40,000(Daly et al., 2017). This estimate is based on the rebuilding plan prepared by a community reconstruction committee of one of the Newari settlements. Daly further elaborates that the cost for constructing a non-traditional house for a family of four is a minimum of US$ 15,000 and these estimated figures far exceed the housing grant that the NRA is providing and the housing grant serves more as a symbolic gesture rather

than an important source of financing. Daly further explains that it is no surprise, that there are reports claiming that beneficiaries of the first and second tranches of the housing grant openly talk about using the money towards purchasing basic things that are unrelated to reconstruction. The report found that Bhaktapur, Kathmandu, and Lalitpur – where there is the highest concentration of urban areas have the highest median construction costs at 2,500,000 NPRs (21,144 US $), 2,250,000 NPRs(19,029.6 US$), and 1,200,000 NPRs(10,149.1 US$) respectively(HRRP, 2018). HRRP further elaborates that the most expensive houses were RC frame structures in Kathmandu and Nuwakot that cost 6,500,000 NPRs (54,974.3 US $) and the median cost of construction for the 14 districts is 675,000 NPRs(5708.07 US $) and in this case the GoN housing reconstruction grant of 300,000 NPRs(2537.27 US $) represents almost 50% of the total cost of construction and is a significant contribution and incentive and However, for urban areas the grant may represent as little as 0.05% of the total cost of construction which greatly reduces the significance and impact of the grant.

2.7 Access to housing credit in rural environment

Nepal is a rural dominant but rapidly urbanizing nation. In the late 80's the access to institutional housing finance was almost nil and there were only government and semi-government operated banks in the country which considered housing as an unproductive sector to finance (Karki, 2004). In this situation, the family themselves used to acquire land, marshal resources, procure building materials and organize the construction activities. Accomplishing all these activities used to be a very costly, tedious and time-consuming task to the majority of the households. As a result, they used to take years to improve their savings; house construction process was incremental, floor by floor and unfinished. Karki further elaborates that the other form of acquiring housing finance was to sell or mortgage jewelry or take informal lending at high rate of interest say 20 % to 40 % per annum and similar was the situation for housing developers and it is estimated that the land purchase occupies 50 % to 60 % of the total housing expenditure in Nepal. Karki further explains that the banks and finance companies of Kathmandu valley have already developed a policy to provide home loan and the lending is on the regular monthly installment for the period of 5 to 18 years and the rate of interest ranges from 8.5 to 9.5 %. After 1991, with the emergence of new democratic government in Nepal, plenty of private commercial banks and finance companies emerged and even then, housing finance was still a low priority for them as they had lot of clients for industrial and commercial purposes. By mid-March 2020, there are altogether 162 banks and financial institutions including 27 commercial banks, 23 development banks, 22 finance companies, 89 micro finance companies and 1 infrastructure development bank are in operation (Economic survey, 2019). Economic survey further elaborates that the number of branches of banks and the financial institutions including micro finances has reached 9,640 and by Mid-March of 2020, the branches of commercial banks have reached at 746 local levels and Sixty-one (61) percent of the citizens have at least one bank account in the bank and financial institutions.

The GoN addressed the problem of inadequacy of funds for rebuilding houses by introducing a provision for 'soft loans' to earthquake victims listed as beneficiaries, with an interest rate of two percent and under this provision, earthquake victims in the Kathmandu Valley would be eligible for a maximum of approximately US$ 24,000, while those outside the Valley and in remote areas would get a maximum of about US$ 14,000 (Daly etal., 2017). Daly further elaborates that a majority of earthquake victims are either unaware of the loan provision or have limited access to updated information that would enable them pursue the loan option and in addition, the conditions for obtaining the loan are the same as for obtaining the housing grant and present building permits while strictly adhering to the building codes and by-law mandates which means residents experience similar obstacles. As such, the provision of 'soft loans' has so far been yet another case of false hope and promises on paper but unattainable in practice.The scheme entailed banks and financial institutions (BFIs) taking loans from the central bank at zero interest rate and issuing loans to the quake survivors at two percent interest rate (Kathmandu post, 2018). The Kathmandu post further elaborates that NRB records show banks and financial institutions disbursed Rs2.19 billion in housing loan at the concessional interest rate of two percent as of mid-August 2018 and the authority has an alternative for quake survivors who could not rebuild their homes due to lack of funds. The Kathmandu post further

explains that the government unveiled the Integrated Working Procedure for Subsidised Credit 2018 and offers for concessional loans up to Rs. 300,000 and a repayment term of five years to earthquake survivors who could not start reconstruction of their houses due to lack of funds and under this procedure, the government will cover five percent interest rate provided to the earthquake survivors by the BFIs. The financial institutions have been allowed to scale up profits up to two-percent on their base rate.

To secure adequate housing, households confront the choice between renting and owning. These options in turn are determined greatly by a household's access to financial resources(Doling et.al, 2013). Doling further elaborates that renting requires a regular income stream, while owning requires access to a large amount of accumulated finance because the purchase of a dwelling is very costly and indeed it is the largest asset that most households will ever possess. Doling further explains that finance also plays a key role in housing construction, supporting the large costs of developers before housing units can be sold or rented out and housing finance may be limited to those with a high and steady income and those who are able to secure finance are often required to provide an initial (down) payment of 30% or higher, of the value of the unit and the mortgage may be large relative to income.

The average price of a home in a developed country to be four times the average household's annual income (Ball, 2003). While in high-income economies mortgages are widely available and routinely used for consumer financing of housing, many low and lower-middle-income countries only register a few thousand loans or a few hundred in some cases (Badev, 2014). Badev further elaborates that a mortgage loan is often the major liability of households in developed countries, with the house being the corresponding asset on the household balance sheet, and thus a critical part of household welfare. Housing finance, however, has also been at the centre of multiple banking crises, most recently in the U.S., Ireland, and Spain, and recent research has shown that banking crises linked to housing boom and bust cycles are typically deeper than other crises (Claessens et al., 2011).

2.8 Housing construction skill development in Nepal

Labour shortage is yet great challenge for owners who planned to rebuild their houses and finding skilled workers such as masons, carpenters, plumbers, and electricians was challenging though many nongovernmental organizations have launched training programs in rural areas, almost no women and Dalits (minorities) participated in the housing reconstruction training (Kisi et.al, 2020). Kisi further elaborates that skilled worker moved to other areas where they could get higher wages and conversely, women complained that they were not always hired as wage labourers because they were deemed to be physically weak, and if hired, they received lower salaries than male labourers and due to high demand for skilled workers after the disaster, the owners and builders had to provide wages that were doubled or tripled compared to the wages before the earthquake.

Kisi further explains that scarcity of skilled workers and uncontrolled wages led builders and contractors to hire workers from India because they were easy to hire worked for low wages and the unskilled workers started working on their projects as skilled workers because the owners wanted to complete their homes, the contractor didn't care too much about the issue. Kisi further explains that regarding the availability of the skilled labour, 90% of the contractors and 83% of the supervisors reported that they had difficulty finding skilled workers in the construction projects and they reported hiring skilled labourers from India and a total of 72% of the labourers reported that they work with different people from across the country and abroad and a total of 48% of the workers also reported that they get multiple job offers from other projects nearby. There is a short fall of masonry labour productivity in building construction projects and requires proper assessment measures in India (Karthik and Rao, 2019).

Karthik and Rao further elaborates that the most important factor affecting the construction labour productivity is found to be the lack of skill and experience of worker and the least important factor is found to be the labour interface and congestion, which is peculiar. Labour productivity is regarded as one of the most influencing factors that affects the performance of any construction project (Loganathan and Kalidindi,

2015). Loganathan and Kalidindi further elaborates that in most countries, experience and literature have revealed that labour cost comprises 30 to 50% of the total cost of a project and in Indian construction industry context, the seasonal and migrant workers constitute a significant portion of the total construction workforce and lack of training and improper organizations of the migrant workforce has resulted in unproductive and unpredictable work environment.

A significant amount of unskilled work has been undertaken by family members themselves during reconstruction, which to some extent alleviated labour requirement need and of main concern is the skilled workforce, which constitutes around 46 per cent of the needed labourers (Hada, 2018). Hada further elaborates that the housing component alone may need over 20,000 masons who are often part-time workers, or migrating between Nepal, India and the Middle East and Over the year (2016-17) period, 59,555 local people were trained out of a planned total of 80,119 in the 14 most affected earthquake districts of Nepal and among the imparted skills were mainly in masonry followed by carpentry, electrical, plumbing, social mobilization, master mason workers and refresher. Hada further explains that the total share of masonry training events consists of 84.4 per cent of the total output followed by the rest of occupations related to construction sector and out of the total trained 50,330 mason workers, 69 per cent (34,871) of trained falls under short-term category (7-10 days), 29 per cent (14,613) under 50 days (which includes On-the Job-Training (OJT)) category, followed 2 per cent (846) under new mason training (up to 45 days). There is still need to train at least 20,000 new mason workers so as to meet unfulfilled demand of 70,000 mason workers by organising high quality 50 days training with compulsory provision of OJT.

The conventional construction techniques in Nepal such as reinforced concrete frame structure with brick walls takes significantly more time and extra construction space compared to the modular construction technique(Kisi *et al.*, 2019). Despite the benefits of the modular construction techniques, most people in Nepal reconstructed their houses using traditional methods such as reinforced concrete frame structure with brick walls(Kisi *et al.*, 2019). Wider adoption of modular construction is challenging in Nepalese construction industry despite their well-documented benefits. There are enough evidences of seismic –resistant elements in traditional building typologies and construction practices. Some of these practices have been passed on from generation to generations. A survey of vernacular building types in various parts of Nepal revealed several earthquake-resistant features being incorporated in local building constructions(Dixit *et al.*, 2004). These included symmetric configuration, small length-to-breadth ratio, symmetrically located small openings; a low floor-height, and a limited number of stories(Dixit *et al.*, 2004). Use of wooden studs that are found to render resistance to lateral loads, and the energy-dissipating property of some of the typical construction details are example of earthquake-resistant elements used in indigenous constructions(Dixit *et al.*, 2004). Numerous residential private buildings in the historical city of Bhaktapur are more than 400 years old and they have survived at least 3-4 major earthquakes of intensity IX-X. There were several such surprises! It is conspicuous throughout the Himalayan region that the traditional knowledge of building construction did have the practice and methods of securing the stability of buildings against earthquakes. But many of the “good practices” are being lost in the advent of new construction technologies based on the use of cement concrete(Dixit *et al.*, 2004).

2.9 Major Constraints of Building code compliance in Nepal and other countries

It is understandable that developing countries such as Bangladesh and Nepal face constraints in implementing building codes(Ahmed *et al.*, 2018). Ahmed further elaborates that beyond the oft-cited issues of enforcement and corruption, affordability is a key constraint for the vast bulk of the population that build informally and the codes provide a broad spectrum of good practice guidelines, often based on developed country models, and can thus be onerous and difficult to implement in their entirety in the socioeconomic context of South Asia. However, the codes also include guidelines for safety to enable buildings to be disaster resilient and these hazard-related codes can be termed as ‘safe building codes’ to differentiate them from codes that deal with other aspects. At a bare minimum, if only the safe building codes are followed, a level of disaster resilience can be achieved.

Ahmed further explains that the generation of scientific knowledge on building codes and construction continues apace globally, but its application to disaster risk reduction and resilience-building is lacking and South Asia is a case in point because land-use and building code frameworks are generally inadequate in low-income countries, such as the case study countries in this project and the bulk of buildings are constructed informally; rough estimates indicate that over 80% of housing in these two countries is informal. There is very little or no application of building codes in informal sector construction. Even in the very small proportion of formal sector housing, adherence to building codes are generally lacking or limited at best. Ahmed further explains that the building codes are not well-integrated into construction and planning regulations and Bangladesh and Nepal have building codes, but enforcement and compliance face significant challenges; the codes serve mainly as good practice guidelines and it is up to professionals, builders or authorities to follow them.

Peru has an old history for developing National Building Code; established in 1963 and enacted in Lima in 1968, and even recently updated incorporating advanced understandings on earthquake safety (Ando, 2008). Ando further elaborates that with the advanced building code in place, however, the implementation of the code is still not effective owing to various reasons and particularly, the lack of awareness and sensitization of the importance of the latest building code amongst professionals, lack of capacity of municipal authority to deal with the building and related urban planning issues are the major constraints. Ando further explains that in order to achieve the essential objectives of the code earthquake safety, it requires a mechanism to enforce the application of the code, monitoring of its performance, the advancement of the level of understanding and the specific preparation of design / supervision by professionals and more importantly, there is an indispensable need for capacity building of local governments for effective enforcement as well as guidance of citizens for the building code compliance.

Some of the countries in Asia, such as Bangladesh and Nepal that have building code lack the compliance application in reducing disaster (Ahmed et al., 2018). Ahmed further explains that Non-adherence to compliance culture has been attributed to the low-income countries, which described that compliance criteria's in those countries are too high because of over-dependency on imported building materials. In many low-income countries, there is no integration among the major stakeholders involved in the building industry, which account for significant challenges facing enforcement and compliance (Moullier and Krimgold, 2015).

2.10 Contributing factors in the non-compliance

Challenges, such as large family size, low-income levels, poor public awareness of planning and building regulations and lack of housing finance facilities, are accompanied by an increasing demand for housing. Accelerated demand for housing under these socio-economic conditions provides opportunities to build with low levels of compliance with planning standards (Alnsour and Meaton, 2009). Alnsour and Meaton further elaborates that the most important factors contributing to poor compliance with residential standards are the current municipal management culture and effective monitoring system too.
The rising and increasing spate of informal housing developments in Bayelsa State, Nigeria and other developing countries may not be unconnected with the fact that the existing minimum housing standards is unrealistic and this gap is in part due to the economic status of the developers who are mostly low-income earners who cannot cope with the demands required by the standards (Atamewan, 2019). Atamewan further posits that the level of awareness of the existence of housing standards is quite low. Noncompliance cases in RCC buildings are found to be higher than in masonry buildings and The reason behind large number of noncompliance cases for RCC buildings is due to lack of trained mason for construction of RCC building in rural areas and field technicians submitted mostly RCC buildings to DSE for structural analysis (Shrestha *et al.*, 2020). The study has revealed that lack of training and development (capacity building) also causes non-compliance with standards and regulations apart from the administrative and social factors identified in other studies (Yakubu, 2019).

2.11 Review approach and Identification of research gap

This section presents the brief summaries of the literature review regarding compliance of the National building code in private housing reconstruction to set the environment for study and identify the research gap.

The adobe construction, wooden framed houses and rubble stone masonry constructions are more popular in villages of Nepal. However, most of the urban and suburbs constitute majority fraction of stone or brick masonry buildings among them 20 % consist of reinforced concrete (RC) (Gautam *et al.*, 2016). Ninety-five percent damage is shared by random rubble and adobe buildings. The performance of RC buildings and the wooden framed houses was better. GoN enacted the Building Act in 1998, followed by the Local Self-Governance Act in 1999 and the Local Self-Governance Regulations in 2000 but none of these policy instruments ensured compliance with the NBC. The Lalitpur Sub-Metropolitan City decided to enforce the NBC in 2004 and a couple of other municipal governments followed the suit(Arendt *et al.*, 2017). The incidence of poverty is more severe in the rural (44 percent) and mountain (56 percent) areas.

Agriculture still remains the prime occupation for majority (80 percent) of the population in Nepal. The majority of the population (88 percent) still live in the rural areas where agriculture remains the major source of employment and livelihood.Sindhupalchowk is basically agriculturally based district. The occupation pattern of Sindhupalchowk is approximately 77.3% of the active populations are involved in agricultural sector. Subsistence agriculture farming, mainly small-scale livestock is the main source of occupation and livelihood of the majority of the population, with 79% of the population active in this sector (Source: Rural access phase 3). Tentatively, construction of even a 300sqft (which is much smaller than the average house size in Nepal) house constructed of stone in mud where stones are locally available would require at least Rs4,00,000 (including cost of earthquake resistant features)(Bothara et al., 2016). A reasonable house would cost around NPR one million which would necessitate beneficiaries to borrow loan. However, a majority of earthquake victims are either unaware of the loan provision or have limited access to finance.

Every building construction needs to abide the national building code and require permission from the local government authorities. Though the government has enforced the building code, the code compliant status in rural municipality has not been studied till now.
Against above backdrop, this study intends to fill the knowledge gap by identifying reasons for non-compliance which will be instrumental for formulating appropriate policy instruments.

CHAPTER 3
RESEARCH METHODOLOGY

This chapter gives an outline of research methods that were followed in the study. It also elaborates on the sample size and respondents. The data collecting instruments are also described. The analytical methods are also highlighted.

3.1 Research Design

With the aim to determine the compliance of Nepal National Building Code and Byelaws in private housing reconstruction, this research was conducted in Indrawati Rural Municipality of Sindhupalchok district. The problems encountered in the effective implementation of building code and byelaws in the municipality was identified and studied throughout the research time period. Various literatures and articles on the building code (published as well as unpublished articles) were also reviewed. The primary and secondary data were collected through the methods of key informant interview, observation and questionnaire. All data and information were used for analysing and interpreting for achieving the research objectives. The Fig. 3.1 shows the schematic diagram of research design.

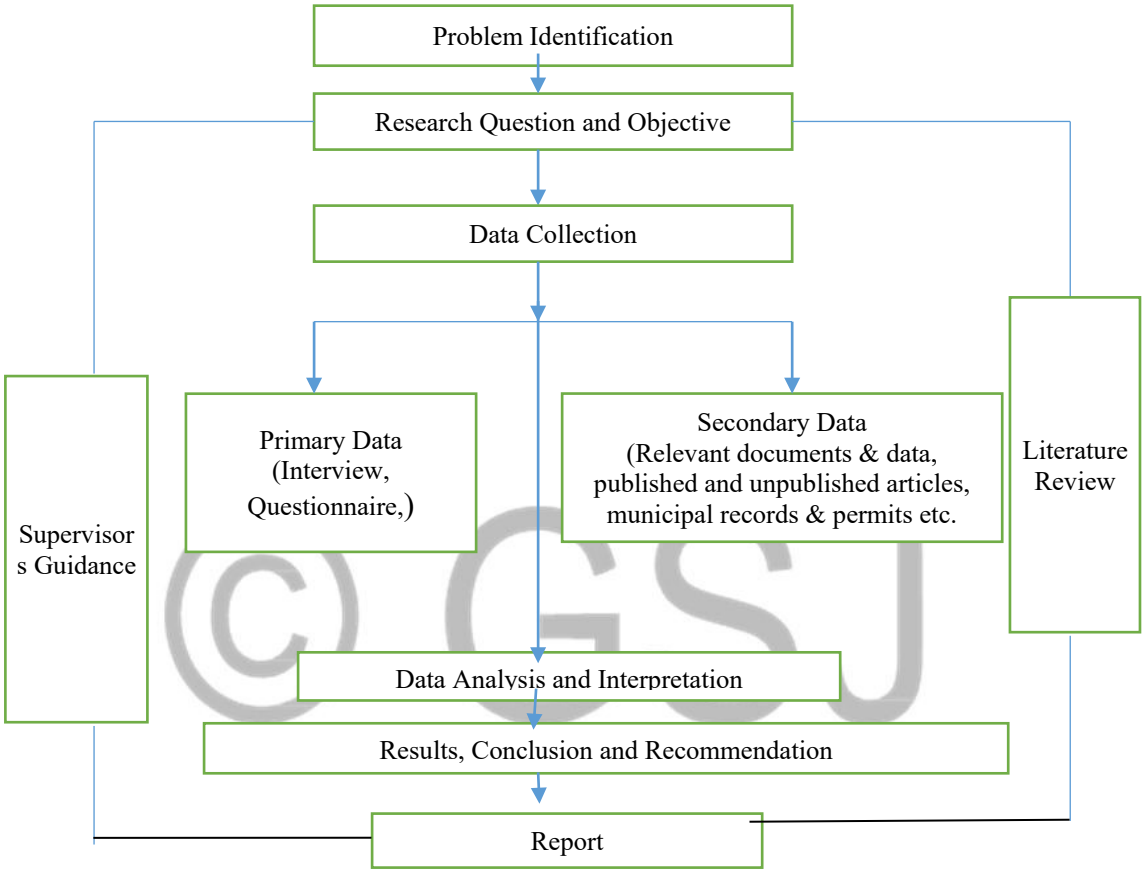


Figure 3.1 Research Design

3.2 Research Approach

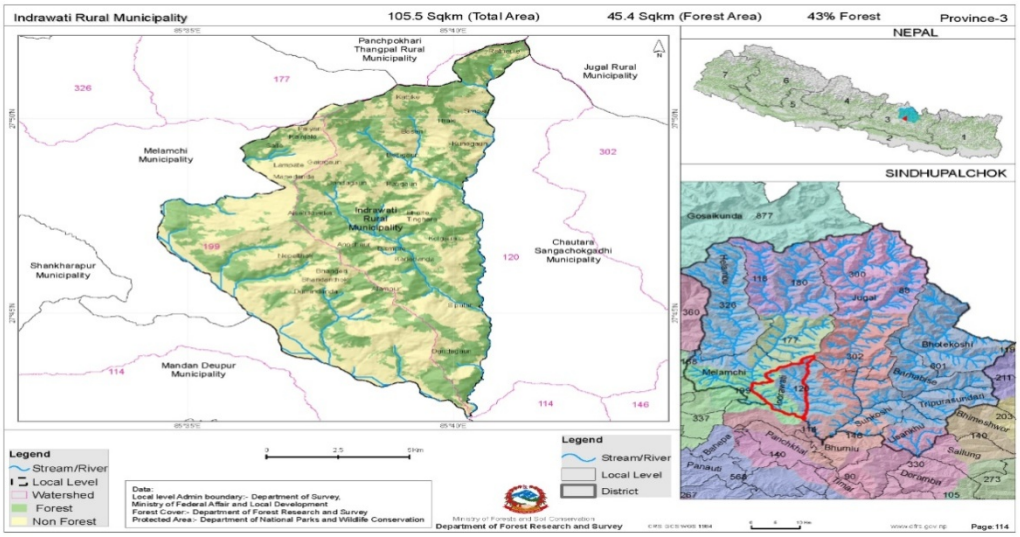
This study followed both quantitative and qualitative approach. Standardized structured questionnaires consisted of both quantitative and qualitative approach to address the issues arising in the building code compliance in private housing reconstruction activity.

3.3 Study Area

The Indrawati Rural Municipality was selected as the study area.
Located in the Sindhupalchowk district of Bagmati Province, the Indrawati Rural Municipality (IRM) has an extant of 105.11 sq. km. It is spread over an area of PanchpokhariThangpalGaupalika and JugalGaupalika to the North, Melamchi Municipality to the West, Kavreplanchok District to the South and ChautaraSangachokgadhi Municipality and JugalGaupalika to the East with an average elevation of 654 m.

Although some parts of the hilly areas are fertile, the IRM is mainly covered with bushy forest. Fig. 3.2 shows the location map of the study area.

Having 12 Wards, the IRM consists of Simpalkavre, Kunchok, Nawalpur, Badegaun, Sipapokhare, Bhotsipa, and Bhimtar former Village Development Committees. According to the National Census, 2068 BS, IRM has a population of 28,517 of which males constitute 46.91 percent (13376) and females' 53.09 percent (15141). Among them, the Tamang community's population size is 7414 (26 percent), followed by Brahmins 4282 (15.02 percent) and Chhetri 4184 (14.67 percent). There are a total of 59 educational institutions including 12 community secondary schools, 39 basic and 8 community child development centres.
The Fig. 3.2 shows the IRM's Location



Source: https://nepalindata.com/resource/local-resource-map---indrawati-rural-municipality/

Fig 3.2: Map of Indrawati Rural Municipality

3.4 Methods of Data Collection

Both primary and secondary sources of information were used.

3.4.1 Secondary Data

Various relevant published and unpublished reports and articles, journals, statistical data published by CBS, DLPIU and CLPIU, literatures, books, published thesis and related articles available online and municipal records were taken as secondary data sources.

3.4.2 Primary Data

The primary data were collected from the municipal and NRA technical personnel's, house owners, contractors, and masons. Key informants' interview to the focal engineer and ward chairman was conducted on compliance of the national building code in the private housing reconstruction of IRM. Similarly, questionnaire survey was conducted among house owners, NRA technical personnel's, local contractors, EHRP consultants/engineers and Municipal technical personnel's.

3.5 Data Collection Instruments

Municipal records, building codes, bye-laws, legislative, literature reviews, questionnaire survey, KII were used as the data collection instruments to achieve the research objectives.

3.5.1. Household Survey

In order to identify causal factors of non-compliance, the household survey is administered. In IRM, till 2nd February 2021,422 houses were non-compliant out of which 167 buildings were selected as sample. The sample size was determined as:

The sample size was identified based on the following formula (Israel, 1992)

Where, n = Sample Size

z = 1.645 for 90% Confidence Level

p = 0.5, q=0.5, e = Margin of error, using 5% error margin

For N= 422

$$n=\frac{1.645^2*0.5x0.5/0.05^2}{1+ (1.645^2*0.5x0.5/ (0.05^2x422)}$$

n=167

For N=422, number of samples is 167.

The total sample size of 167 was further allocated to each ward based on **Proportionate Random sampling** method.

Table 3.1 shows the ward wise sample size.

Table 3.1: Sample size (Ward wise)

Wards of Indrawati Rural Municipality	Population	Sample	% Distribution
1	5	2	1.13
2	14	5	3.18
3	6	2	1.36
4	37	14	8.42
5	43	16	9.79
6	25	10	5.69
7	115	48	28.47
8	92	38	22.55
9	12	5	2.73
10	46	17	10.47
11	9	3	2.05
12	18	7	4.10
Total	422	167	100

3.5.2 Local contractors within the municipality

There are 50 numbers of Local contractors working in the reconstruction of above mentioned 167 houses.

The sample size is determined as: (Israel, 1992)

Where, n = Sample Size

z = 1.645 for 90% Confidence Level

p = 0.5, q=0.5, e = Margin of error, using 10% error margin

For N= 50

$$n=\frac{1.645^2*0.5x0.5/0.1^2}{1+ (1.645^2*0.5x0.5/ (0.1^2x50)}$$

n=28

For N=50, number of samples is 28.

Therefore, the representative sample size for the local contractors will be taken as 28.

Table 3.2: Sample size (Ward wise)

Wards of Indrawati Rural Municipality	Population	Sample	% Distribution
1	3	2	6
2	4	2	8
3	3	2	6
4	6	3	12
5	4	2	8
6	5	3	10
7	6	3	12
8	4	2	8
9	5	3	10
10	5	3	10
11	3	2	6
12	2	1	4
Total	50	28	100

3.5.3 Municipal engineers/ Technical professionals

There are 6 technical personnel, engineers/sub-engineer in the municipality and the researchers choose to study the entire population because the population size is relatively small and all of them were considered for questionnaire.

3.5.4 NRA engineers/ Technical professionals

NRA technical personnel here refer to the engineers/sub-engineers working within the municipality who were mobilized to facilitate the reconstruction of private housing with technical support by MoUD/CLPIU. All of them (i.e., total number 18) were considered for questionnaire.

3.5.5 EHRP Consultants/engineers

EHRP Consultants here refers to the engineers working within the municipality who were mobilized to facilitate the reconstruction of private housing. All of them (i.e., one senior engineer and four numbers of engineers) were considered for questionnaire and interview.

3.6 Data Analysis

After the collection, all primary and secondary data were carefully analysed and coded which was followed by data analysis to ascertain the magnitude of non-compliance and to identify causal factors of non-compliance of private housing reconstruction.

Both descriptive and inferential statistics are employed in the data analysis. In the analysis
The General ranking method is adopted to establish the relative importance of the contributing factors in the non-compliance of private housing reconstruction. Likert's scale of five ordinal measures of agreement towards each statement (1, 2, 3, 4 and 5) is used to calculate the mean RII for each factor that is used to determine the relative ranking.

For data analysis RII is used by following equation:

$RII = W / A*N \ (0 \leq RII \leq 1)$

Where: W – The weight given to each factor by the respondents and ranges from 1 to 5, (where "1" is "strongly disagree" and "5" is "strongly agree")

A – The highest weight (i.e., 5 in this case) and N – The total number of respondents.

3.7 Research Matrix

Table 3.3 Linking research questions with data collection instruments and analytical methods

S.N	Research Objectives	Data collecting tools	Method of analysis
1	To ascertain the magnitude of non-compliance and the contributing factors for the non-compliance of private housing reconstruction of IRM	• Municipal records, building codes, bye-laws, legislative and other related documents • Questionnaire survey • Key informant interview	• General ranking method i.e., RII
2	To identify the more responsible causal factor for boosting the non-compliance of private housing reconstruction of IRM	• Questionnaire survey • Key informant interview	• General ranking method i.e., RII
3	To assess the available technical support provisions towards building code compliance in the private housing reconstruction	• Questionnaire survey • Key informant interview	• Comparative analysis of questionnaire • Analysis of key informant interview.
4	To identify the source and level of household income and the constraints for accessing bank loan in the private housing reconstruction	• Questionnaire survey • Key informant interview	• Comparative analysis of questionnaire • Analysis of key informant interview.
5	To recommend the appropriate strategies for effective implementation of building code in the private housing reconstruction	• Questionnaire survey • Key informant interview	• Narrative Analysis based on theoretical framework,

CHAPTER 4
RESULTS AND DISCUSSION

This chapter deals with the analysis and discussion of the data gathered from the KII and questionnaire survey. It includes the identification of the magnitude of non-compliance and contributing factors for the non-compliance of private housing reconstruction and available technical support. Furthermore, it also

includes the description of the occupational profile of surveyed house owners with respect to their income and expenditure.Furthermore, it also includes the arrangement of additional amount and their level of access to bank loan for housing reconstruction. This chapter also elaborates the technical inspection guidelines for setting the context for technical assistance which is followed by municipal technical support mechanisms in the municipality.

4.1 Magnitude of non-compliance

4.1.1 Building typology

There are basically six building types: Stone Masonry in Mud Mortar (SMM), Stone Masonry in Cement Mortar (SMC), Brick Masonry in Mud Mortar (BMM), Brick Masonry in Cement Mortar (BMC), Reinforced Cement Concrete (RCC), Hybrid and building constructed with non-conventional construction materials.

Stone masonry is the most common type of buildings found in rural areas of Nepal. The stone units used in the SMM walls are from various nearby sources such as river (fairly round shaped), naturally fractured rocks and from quarry sites. The mud mortar used in the SMM wall construction is prepared from locally available soil. Most of the PRE-SMM buildings, traditionally constructed by local masons, are unreinforced and often built with un-coursed random rubble stone in mud mortar thus displaying poor tensile and shear strength. The SMM walls are usually thick (400–600 mm) and the wythes are not properly inter-connected using adequate amount of through thickness stones (Bothara et al. 2018). The number of stories varies from one to three and the storey height is typically low at about 2 m. The POST-SMM buildings also have 400-600 mm thick un-coursed random rubble stone masonry walls as in the PRE -SMM construction. Most of the POST-SMM constructions are single storeyed with one to two rooms only, although the NBC 203: 2015 code allows multi-storeyed construction of up to two storeys plus an attic floor. The storey height is typically low at about 2 m. The RC seismic bands are typically 75 to 100 mm deep (Fig. 4.1) and extend through the whole thickness of the SMM walls. The roof is mostly gable type and is made of a timber structure with light roofing material (corrugated iron sheet) (Fig. 4.1).

Fig 4.1: Stone masonry buildings in mud mortar

In brick masonry walls are load-bearing and bricks are either bonded with cement or mud mortar. Wall construction is double brick with no cavity and is normally 230mm or 350mm thick. The height of the building can be one-story or two stories depending on wall thickness. The floor system is usually mud on bamboo or timber joists (Fig. 4.2) and sometimes reinforced concrete (generally in urban areas). The roof structures are timber or steel with CGI or tiles in some cases, a sloped roof is built using RC slabs.

Fig 4.2: Brick masonry building in cement mortar.

RCC buildings are constructed by the cast in situ concrete columns, beams and slabs (Fig.4. 3). They have a brick wall or block wall as infill walls and can be non-engineered or engineered. There are two common ways to construct RCC buildings; the walls can be done first or the walls can come afterward. RCC structures are most prevalent in the urban area, but they are becoming more common in rural areas where access to engineering support and quality materials is limited.

Fig 4.3: RCC frame building

Hybrid structure (Mix structure) is the combination of two or more type of structural system that is generally constructed with different technology and materials in accordance with level of floor. The ground floor is constructed by masonry structure and the first floor by timber or steel frame structure with lightweight such as CGI sheet or wooden planks as shown in fig 4.4. The masonry structure at ground floor shall consist of all the earthquake resistant elements such as horizontal and vertical bands. R.C. or wood both can be used to construct these bands, but it shall be compliant with the respective minimum requirements. The first floor shall be timber frame structure. Since, no any specific guidelines have been made till date, different construction technologies resulting from connection details to materials is used for construction of timber framed structures.

Fig 4.4: Hybrid structure with CGI covering at first floor

Besides SMM and BMC, there has been a construction of new type of structures like hybrid, light frame steel and timber, hollow blocks, CSEB blocks, confined masonry structures after they were introduced by NRA (NRA, 2017). RCC structures was third most preferred structure despite the increased cost as required, to transport construction materials which is also relatively new technology in rural areas. This might be due to the perception of people about safety of RCC structures as only few of RCC structures were damaged compared to other structure (NPC, 2015).

4.1.2 Non-compliance

One of the main NRA objectives is to build a multi hazard resilient community by providing socio-technical assistance and grants. Beneficiaries receive grants if their buildings are earthquake resistant. A structure is categorized as non-compliant if it does not comply with minimum requirements (MRs) set up by NRA. At first, a field technician checks compliance of building as per the minimum requirement and compliant houses are recommended for tranche payment the non-compliant houses are reported to the District Support Engineer (DSE) for structural analysis. For non-compliant houses, the house owner is obliged to implement DSE's improvement recommendations.

The households carry out vertical and horizontal extension after clearing off entire tranches which violate building codes. Fig. 4.5 shows the stone masonry building without gable band which is indispensable for building code compliance.

Fig 4.5: Stone masonry building with no gable wall

The gap between the top horizontal band and rafter/purlin is filled with two or three layers of masonry units with mortar. The masonry above band has very small height. It is also restrained by vertical elements on sides so failure is unlikely to happen in this zone (Exception).Similarly, Fig. 4.6 shows the non-compliant stone masonry building without sill band in attic level and improper band location.

Fig 4.6: No sill band in attic level and improper band placement

Horizontal bands and vertical reinforcement are required to take lateral load. Correction is provided as per exception and correction manual and structural analysis.

Fig 4.7 shows an example of noncompliance RCC building with 9''x 9'' column which makes it non-compliant. The minimum column size is 12''x 12'' with 12 mm reinforcement bars in compression member.

Fig 4.7: RCC building with 9x9 column

Table 4.1 reveals the non-compliant building typologies with their share.

Table 4.1Non-Compliant Building typologies with their share

S.N	Ward	BMC	SMM	RCC	Hybrid	Others	Percentage (%)
1	7	10	71	4	1	29	27.25
2	8	11	50	4		27	21.80
3	10	30	13		1	2	10.90
4	5	17	11	8		7	10.18
5	4	14	2	14	1	6	8.76
6	6	13	9			3	5.92
7	12	13		5			4.26
8	2	6	8				3.31
9	9	4	4	1		3	2.84
10	11	1	2	5		1	2.13
11	3	1	5				1.42
12	1		4		1		1.18
Total		120	179	41	4	78	422
Percentage (%)		28.43	42.41	9.71	0.94	18.48	100

Source: EHRP Survey, 2020

There were 179 non-compliant SMM houses out of the total 422 (EHRP Survey, 2020). Similarly, there were 120 BMC and 41 RCC non-compliant houses. Out of the total non-compliant cases, ward 7 has highest share (27.25 %) while ward 1 has the least (1.18 %). Noncompliance cases in load bearing structures are found to be higher than in RCC buildings. KII survey carried out with focal IRM engineer of concluded that the negligence of technicians and lack of awareness is the reasons behind the maximum non-compliance issues in ward 7. Similarly, the reason behind the noncompliance cases for RCC buildings is due to lack of trained mason for construction of RCC building in rural areas and field technicians submitted mostly RCC buildings to DSE for structural analysis. They provide solution of non-compliant masonry buildings as per Exception/Correction manual themselves. Table 4.2 shows major non-compliance issues in RCC framed structure.

Table 4.2 Major non-compliance issues in RCC framed structure

S. N	Non-compliance issues	No of house hold (X)	Percentage (%)
1	Column size less than M.R i.e., (9x9)	10	25
2	Aspect ratio > 3	7	17.5
3	Plinth area > 1000 sq. ft.	10	25
4	One bay building	5	12.5
5	More than 2.5 storey	8	20
	Total	∑X=40	100

As shown in Table 4.2 the major non-compliance issues were: column size (25 %), one bay building (12.5 %) least one. The reason behind the above non-compliance issues in RCC framed structures is poor mobilization of technical persons, lack of socio-technical awareness, and lack of trained mason for construction of RCC building in rural areas.

The Table 4.3 reveals the non-compliance issues in load bearing structure. Out of the total non-compliance issues, the occurrence of absence of horizontal and vertical bands is highest (23.61 %) whereas wooden post used for vertical reinforcement has the least incidences (6.94 %). The beneficiaries' perception of grant as reconstruction cost of their damaged house resulted the higher amount of non-compliance in load bearing structures. Inclusion of single room building in one of the 17 designs catalogue and invoking tight deadline for grant disbursement further prompted such non-compliance. Later, NRA issued circular on minimum requirements for single room house but it was too late. Some beneficiary also constructed single room house just to receive tranche as their previously reconstructed building was non-compliant.

Table 4.3 Major non-compliance issues in Load bearing structure

S. N	Non-compliance issues	No of household (X)	Percentage (%)
1	Absence of horizontal and vertical bands	85	23.61
2	Absence of roof band	68	18.89
3	Room size greater than M. R	51	14.17
4	Wooden post used for vertical reinforcement	25	6.94
5	Absence of gable band	35	9.72
6	Size of attic more than 3 ft.	32	8.89
7	Inappropriate wall size	36	10
8	Wooden band with attic	28	7.78
	Total	∑X=360	100

4.1.3Construction technology

Construction technology refers the methods and equipment used to build structures. Construction technology's two core elements are: building materials and construction techniques which are the issues deliberated in this section. Furthermore, construction costs are also dealt.

4.1.3.1 Construction materials

Most of the households use local construction materials like stone, mud mortar, timber, CGI sheet in their SMM houses. More than sixty one percent households used the local materials because of its availability and affordability. Construction materials and skilled masons are extremely scarce in the area, particularly with respect to the modern materials. Similarly, 38.92 % maintained that they used the modern materials like brick, cement, sand, aggregate, reinforcement for strength and durability. Irrespective of their opinion all respondents pointed out insufficiency of housing grant. Due to weak construction materials and inferior construction workmanship, the non-compliant houses are not earthquake resilience.

Furthermore Nepal in general going through rapid change in building typology particularly because of households' remittance income, increased accessibility to construction materials and technology due to increased road network (Bothara *et al.*, 2016). The motive for vertical expansion was triggered by increased land cost, rapid urbanisation, etc. Bothara further elaborates that the relatively better performance of RC frame buildings compared to low strength masonry buildings during the earthquakes, despite these being structurally deficient, has further reinforced the notion that RC frame buildings are the only building types

which are earthquake resilient. Furthermore, the RCC structures are believed to have enhanced social status. All these factors influenced towards RC frame buildings.

4.1.3.2 Construction techniques

Stone masonry is the most commonly used house construction technique. Stones are either bonded with cement or mud mortar. Walls are normally 14" or 18" thick and constructed in multiple wythes. Height of building are found one or two storeys depending on wall thickness, mortar used and type of horizontal band. Flooring is normally timber joist or bamboo with mud plaster and roof is generally constructed with rafters and CGI or tiles. Similarly, Brick masonry is also found in the study area. Bricks are either bonded with cement or mud mortar. Walls are normally 9" thick and flooring is normally timber joist or bamboo with mud plaster or RCC slab and roof is generally constructed with rafters and CGI or tiles covering. Furthermore, RCC buildings are constructed by cast in situ concrete columns, beams and slabs. They have brick or block walls as infill walls and can be pre-engineered or engineered. RCC structures are mostly found in urban areas with higher number of storey than other type of structures. Trend of construction of RCC structures in rural areas is taking momentum after the Gorkha earthquake.

4.1.3.3Construction costs

More than 47% respondents reported house construction cost ranges between NPR 5, 00,000(5,000 US $) to 600,000 (6,000 US $). Similarly, 36.52 % respondents reported that housing cost is in the range of NPR 450,000 (4,500 US $) to 5, 00,000(5,000 US $). Furthermore, 12.57 % households' cost ranged between NPR 8, 00,000(8,000 US $) to 9, 00,000(9,000 US $). Only 3.59% sample households mentioned that the housing grant was sufficient.

The cost of construction depends on the typology chosen by beneficiaries and location. The Stone Mud Mortar Masonry (SMM) was found cheapest and Reinforced Cement Concrete (RCC) was the most expensive one. The median cost is NPR 650,000 (6,500 US $). Costs range starts from 25,000 NPRs, a Hollow Concrete Block house at plinth level to 10,000,000 NPRs for construction of RCC houses in Kathmandu and Lamjung(Paudel et al., 2011).

4.1.4Magnitude of non-compliance

Four hundred twenty-two houses were identified as non-compliant cases in IRM (Oriental Consultants Global, 2020). The highest non-compliance caseloads were concentrated in ward number 7 (16.7%) whereas ward number 1 had less than 1%. Table 4.4 shows status of non-compliant houses in IRM.

Table 4.4Number of non-compliance houses according to the wards

Wards	Total number of households	Number of NRA beneficiaries	No of non-compliance houses	Percentage of non-compliant cases
1	788	785	5	0.63
2	808	792	14	1.76
3	675	653	6	0.91
4	942	931	37	3.97
5	958	943	43	4.55
6	631	619	25	4.03
7	707	706	115	16.28
8	491	485	92	18.97
9	543	524	12	2.29
10	842	839	46	5.48
11	505	504	9	1.78
12	962	791	18	2.27
Total	8852	8572	422	100

Source: Field Survey, 2021

4.2 Contributing factors for non-compliance

The contributing factors for non-compliance were derived through various surveys: Questionnaire, key informant interview and focus group discussion. NRA, EHRP technicians, house owners and contractors were the respondents. The outcome was analysed through Relative importance index (RII) method and is shown in table below. In the analysis the General ranking method is adopted to establish the relative importance of the contributing factors in the non-compliance of private housing reconstruction. Likert's scale of five ordinal measures of agreement towards each statement (1, 2, 3, 4 and 5) is used to calculate the mean RII for each factor that is used to determine the relative ranking.
For data analysis RII is used by following equation:

$RII = W / A*N \ (0 \leq RII \leq 1)$

Where: W – The weight given to each factor by the respondents and ranges from 1 to 5, (where "1" is "strongly disagree" and "5" is "strongly agree")

A – The highest weight (i.e., 5 in this case) and N – The total number of respondents.

4.2.1 Combined Ranking of Contributing Factors for Non-Compliance

Table 4.5 shows the overall ranking of each contributing factors of selected 218 number of respondents including house owners, contractors, NRA and EHRP technical personnel involved in the reconstruction and all contributing factors have RII value more than 50%, means all factors were responsible for the non-compliance of private housing reconstruction in IRM.

Table 4.5Overall Ranking of Contributing Factors for Non-Compliance

		Combine RII		NRA		EHRP		Contractors		House owners	
S. N	**Contributing factors**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**
1	Construction cost	0.929	I	0.8778	I	0.88	I	0.9	II	0.941	I
2	Inadequacy of Housing Grant	0.8986	II	0.7222	V	0.68	VI	0.9429	I	0.9169	II
3	Difficulty technological adoption	0.7266	III	0.7444	IV	0.8	II	0.7214	IV	0.7234	III
4	Lack of house owners' awareness	0.7055	IV	0.7556	III	0.8	II	0.7643	III	0.6874	IV
5	Ineffective NRA's monitoring	0.6406	V	0.6556	VIII	0.64	VII	0.6857	VI	0.6313	V
6	Lack of contractors' awareness	0.6119	VI	0.6556	VIII	0.76	V	0.55	X	0.6132	VI
7	Inadequate mason trainings and awareness campaign	0.5881	VII	0.4333	XI	0.48	X	0.7143	V	0.5869	VII
8	Inadequate supervision and inspection	0.5844	VIII	0.7778	II	0.6	VIII	0.6143	VIII	0.5581	IX
9	Houseowners' unethical practice	0.5641	IX	0.6778	VII	0.76	IV	0.6786	VII	0.5265	XI
10	Inadequate trained workers	0.5587	X	0.5	X	0.52	IX	0.5571	IX	0.5665	VIII
11	Inadequate manpower	0.5339	XI	0.7111	VI	0.4	XI	0.4643	XI	0.5305	X

4.2.1.1 Construction cost

The construction cost is found to be the most significant factor having first rank with RII=0.929 as shown in the table 4.5 and fig 4.8. As shown in the Table 4.5, there is consistency of ranking among NRA (RII =0.8778), EHRP (RII = 0.88), Contractors (RII = 0.9) and House owners (RII = 0.941). Higher level of construction costs affects housing affordability. Ability to pay indicates the financial affordability of housing with respect to occupants` income. Therefore, the problems in the study area are: unaffordability because of high construction costs, low-income level that they may not afford for better housing. Unemployment and poverty hindering their ability to afford.

4.2.1.2 Inadequacy of Housing Grant

Inadequacy of housing grant has secured second rank with RII=0.8986 as shown in the Table 4.5 and fig 4.8. There is consistency of the opinion among the house owners and contractors with RII = 0.9169 and RII = 0.9429.Correspondingly, there is consistency of the opinion among the NRA and EHRP with RII = 0.7222 and RII = 0.68. The technical personnel of NRA and EHRP were aware of the fact that the cash grants were provided to leverage for resilient reconstruction. However, beneficiaries took it as a compensation for losses which resulted in as the major challenges for post disaster reconstruction (Dangi, 2018). Dangi further explains that the amount provided by government is less than half to build the house because most of the beneficiaries have invested more than the seven lakhs for reconstruction of their house.

4.2.1.3 Difficulty in technological adoption

Difficulty in technological adoption is the third most contributing factors of the non-compliance having RII = 0.7266 as shown in the table 4.5 and fig 4.8. There is consistency of ranking among NRA (RII =0.7444), EHRP (RII = 0.8), Contractors (RII = 0.7214) and House owners (RII = 0.7234). The construction workforce in Nepal lacks knowledge on earthquake-resistant technology, in general, and traditional technologies and processes in particular (Bothara *et al.*, 2015). Bothara further elaborates that the building construction mechanism is mostly vernacular, non-formal, incremental in nature, and dictated by the affordability of the owners and local availability of construction materials. The government's financial assistance package comes with a precondition that the houses will incorporate earthquake resistant features but the beneficiaries do not have much knowledge about the modern construction techniques which deters them to adopt the modern construction technology.

4.2.1.4Lack of house owners' awareness

Lack of house owners' awareness have fourth rank with RII=0.7055. There is consistency of ranking among NRA (RII =0.7556), EHRP (RII = 0.8), Contractors (RII = 0.7643) and House owners (RII = 0.6874). In context of Nepal, most of the buildings constructed are generally owner-driven. They are constructed without the technical assistance of engineers/architects. But after the recent earthquakes, there seems to be increased level of awareness among the people regarding the construction of earthquake resistant buildings, but this awareness level is still not enough (Khadka, 2017). There are several pitfalls in the effective implementation of building code and bye-laws.

4.2.1.5Ineffective NRA's monitoring

Ineffective NRA's monitoring has fifth rank with RII=0.6406. There is consistency of ranking among NRA (RII =0.6556), EHRP (RII = 0.64), Contractors (RII = 0.6857) and House owners (RII = 0.6313).There does not exist an effective building monitoring and site enforcement mechanism for implementing and enforcing the building code - even in the Kathmandu Valley and municipalities, let alone in the rural ones(Sharma et.al, 2018).

4.2.1.6Lack of contractors' awareness

Lack of contractors' awareness has sixth rank with RII=0.6119. There is consistency of the opinion among the NRA and contractors with RII = 0.6556 and RII = 0.55.Correspondingly, there is consistency of the opinion among the EHRP and house owner with RII = 0.76 and RII = 0.6132.The building construction mechanism is mostly vernacular, non-formal, incremental in nature, and dictated by the affordability of the owners and local availability of construction materials. The most common construction materials in the earthquake-hit areas are non-engineered and traditional such as stone, mud, brick, timber whichare likely to continue in years to come. The contractors do not have much knowledge about these construction types and methods.

4.2.1.7Inadequate mason training and awareness campaign

Inadequate mason training and awareness campaignhas seventh rank with RII=0.5881. There is consistency of the opinion among the house owners and contractors with RII = 0.5869 and RII = 0.7143.Correspondingly, there is consistency of the opinion among the NRA and EHRP with RII = 0.4333 and RII = 0.48.construction artisans in the earthquake-hit areas are not formally trained (Daly *et al.*, 2017). Their skills are passed down from generation to generation, or learnt from other masters. Of course, a small number of craftsmen who have worked abroad or in cities of Nepal have got better experience in steel fixing, concrete, etc. Without formal training, newer techniques using modern materials cannot be introduced to craftsman and technicians at massive scale.

4.2.1.8Inadequate supervision and inspection

Inadequate supervision and inspection have eighth rank with RII=0.5844. There is consistency of the opinion among the EHRP (RII = 0.6), house owners (RII = 0.5581) and contractors (RII = 0.6143). The building codes/guidelines compliance rate of constructed houses has increased significantly in different areas of the Nuwakot district with an increase in socio technical assistance (Dhungel et al., 2019). This shows that technical supervision is one of the most important factors to ensure the safety of structures. Frequent visits to the site help in the timely identification of faults during construction ultimately achieving structural safety. So, it is necessary to know if the buildings have achieved the desired level of technical safety or not as per the judgment of experts working in their areas.

4.2.1.9Houseowners' unethical practice

Houseowners' unethical practice has ninth rank with RII=0.5641. There is consistency of ranking among NRA (RII =0.6778), EHRP (RII = 0.76) and Contractors (RII = 0.6786). The negligence of houseowners in the private housing reconstruction in order to receive their grant only contributes even more to the non-compliance.

4.2.1.10Inadequate trained workers

Inadequate trained workers have tenth rank with RII=0.5587. There is consistency of ranking among NRA (RII =0.5), EHRP (RII = 0.52), Contractors (RII = 0.5571) and House owners (RII = 0.5665).The construction workforce, in general, lacked knowledge of earthquake-resistant technology because it has never been considered as an integral part of general engineering education in Nepal. Moreover, construction artisans in the area are not formally trained (Sharma et al., 2018).

4.2.1.11Inadequate manpower

Inadequate manpower is the least significant factor having eleventh rank with RII=0. 5339. As shown in the Table 4.5, there is consistency of ranking among EHRP (RII = 0.4), Contractors (RII = 0.4643) and House owners (RII = 0.5305). About 2.2 million Nepalese youths are working in foreign countries (excluding India)

as migrant workers. It was predicted that the reconstruction effort would require some 10,000-skilled manpower that included engineers, foremen, masons, and carpenters - and another 40,000 semiskilled/ unskilled workers. Developing manpower on this scale is in itself a mammoth task. National Planning Commission's damage and needs assessment in 2015 estimated that only 20% of the needs of human resources could be met within Nepal's existing resources. Therefore, the phenomenon of migrant labour and the need to train and inform them was identified from a very early stage. However, unfortunately NRA has not proposed a rigid plan to train such a huge number of manpower required to accelerate the reconstruction. Many people can build their houses without financial support from the government and also are willing to build the house as soon as possible but are facing lack of manpower and do not know how to construct earthquake resistant building.

Figure below shows the bar diagram of overall ranking as per contributing factors

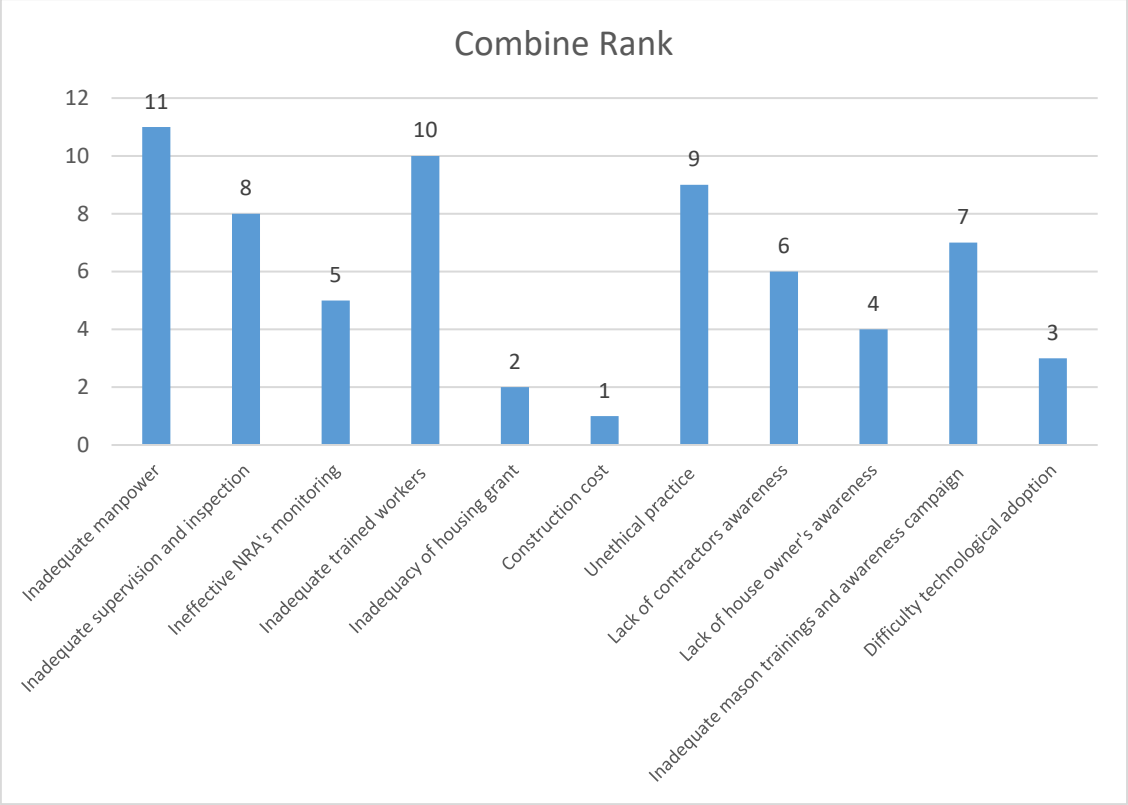


Figure 4.8 Overall Ranking as per contributing Factors

4.3 Source and level of household's income

4.3.1Sources of livelihoods in the IRM

Five different sources of livelihoods were identified in the IRM community viz., Agriculture and livestock, remittance, wage labour, service sector, and other shops and small business. Agriculture is natural resource-based livelihoods sources, while the rest form non-natural based livelihoods sources. Farming includes income from crops grown for own consumption or for sale and livestock. Income from crops was calculated by measuring the value of different crop products over one year period for each household. Income from livestock consists of two components: sale of live animals and livestock products either consumed or sold. Market prices or own reported values were used to estimate the income from farming. Wage labouring includes the off-farm activities for which the households are paid on an hourly or daily basis. In the survey, wage labouring includes both agricultural and non-agricultural labour. For non-agricultural labour, the adult male members of the family migrate temporarily outside the village during the dry season when there are no

agricultural activities to be done. Another important source of livelihoods for the IRM community is remittance from abroad, usually earnings through labouring in India and other countries like Israel and Malaysia. Wage labouring, skilled non-farm jobs and remittance involve temporary migration because there are very few earning opportunities at the local level. Next source of income for the community is the income from service sector and other shops and small business

4.3.1.1Agriculture and livestock

Most of the people (54 percent) are involved in agriculture and livestock in IRM as shown in table 5.1. Generally, people have subsistence agriculture. However, the crop production depends upon the land size, elevation and availability of irrigation facility. Major cereal crops of this rural municipality are paddy, maize, wheat, and millet. Similarly, potato, green vegetables, mustard, ginger, cardamom and orange are main cash crops in this area. In addition to household consumption, the surplus food grain is sold in the village or market centre. Cash income is generated from potato farming, vegetable farming and production of cash crops apart from the cereal crops.

The livestock is another integral aspect of rural livelihood in this area which is the second important economic activity. Possession of land or livestock defines and reflects both wealth and social status of people. The household with livestock has their daily activity revolved around their animals, from feeding fodders, cleaning their sheds, milking, to grazing, etc. Although, every member indirectly involves for raising animals, household head or some dedicated family member is in-charge of looking after the cattle in their house. In few household people are hired from outside for animal husbandry. Cattle are mostly used for ploughing their farmland. Animal's waste has been used as a fertilizer in agricultural field. Similarly, animals are the vital source of nutrition providers-milk, meat, etc. for the families.

More than 59% of the total 9950 ha of land is cultivable (CBS, 2011). Land is the major assets people want to invest and own in IRM. Holding large area of land has higher social and economic value in the village. Basically, people's status is determined by the land they are possessing. It is due to opportunity to cultivate multiple crops and in large volume which eventually gives high returns. Table 4.6 shows that 37 percent of household has less than 3 ropani of land in the rural municipality. Similarly, 11 percent owns more than 16 ropani of land. Similarly, 28 percent does not have any of the agricultural land for cultivation particularly. The people of Indrawati rural municipality have sizable numbers who are engaged in different income generating activities other than agriculture.

Table 4.6 Land holding in Ropani (1 ropani = 508.74 sq. m)

VDC	Category	Without land	Less than 3	3 to 7	8 to 11	12 to 15	16 above
Indrawati Rural Municipality	land	25	33	11	4	7	10
	Total beneficiaries	90	90	90	90	90	90
	Percent	28	37	12	4	8	11

Source: Field survey, 2021

Most of the farmers have small land holding size. The dominant crop produced is cereal. The total of 135 metric ton of cereal crops were produced in surveyed household. Where, paddy was the leading crop produced with 44 percent of the total production followed by maize 24 percent, millet 18 percent and wheat 10 percent as shown in table 4.7. Although, paddy is the major cereal crops to be cultivated, 24 percent of household produces less than 100 kg. Similarly, 28 percent of household produces between 101 to 500 kg of paddy. Only a few (2 percent) households produce more than 2000 kg. Other cereal crops also have similar figure. Likewise, 52 percent of household produces below 100 kg of wheat and for maize and millet 29 percent of household produces less than 100 kg.

Table 4.7: Cereal crop production in Indrawati Rural Municipality

Production in KG	Paddy HH no	Paddy %	Wheat HH no	Wheat %	Maize HH no	Maize %	Millet HH no	Millet %
Less than 100	22	24	47	52	26	29	26	29
101-500	25	28	31	34	42	47	42	47
501-1000	18	20	5	6	13	15	13	15
1001-1500	14	16	4	5	3	3	3	3
1501-2000	9	10	1	1	4	4	4	4
2000 above	2	2	2	2	2	2	2	2

Source: Field Survey 2021

Cereal crops are the major food for the subsistence needs of family but people have been involved in commercial farming specially vegetables farming. Households having the road access are involved in seasonal and off seasonal vegetable farming as well as high value cash crop such as cardamom, ginger where they have access to market for sale.

Development of road networks and expansion of market centres have played a key role on changing the agricultural pattern. Such case was observed in eastern hill of Nepal after construction of road in 1987–88 especially in Dhankuta when it was connected with Terai (Koirala, 2008). As a result, potatoes and other green vegetables are cultivated more in Nawalpur. Mustard is grown in all VDCs but most of the production is just for household consumption.

Table 4.8 shows the average income of agriculture, vegetables and livestock products in different categories.

Table 4.8 Average Annual Household Income from Livestock, Agriculture Products

Sources of income	Land and livestock's	Indrawati Rural Municipality	
		Income (Rs)	Percent
	Less than 3 ropani and 3 to 4 animals	1,40,000	12
	3 to 7 ropani and 5 to 6 animals	1,85,000	15
	8 to 11 ropani and 7 to 8 animals	2,35,000	19
	12 to 15 ropani and 8 to 9 animals	2,75,000	22
	16 above and more than 10 animals	3,18,000	25
	Total	13,85,000	100
	Mean income	2,30,833	

Source: Field Survey 2021

4.3.1.2 Remittance

Remittance has become an integral livelihood component in Indrawati rural municipality. According to the field survey 18 percent of surveyed households were remittance earner. Of the total sampled household 53 percent worked in Gulf Countries, 30 percent in India with 17 percent in Malaysia as shown in table 4.9.

Table 4.9: Household Level Average Annual Income from Remittance

Sources of income	Country	Number of beneficiaries	Percentage	Indrawati Rural Municipality	
				Income (Rs)	Percent (%)
Remittance	India	9	30	420000	19
	Malaysia	5	17	860000	38
	Gulf countries	16	53	973000	43
	Total	30	100	22,53,000	100
	Mean income	7,51,000			

Source: Field Survey, 2021

Gulf Countries (53%) are the major remittance supplier nations in surveyed household. Similarly, Malaysia and India also contributed equal in total remittance. As informed by the participants of FGDs, rural youths are attracted for employment towards the gulf countries where earning level is high as shown in table 4.9. Not only in Indrawati rural municipality, but also most of the rural areas in Nepal, remittance has become main base of livelihood in these days. Koirala (2010) found that more than one-third of the total households are dependent upon remittance for livelihoods in the eastern hill district Dhankuta. In the similar way, almost half of the surveyed households belong to remittance-based livelihood (Koirala, 2011) in rural areas of Dolakha.

4.3.1.3 Wage labour

Families without proper source of income are engaged as wage labour. People are engaged as wage labours in both agricultural and non-agricultural sectors. But most of them are engaged in non-agricultural sector. During the planting and harvesting season people work as agricultural labour in own field and barter their labour with their neighbours locally known as Parma system. During non-agricultural seasons people get engaged in construction, transport, sectors in their neighbour settlements.

4.3.1.4 Service sector (Government / Private Job)

Some people involve in service sector. Having good educational background, Brahmin, Kshetri and Newar people involve in service sector with the uniform source of income. They work in school, army, police and NGO.

4.3.1.5 Other (shops and small business, etc.)

Agriculture supply stores such as fertilizers, pesticides, hybrid seeds have absorbed some business people. The demand of such farming goods had inspired people to open shops to sell these goods in the rural areas together with collection centre for food grains, dairy, grocery shops are other business activity people have opted. Along with urbanization drive hospitality, construction and electronic business have also been growing.

4.3.2Diversification of livelihood sources

It was found that the entire households depended on two or more sources for their livelihoods. Thus, livelihood diversification is common among the IRM community. Activity portfolio of the sampled households was analysed to observe the patterns of combination of livelihood sources. Three broad groups of livelihood strategies have been identified based on the number of livelihood sources the households depend upon. Altogether, 12 different patterns emerge from the analysis, which is given in Table 4.10. Farming is the mainstay of the livelihood, as it forms one of the components in all the livelihood patterns. It can be observed that gross annual household income is the lowest for the group with only two livelihood sources, and the income increases with the combination of more livelihood sources. Overall, the lowest income is NRs. 3, 74,833 for the combination of farming and wage labouring, and the highest is NRs. 14, 57,833 for the combination of four livelihood sources including agriculture, remittance, service sector and shops and small business. From Table 4.10, it is evident that the annual income from the livelihood strategies having remittance as one of the components is higher within each group and also higher than the aggregate mean income. This implies that, remittance is comparatively more remunerative livelihood sources.

Table 4.10: Gross Annual income of diversification of livelihood sources

Livelihood	No of	Gross annual income/	Annual	Savings	NRA grant	Average	Surplus

strategies	households	HH (NRs)		expenditure/ HH (NRs)	(x) (NRs)	(y) (NRs)	construction cost of house (z) (NRs)	amount ((x+y)-z)) (NRs)
Two sources	Frequency	Mean	SD					
Agriculture, Remittance	15(8.98)	9,81,833	2,19,107	1,44,000	8,37,833	3,00,000	6,50,000	4,87,833
Agriculture, wage labour	27 (16.16)	3,74,833	1,56,758	1,44,000	2,30,833	3,00,000	6,50,000	-1,19,167 (deficit)
Agriculture, shops and small business	15 (7.18)	4,46,833	74,012	1,44,000	3,02,833	3,00,000	6,50,000	-47,167 (deficit)
Agriculture, service sector	20 (11.97)	4,90,833	43,174	1,44,000	3,46,833	3,00,000	6,50,000	-3,167 (deficit)
Sub-total	77 (44.29)	382532						

Livelihood strategies	No of households	Gross annual income/ HH (NRs)		Annual expenditure/ HH (NRs)	Savings (x) (NRs)	NRA grant (y) (NRs)	Average construction cost of house (z) (NRs)	Surplus amount ((x+y)-z)) (NRs)
Three sources	Frequency	Mean	SD					
Agriculture, Remittance, shops and small business	12 (7.18)	11,97,833	1,07,750	1,80,000	10,17,833	3,00,000	6,50,000	6,67,833
Agriculture, Remittance, wage labour	28 (16.76)	11,25,833	1,17,695	1,80,000	9,45,833	3,00,000	6,50,000	5,95,833
Agriculture, wage labour, shops and small business	12 (7.18)	5,90,833	1,51,075	1,80,000	4,10,833	3,00,000	6,50,000	60,833
Agriculture, service sector, shops and small business	7 (4.19)	7,06,833	77,608	1,80,000	5,26,833	3,00,000	6,50,000	1,76,833
Agriculture, service sector, wage labour	7 (4.19)	6,34,833	1,01,056	1,80,000	4,54,000	3,00,000	6,50,000	1,04,000
Sub-total	66 (39.5)	9,45,136	5,55,185					

Livelihood strategies	No of households	Gross annual income/ HH (NRs)	Annual expenditure/ HH (NRs)	Savings (x) (NRs)	NRA grant (y) (NRs)	Average construction cost of house (z)	Surplus amount ((x+y)-z)) (NRs)

							(NRs)	
Four sources	Frequency	Mean	SD					
Agriculture, Remittance, shops and small business, service sector	7 (4.19)	14,57,833	99,619	2,40,000	12,17,833	3,00,000	6,50,000	8,67,833
Agriculture, Remittance, wage labour, shops and small business	12 (7.18)	13,41,833	48,407	2,40,000	11,01,833	3,00,000	6,50,000	7,51,833
Agriculture, wage labour, service sector, shops and small business	5 (2.99)	8,50,833	1,92,863	2,40,000	6,10,833	3,00,000	6,50,000	2,60,833
Sub-total	24 (14.36)	12,73,375	340888					
Aggregate	167 (100)	1,02,00,996						

Source: Field survey, 2021

Note: Figures in parenthesis indicate percentage

HH: Household; NRs. = Nepali Rupees; 119 NRs. = 1 US$; n = number of households; SD: Standard Deviation

Among all the livelihood strategies, combination of three livelihood sources forms the most dominant livelihood strategy, out of which combination of agriculture, remittance and wage labouring, is the most common diversification strategy followed by nearly 17 % of the households. In fact, wage labouring is not simply alternative options, but is integrated into the livelihood of IRM community. During the dry seasons, when there are few agricultural activities in the village, Communities undertake wage labouring to fulfil the consumption needs, for which they temporarily migrate outside the village for jobs like carrying loads, working in stone quarries, and road constructions. IRM's communities also depend on shops and small business for their livelihood. Apart from that, service sector is an important source of income especially during the lean periods. However, income from this particular combination is the lowest within this group and is lower than the aggregate average annual income. This shows that the majority of IRM's community is dependent on less remunerative livelihood strategies earning comparatively lower returns. This implies that the households are constrained from choosing more remunerative non-farm livelihood options, and are compelled to continue depending on these livelihood sources due to lack of formal education, vocational training, citizenship certificates, capital for investment, and lack of non-farm opportunities. As a result of low level of education, they are unable to pursue salaried jobs, or go abroad for foreign employment as they are unable to follow the necessary official procedures required.

Land is the most important asset for any rural community. Land can be used as a liability to obtain loans for investments in more remunerative options, but for that land need to be registered. However, more than 25 % of the sample households do not possess registration certificates for the lands that they cultivate, partly because of lengthy official procedures, and partly because of faulty government policies which registered only permanently cultivated lands thereby excluding the lands under shifting cultivation practices. Unregistered lands cannot be used as liabilities to obtain loans for further investments. Livestock is next important asset for the communities in IRM. However, most of the households belong to small-holders' category owning less than 5 livestock units, so that they rarely make extra income that can be saved or used for further investments. The livelihoods of IRM'S community are thus constrained from choosing a more remunerative option by many interacting factors like low educational attainments, low asset possession, unfavourable government policies, and lack of access to land registration certificates.

4.3.2.1Sources of loan

The identified beneficiaries whose surplus amount is deficit derived the loan through formal and informal sources to construct the house. Formal sources are those that are licensed and supervised by NRB and comprise commercial banks, development banks, micro-credit development banks, savings and credit cooperatives, and microfinance NGOs. Informal sources are relatives, friends, money lenders, traders and (Unlicensed) Savings and credit cooperatives (Table 4.11).

Table 4.11: Category of the sources of loan

S. N	Source	Type	No of beneficiaries	Percent
1	Formal	All banks licenced by NRB	9	19
2	Informal	Money lenders, traders, families and relatives, self-help groups, (Unlicensed) Savings and credit cooperatives etc.	38	81
Total			47	100

Only 9 respondents, out of 47 (19 %) responded that they raise the extra fund for the construction of their houses through formal sources and mention 15% interest on their borrowed amount. Many had to travel long distances and spend thousands of rupees to reach bank branches. Often, they had to wait for several days before being able to withdraw the money due to long queues or the fact that while bank accounts had been opened, the cash had not yet been deposited in them. Others found they could not access their accounts due to inconsistencies in the spelling of their names in their grant agreement, bank account documents, and citizenship certificates. The respondents added that the level of access to bank loan is too poor in terms of number of BFIs in IRM and the procedure for obtaining loan is too troublesome and difficult. Similarly, 38 respondents, out of 47 (81 %) responded that they raise the extra fund for the construction of their houses through informal sources and mention 22 to 24 % interest on their borrowed amount. They also added that due to the poor access to bank loan they had compulsion to take loan from such informal sources on high interest and submission of citizenship certificate and photograph is adequate for the loan with no collateral at all.

4.3.2.2 Policy & Provision of Concessional Loans for the Earthquake Beneficiaries

The role of BFIs was substantial in the time of the disaster and emergencies in providing the access to the financial services. Banking sectors has played a major role in transferring cash grants for the eligible victims through the banking channel mitigating various financial risks. The NRB issued the refinance policies in the aftermath of the devastating earthquake of April 2015 to facilitate the reconstruction of privately owned houses. At the initial stage, the amount of loans was fixed as NPR 2.5 and NPR 1.5 million in Kathmandu valley and outside the valley respectively. The beneficiaries could borrow money from BFIs at two percent interest per year and no other charges. That financial assistance loan provisions for private housing reconstruction were discontinued and superseded with the new policy, as the GoN launched new Act “The Unified Procedure of Interest Grant for Concessional Loans, 2075 (2018)” targeting to support the disaster-prone victims in accessing the loan in subsidized rate from the BFIs. Under this provision, maximum amount of the loan NPR 300,000 is to be offered to the earthquake beneficiaries for completing the private housing reconstruction endeavours. According to the NRB, Current Macroeconomic and Financial Situation of Nepal (based on Eight Months as of FY 2019/20) the outstanding refinance extended to BFIs for providing concessional housing loan (1.5 million & 2.5 million) to1, 592 earthquake victims stances at Rs.1.53 billion. Whereas,172 earthquake beneficiaries utilized the loan for NPR 300,000 under the Loan extended under " The Unified Procedure of Interest Grant for Concessional Loans, 2075 (2018)".

4.3.2.3Eligibility Criteria for Concessional Loan

The identified eligible beneficiaries, who have signed an agreement with the local bodies to avail government's grant to reconstruct private houses, but have not received or applied for the second tranche of the grant and been unable to start reconstruction due to lack of adequate funds, can apply for subsidized credit worth NPR 300,000. The loan will have a payback period of five years and five percent interest rate subsidy on the interest rate charged by the BFIs. However, the BFIs can charge two percent premium on their base rate as an interest. Likewise, the Guideline has also clarified the collateral provision required for providing such loan to the earthquake beneficiaries. BFIs are supposed to provide loan against the collateral of their houses without considering the present housing structure.

4.3.2.4 Access to the financial services to the Earthquake Beneficiaries

To ascertain the access to financial services prior to the earthquake and till date, as per NRB data illustrates that there has been a significant increase in the Bank's branch network and services expansion as shown in table 4.12.

Table 4.12: Access to Financial Services in Sindhupalchok District:

S.N	Bank/BFI Networks as of Poush 2071 (Mid-Jan 2015)			Total no of BFIs	Bank/BFI Networks as of Baisakh 2078 (Mid- May 2021)			Total no of BFIs	BFIs branch increased/decreased
	Class A	Class B	Class C		Class A	Class B	Class C		
1	20	9	1	30	37	10	-	47	17
Source: NRB Banking and Financial Statistics Poush 2071(Mid-Jan 2015)/NRB Banking and Financial Statistics Baisakh 2078(Mid-May 2021)									

The data analysis of the Number of Bank/BFI branches has been assessed to ascertain the trend of BFIs outreach in Sindhupalchok district with comparisons pre-earthquake scenario as per the Table 4.12 portrays there were total 30 number of BFIs branches, however post-earthquake scenario there has been an augmentation to total 47 number of BFIs branches, as a result substantial increment overall 17 number of Bank/BFIs branches networks. This might also draw out the result that the NRA's private housing initiatives of transferring the cash grant through BFIs, also contributed in enhancing access to financial services as per the GoN and NRB's envisioned strategies to expand financial inclusion in Nepal and in particular to the deprived rural population.

Furthermore, out of the surveyed beneficiaries, only 35.32 percentages of beneficiaries already held a bank account. However, 64.68% of beneficiaries opened new bank account to receive the cash grant as shown in table 4.13. Moreover, opening of the account is mandatory to receive the government's housing grant.

Table 4.13: Beneficiaries Responses Analysis in IRM

S.N	No of total Surveyed Beneficiaries	Previous bank Account	Easy Access/Services from Bank	Money saved in bank account	Concessional Loan Recipient
1	167	59	75	33	0
Percentage out of total surveyed beneficiaries		35.32	44.91	19.76	0

Source: Field Survey 2020

The above Table 4.13, data also depict that the earthquake beneficiaries' access to financial services outreach through the opening of the bank account has been tremendously increased due to the reconstruction momentum. Likewise, out of the total surveyed beneficiaries, 44.91% of beneficiaries seem to have received appropriate services from the concerned BFIs. Conversely, there seems to be a nominal trend to save money in the bank account, this might be due to the limited government cash grant provided as a result the funds are been utilized towards the private housing reconstruction endeavours. None of the respondents received the concessional loan facilities in IRM. The respondents added that the level of access to bank loan is too poor in terms of number of BFIs in IRM and the procedure for obtaining loan is too troublesome and difficult. All of

the interviewed local representatives stated that although some of the beneficiaries were aware about the concessional loan facilities, the implementation is not effective as expected due to less instigation by the BFIs and the perceived notion of arduous and extensive banking procedures to obtain loans.

4.4 Available technical support provisions

4.4.1 Site topography and geology

Site topography and geology are determinants of housing safety which requires site engineer's guidance to homeowners. The site must be safe from earthquake induced landslides and floods.

4.4.2 Confirmation of Site selection and Layout

During the building construction period, the inspector should certify that the site from geographical and geological considerations as shown in table 6.1.In addition, the beneficiaries can seek inspector's assistance for layout of the house construction.

Table 4.14: Confirmation of Site selection

(NBC 202 Checklist)					
S. N	Category	Description	Comply to MRs		Remarks
			YES	NO	
1	Site selection	Geological fault or Ruptured Area	☐	☐	
		Steep Slope > 20°	☐	☐	
		Landslide susceptible Area	☐	☐	
		River bank and Water-logged Area	☐	☐	
		Rock-fall Area	☐	☐	
		Liquefaction susceptible Area	☐	☐	
		Filled Area	☐	☐	

A housing site, as indicated in table 4.14, must be free from geological fault which triggers massive avalanches after rainwater loosens inner masses. The building site with more than 30^0 is susceptible for landslide as natural forces act to maintain degree of repose. There can be other factors which may induce landslide such as underground water, old landslide in the vicinity etc. River banks are incessantly pummeled by river currents making such areas vulnerable for erosion. The hazardous rock falling areas can damage housing structures and cause fatality. The geological formation of liquefaction and foundation on embankment may trigger settlement inducing subsidence and causing cracks due to differential settlement. Housing sites of such characteristics must be avoided and the inspector is expected to advise to the owner.

4.4.3Technical Inspection Guidelines for Housing Reconstruction 2073

The technical inspection guidelines ensure house's resilience against the earthquake force. Adherence of technical criteria which is administered through technical supervision through trained human resources is essential. The Nepal Rural Housing Reconstruction Program (2016) supports beneficiaries with socio-technical assistance; training and market facilitation. The NRA provided housing grants in three tranches which was intended to ensure housing resilience. Ultimately the designated competent authority appraises the building for its compliance to the Nepal's National Building Code (NBC). The successful houses are granted completion certificate.
The technical inspection guidelines have mandated three major milestones for ensuring earthquake resilience: first inspection – plinth level; secondinspection – roof band level and third inspection – after completion.

4.4.3.1. First Inspection - Plinth Band

The RCC, timber, Bamboo or other approved construction material are used as the plinth bands which are also known as DPC Band locally.After signing the grant distribution agreement a beneficiary may seek technical support to construct the foundation. Upon receipt of such request, the concerned VDC or municipality informs arrival date of a technician team to the construction site. It is the beneficiary's responsibility to comply with the technical team's feedback which is guided by the technical inspection sheet. The check list delves around plinth band and requirements in foundation.
Certification of compliance up to plinth band would enable beneficiary to claim the second tranche. However non-compliant beneficiary receives correction order which the beneficiary is expected to adhere.

4.4.3.2. Roof level

Beneficiaries can construct their houses after the certification of plinth level from the designated technical team. Beneficiaries can seek technical assistance for the the construction of super structure. After completion of the roof band of one story and the first floor of the multi-storey house, beneficiaries should request for the second inspection. Inspection is conducted as per the technical inspection sheet. Technical requirements of walls, doors and windows, and horizontal bands are assessed in the technical inspection. The compliant houses are eligible for the third tranche and non-compliant houses are subject to implement correction measures.

4.4.3.3. Construction Completion

Ultimately, the Technical Inspection Team should inspect the house in accordance to the mandatory requirements before issuing the completion certificate. Mainly technical requirements of walls and roof are verified. The compliant houses receive completion certificate and non-compliant are expected to implement corrective measures.

4.4.4 Adequacy of technical staff

There were 32 technical staff in the FY 2073/74 and 2074/75. Similarly, 31 and 24 technical staff was available in the FY 2075/76 and 2076/77 and 18 in the FY 2077/78 as indicated in Table 4.15. In FY 2073/74, there were 141 houses under the responsibility of one technician for the total inspection. The situation deteriorated further in FY 2074/75 and one technician was responsible for 277 houses. In the subsequent year of FY 2075/76 and FY 2076/77, FY 2077/78, one technician was responsible for 193, 189 and 98 houses respectively. Further, comparing the supply of technicians with the demand, severalgaps were identified in the number of technicians in each fiscal year during the reconstruction.Meaningful inspection would have been extremely challenging under such circumstances and housing compliance was compromised with paucity of technicians.

Table 4.15: Number of technical staffs versus total inspection per year

Particular	Indrawati Rural Municipality				
	FY 2073/74	FY 2074/75	FY 2075/76	FY 2076/77	FY 2077/78
Total beneficiaries	8584				

First inspection	2123	3260	1575	1100	500
Second inspection	1580	2950	1975	1453	600
Third inspection	820	2660	2425	1990	663
Total Volume of inspection	4523	8870	5975	4543	1763
Demand					
No of houses constructed at a time during maximum working season (45 days)(Sept/Oct)	600	780	720	360	200
Required no of inspection for each house	3	3	3	3	3
Required no of technical persons	40	52	48	24	13
Maximum working season (i.e.45 days) (Assuming 15 days gap for each inspection)	45	45	45	45	45
Supply					
No of existing technical persons	32(deficit)	32(deficit)	31(deficit)	24 (neutral)	18 (surplus)
No of total inspection in per year	141	277	193	189	98

4.4.4.1Identification of the motivational theme

In the municipality, the presence of technical person is almost negligible, and the head mason lead the overall construction process but their presence during ongoing construction stage is still very less. Lack of clarity on duties and responsibilities, working with the local bodies and unresolved issues relating to salary led to picketing and mass protests which halted on going housing construction. Provision of vehicle enhances' morale and bolsters efficiency in movement. All of 18 NRA technical personnel were dis-satisfied with their pay and the working environment which was further confirmed by the KII. Having inaccessibility caused by topographic constraints and sparse settlement pattern, it takes more than 3 hours to travel from municipal ward to the construction site. Many of the areas are totally cut off during monsoon making house inspection an impossible task.

4.4.4.2 Supervision in each stage of construction from technical personnel

Generally, the supervision from the technical personnel is carried out on 3 stages.

First Stage: Temporary permit up to plinth level

Second stage: Permanent building permit, for the superstructure

Third stage: Issuance of the building completion certificate

Table 4.16 Supervision from the technical team

S. N	NRA technical personnel = 18			Contractors = 28			House owners = 167			EHRP technical personnel = 5		
	I	II	III	I	II	III	I	II	III	I	II	III
1	6	6	6	5	10	13	17	85	65	1	1	3

I: Regular II: On call III: As per requirement

(Source: Field Survey, 2021)

From the total respondents of NRA technical personnel, 6 of them claimed they carry out the supervision of construction site on regular basis, 6 of them responded about conducting the supervision on call and rest 6 of them said as per requirement. Out of 5 EHRP technical personnel, 1 of them responded that the supervision work is conducted on regular basis, 1 of them responded about conducting the supervision on call and rest 3 answered supervision of construction site as per requirement. Among 28 contractors, 5 claimed about

conducting the regular supervision, 10 responded on call supervision and rest 13 of them said about supervision as per requirement. Similarly, as per the view of 167 house owners, 17 of them said that the NRA technical team visits the site for supervision purpose on regular basis, 85 answered supervisions on call and remaining 65 responded supervision was conducted as per requirement.

From the analysis of the result, it was found that the supervision of construction site from technical personnel was not effective and sufficient. The construction site lacks the frequency of supervision from the technical personnel in each stage of construction.

4.4.4.3 Role of local governments in reconstruction process

In Nepal, municipalities are the responsible agencies to issue building permits and the current municipal building permit process does not ensure the compliance of NBC (Giri, 2013).Local governments are among the most important for ensuring building resilience. Generally, reconstruction is not of high priority for the local governments. Local governments were more focused on infrastructure development than reconstruction. There are various factors which may explain why local governments did not take ownership of the reconstruction process: 1) Their authority over, and budgets for, reconstruction have been very limited; 2) They have other pressing responsibilities and their capacity and resources are already stretched. KII conducted with the ward chairman illustrates that the mmunicipality still lacks effective and enforceable mechanisms to monitor the presence of technicians in the field. Monthly salary would be released to the technicians on the basis of daily attendance manually rather than electronic attendance mechanism.

4.4.4.4 Provision of technical support and their competency

NRA recruited huge number of technicians and deployed them in the 14 worst affected districts to support reconstruction of damaged houses. Most of the recruits were fresh graduates of civil engineering and architecture with no field-based work experience. They were assigned the task of surveying the enrolment of eligible households in the affected districts. The recruits did receive two days of basic training on the organizational structure of NRA, procedural details for enrolling and disbursing grants to households, earthquake resistant construction technology and housing designs, and standard and minimum requirements for construction. However, this training has not been enough. Understanding how to accommodate for changes in sub-surface geology requires specific expertise, knowledgeable supervision, and technical backstopping. In addition, helping affected families reconstruct their homes requires the ability to communicate with the families and an understanding of local needs and priorities .This lack of experience along with the messy field environment has made things harder.

4.4.4.4.1 Technical Personnel Trainings on NBC

Trainings help to develop the skills and knowledge. For the effective implementation of building code and bye-laws relevant trainings to the technical personnel are necessary.

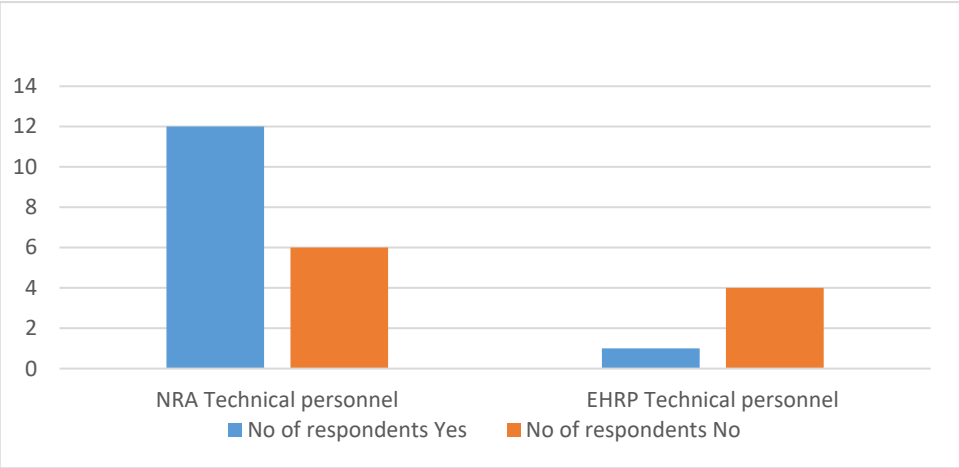


Figure 4.9 Technical personnel with trainings on NBC

The figure 4.9 represents that out of 18 NRA technical personnel, 12 of them have received the relevant trainings on NBC and rest 6 of them have not received any trainings on NBC. Similarly, out of 5 EHRP technical personnel only 1 of them have received trainings on NBC. Few respondents have received TOT trainings for earthquake safer construction and orientation trainings related to NBC.This result shows the technical personnel/engineers lacks NBC related competence.

4.4.4.4.2 Mason Training

For effectively implementing the seismic detailing and building code provision on site mason trainings are crucial as it helps to boost up the technical skills and knowledge of masons and contractors. From the series of questionnaire survey with the contractors and masons working on the building construction sites the result portrayed that only 64% of contractors/masons has received the mason trainings.

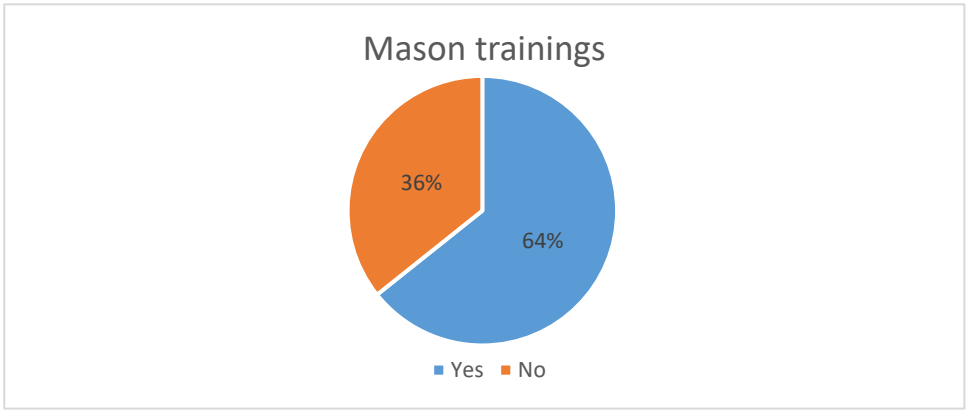


Figure 4.10 Contractors/masons involved in Mason training

Out of 28 contractors, 18 (64%) of them responded that they have participated in mason trainings and remaining 10 (36%) of them have not received any trainings till date.

From the result we can infer that the municipality lacks trained masons. Thus, concerned authorities should provide trainings to masons and contractor for the skill enhancement in earthquake safer construction.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

This chapter summarizes the overall study and has attempted to answer the research questions. The study limitations and a potential future research are also outlined. Ultimately, some recommendations are proposed.

5.1 Conclusion

This study aimed to identify magnitude of and contributing factors for non-compliance of the building standards in the post 2015 Gorkha Nepal earthquake reconstruction. Four hundred twenty-two houses were identified as non-compliant cases in IRM. The highest non-compliance caseloads were concentrated in ward number 7 (16.7%) whereas ward number 1 had less than 1%. It was found that the house construction cost, affordability and access to finance of affected households and inadequate technical assistance were the major contributing factors for non-compliance.

Construction cost and inadequacy of housing grant were the crucial factors for the non-compliance of private housing reconstruction. The financial constraint included affordability and poor access to finance.Technicians' delivery was not up to the desired level which was one of the principal reasons behind non-compliance.

The construction cost depends on the building typology. The Stone Mud Mortar Masonry (SMM) could be constructed in the lowest cost and Reinforced Cement Concrete (RCC) was the costliest one. The median cost was NPR 650,000 (650 US $). In other words, the people invested almost more than double the amount of the housing grant provided by the government.

The housing reconstruction program was owner-driven and the households had to manage the additional investment on the top of the GoN's housing grant. Beneficiaries' perception that the government grant as compensation rather than the leverage for constructing earthquake resilient housing caused non-compliance significantly.

This study identified five different sources of livelihoods in the IRM viz., agriculture and livestock, remittance, wage labour, service sector, and other shops and small businesses.Agriculture remains the major source of income but it was inadequate for their livelihood. It was found that the entire households depended on two or more sources for their livelihoods. The Gross annual household income is the lowest for the group with only two livelihood sources. Apparently, income increased with more sources of income.

The access to financial services through BFIs has been increased in the district headquarters as NRA channelled housing grant through banks which played a crucial role in enhancing the access to financial services. Since the average construction cost was more than twice the government grant amount, additional financing was required either from loans or using own money which forced them to manage the financial shortfall by seeking a loan from informal sources at a higher interest rate worsening the household' debt situation further. The borrowing households preferred informal sources despite higher interest rates because of the tedious process and collateral requirement for securing loan from formal sources. The collateral valuation of rural land was low, which was another reason for evading the formal financial institutions. Nobody received concessional loan as furnishing required documents was difficult. Having an easy access of funds through cooperatives, private lenders or other informal lenders, the earthquake affected households were exposed to extortion as rate of interest reaches to 22 to 24%, whereas the concessional loan interest would have been in the range of 8%.

A number of gaps were identified in the supply of technicians. Inadequate numbers of technicians were fielded and they were not motivated because of their job terms and conditions. Non-conducive working environment in the local bodies and unresolved issues relating to salary and other fringe benefits were major demotivating factors. Moreover, the technicians were not exposed to the National Building Codes and only

40% of contractors and masons received the mason training. Consequently, all of these factors collectively contributed to the non-compliance of the private houses in the reconstruction.

5.2 Recommendations

Although there are a number of implications of the conclusions that are drawn from this study, some major recommendations are proposed.

1. High construction cost was found to be one of the major reasons for non-compliance which can be lowered down marginally with efficient housing design and supply side administrative and facilitating interventions. Under the federal context, the IRM Municipality may consider commissioning a focussed study for devising appropriatelow-cost design with technical support from the Ministry of Urban Development. A growing tendency of using high-cost modern construction materials has risen the construction cost significantly which can be substituted with the low-cost local construction materials.

2. Intervention in supply chain also reduces the construction cost. Imperfect supply chain and profiteering tendency causing an artificial scarcity are the regular phenomena. Despite NRA's stern directives and mobilisation of local administration, the local merchants found some caveats which the IRM may consider handling with utmost priority. In addition, there could be some facilitating mechanism for example bulk purchase combining demand from the concerned households will create some scope for attractive price. In addition, scientific mining of sand, gravel, aggregate and removing cartels leads to lowered cost for which the IRM can play pivotal role.

3. For the non-compliant households with limited sources of income, the construction cost was high as it was beyond their affordability. This issue can be handled with increased level of income. Introduction of housing insurance could be one of the long-term solutions which will need federal government's facilitation. In the short term, the government promulgated offer of concessional loan was not functional which created doubted whether the announcement was for public consumption or was for resolving problem genuinely. The federal government may consider introducing concessional housing loan which is useful for rural people.

4. There was some inhibition with regard to the housing grant which beneficiaries perceived as low. Having limited fiscal space and necessity for ensuring equity, there was a legitimate reason for not offering more. In addition, government intended to create leverage for ensuring building code compliance with the grant which was never intended to be sufficient for house construction which requires the proper communication from government's behalf that was of limited supply in IRM.

5. In the federal context, the issue of non-compliance has to be resolved intrinsically by invoking building permit system where compliance to the building code is the major requirement. However, administrative measure alone will not bear fruition but technical hand holding has to go hand in hand which will lead to desirable destination. This will require adequate number of competent technicians in the municipality. In addition, there has to be proper buy in from the politicians. In retrospection, the NRA's strategy of fielding engineers could have been further effective with either enhanced administrative mechanism or with outsourcing through consulting companies who would have primary responsibility to ensure engineers' presence in their duty station.

5.3. Recommendations for Further Study

There are a number of pertinent studies which needs to be taken forward:
1 Cost effective housing designs adhering vernacular architecture
2. Scope for strengthening supply chain of the construction materials
3. Enhancing banking coverage in rural areas
4. Exploring possibility for increasing level of income among rural households
5. Viability of rural housing insurance policy

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