

**Indigenous knowledge and resources for Sustainable  
Livelihood approach:  
A comparative study of livelihoods of Sankharapur  
Municipality pre and post-earthquake**

A Thesis submitted to  
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Rural Development

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March 2019

## Declaration

I hereby declare that the thesis entitled “**Indigenous knowledge and Resources for Sustainable Livelihood approach: A comparative study of Livelihoods of Sankharapur Municipality pre and post-earthquake**” submitted to the Central Department of Rural Development, Tribhuvan University, is entirely my original work prepared under the guidance and supervision of my supervisor. I have made due acknowledgements to all ideas and information borrowed from different sources in the course of preparing this thesis. The results of this thesis have not been presented or submitted anywhere else for the award of any degree or for any other purpose. I assure that no part of the content of this thesis has been published in any form before.

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## **Letter of Recommendation**

The thesis entitled **Indigenous knowledge and Resources for Sustainable Livelihood approach: A comparative study of Livelihoods of Sankharapur Municipality pre and post-earthquake** has been prepared by **Mr. Sabin Shrestha** under my guidance and supervision. I hereby forward this thesis to the evaluation committee for final evaluation and approval.

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## Approval Letter

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The thesis entitled **Indigenous knowledge and Resources for Sustainable Livelihood approach: A comparative study of Livelihoods of Sankharapur Municipality pre and post-earthquake** submitted by Sabin Shrestha in partial fulfillment of the requirements for the Master's Degree (M.A.) in Rural Development has been approved by the evaluation committee.

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Sabin Shrestha

March, 2019

## Abstract

The modern perspective regards indigenous construction practices as primitive, undeveloped and backward. They may be valid if they measure quality of life on the basis of luxury. But if they measure it on the basis of happiness, wellbeing and pride then traditional buildings can be an alternative. Use of indigenous materials and techniques is one of the main features of vernacular building. Indigenous knowledge has been founded on principles and understanding acquired from long tasting and experience by our ancestors to enhance sustainable development endeavours. The main objective of the study entitled **“Indigenous knowledge and resources for sustainable livelihood approach: A comparative study of Sankharapur Municipality pre and post-earthquake.”** is to assess the relation between IK and resources and sustainable livelihoods on the basis of five assets of capital prepared by DFID.

Assessment of livelihood was based on field survey, observation, Interview and Focus Group Discussion where judgmental scoring method was applied. Structured and unstructured questionnaire tools were developed to collect data. It was developed on the basis of Sustainable Livelihood Framework Guidance Sheet. 40HH sample were chosen on random basis for questionnaire and interview was done to 8 local persons.

Indigenous buildings are less vulnerable to earthquake. The technology of using wooden sill and lintel band around the buildings makes indigenous buildings safer during earthquake. Thermal behaviour of indigenous buildings are good which makes least use of thermal appliance to the user of the building resulting in the low operational cost.

IK and resources also impact on socio-economic, environmental & cultural identity of building. Indigenous materials being entirely natural have no impacts on environment. The architecture of indigenous buildings are such that it offers maximum social interactions preserving its own cultural heritage.

As for sustainable livelihood development, indigenous materials have potential to evolve and to be adapted to contemporary needs, helping to reduce embodied energy and environmental impacts and revive cultural heritage. Therefore, this paper addresses indigenous knowledge and resources as a sustainable livelihood approach in the context of Sankharapur and recommended to develop policies like subsidizing tax on using indigenous materials and techniques encouraging local people to adopts such knowledge.

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## Abbreviations

BnB	Bed n Breakfast
DFID	Department For International Development
FGD	Fixed Group Discussion
HMG	His Majesty Government
IK	Indigenous Knowledge
IA	Indigenous Architecture
RCC	Reinforced Cement Concrete
SL	Sustainable Livelihood
SLF	Sustainable Livelihood Framework
SLA	Sustainable Livelihood Approach
SM	Sankharapur Municipality
UNDP	United Nations Development Programme
VOC	Volatile Organic Compound
VDC	Village Development Committee

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background

Nepal is rich in indigenous architecture which is the contribution by our ancestors in past. Such architectural heritage is the pride of the country but less attentions have been made on such architectural style nowadays. The indigenous building materials and construction techniques used on such type of building plays a crucial role in making livelihood sustainable.

Buildings have a tremendous impact on the environment, using about 40% of natural resources extracted in industrialized nations, consuming virtually 70% of electricity and 12% of potable water, and producing between 45% and 65% of the waste disposed in our landfills. Additionally, they are responsible for a massive amount of harmful emissions, accounting for 30% of greenhouse gases, due to their operation, and an additional 18% induced indirectly by material exploitation and transportation. Simultaneously, the bad quality of indoor environments may result in health issues to employees in office buildings, residential buildings, hence, reducing efficiency and disturbing health. Also Building construction consumes 40% of the raw stone, gravel, and sand used worldwide annually, and 25% of the raw timber. From the environmental impact perspective, the building sector has a significant effect on the entire environment. Residential buildings represent a large percentage of the built environment, and the selections of materials and layouts are necessary for the general sustainability (Usman, Khamidi, & Hassan, 2012).

Considerable initiatives have been carried out by the research community worldwide, in order to find alternative sustainable building materials and low technology methods, which result in a more sustainable and affordable construction adhering to the comfort standards needed today. Adopting green building materials is an excellent approach to meet this target. Selection of construction materials which have minimum environmental burdens is useful in the sustainable development of a country. Therefore, building related contribution to environmental issues is large and therefore essential. Selecting environmentally preferable building products is an

excellent method to boost a buildings environmental performance leading to sustainability (Usman, Khamidi, & Hassan, 2012).

The use of local materials and techniques of construction is one of the most relevant features of indigenous architecture, being an identity factor of regional differentiation. With the Industrial Revolution, and later with the Modern Movement, the increasing use of new industrially-produced and standardized materials led to the homogenization of the different used construction approaches, until then dependent on available local materials. Their wide dissemination meant that the use of these materials became predominant and traditional techniques and materials fell into disuse. Modern architecture, based on the use of industrially-produced materials with a low thermal resistance, especially large glass surfaces, has made buildings extremely vulnerable to outdoor temperature fluctuations and with a high level of dependence on air-conditioning systems to ensure conditions of indoor comfort, representing a substantial energy consumption. Beyond this, industrially-produced materials require a high energy-intensity and have considerable environmental impacts, while natural materials such as timber, clay have positive impacts in the overall life-cycle assessment. On the other hand, using alternative materials and techniques, like the indigenous ones (lime, adobe, stone, clay, timber etc.), the total embodied energy of a building can be significantly reduced, as well as environmental impacts (Fernandes, Mateus, & Braganca, 2014)

Promoting the use of natural materials for construction can create employment opportunities to local people. It makes ease in maintenance as the local people will be familiar with local materials and techniques. The indigenous architecture reflecting rural landscape helps to promote tourism industry. Most of the tourist prefer traditional buildings to live in. It will create income generating opportunities to local people by offering bed and breakfast to them. While using natural materials the negative impacts are threat for degradation of natural resources and biodiversity. Well planned management of natural resources will result high productivity and development but unplanned activities will result in environmental degradation affecting biodiversity and ecosystem.

The 2015 April-May Nepal Earthquakes caused huge loss of lives and properties in the country about 9,000 casualties; 22,300 injuries, 8 million directly affected people (or 1/3rd of the national population), over half a million collapsed houses, and a drop by over 1.5 percentage points in gross domestic product. Most of the indigenous Newari architecture, in the Kathmandu Valley were literally razed to the ground, completely changing the built form of several ancient towns such as Bungamati, Khokana, Lubhu, and most notably Sankharapur municipality (Shrestha, Bajracharya, Bajracharya, Shrestha, & Maharjan, 2016).

Sankharapur municipality is on the process of reconstruction and on this process, people are getting less sensitive on the selection of materials for reconstruction. The intense use of modern materials like cement, steel, glass is transforming rural village into concrete jungle. This thesis focused on how using local materials in the construction of building makes environment sustainable and also improves the livelihoods. The use of locally available materials for housing purpose and for some single components can stimulate the sustainable development. The traditional building technique using local materials has indeed interesting consequences on the rural landscape perception since the color is similar to the countryside surroundings as well as on the agricultural environment, this material being at the end of its useful recyclable in the same context.

The use of local materials enhances local skills giving employment to local people. It helps to utilize necessary materials from local level thus protects the internal money from going outside. It has been proved that the buildings made using indigenous materials are thermally comfortable, functionally balances, economically sound and less vulnerable to earthquake if properly used using traditional techniques.

## **1.2 Statement of the problem**

Although our country is rich in natural resources people of our country has less knowledge in utilizing it. People of rural areas are using natural resources for their livelihood but they are unaware of its benefits. Natural materials are such materials which are available from natural source, which are perishable and which do not have any adverse effects on environment. The use of local materials helps in reducing the need to travel. They are renewable, nontoxic and

therefore safe for the environment. But the use of local materials are decreasing day by day. The development of science and technology has conquered the local technology replacing local materials by modern industrial materials. The wrong information has been delivered to the society by different media that using local materials are not safe and they are not strong and durable. Unfortunately, traditional building techniques are going to be outdated.

With the change in time, there is a change in lifestyle. Everybody is busy working in offices. So, it becomes difficult to maintain home like in a traditional way. The local people in past use to do regular maintenance of home which for this generation has become difficult because of their busy schedule of work. This has made difficulties for the communities to maintain their own cultural identity to achieve as sustainable build environment. Our government has not been successful to address the unemployment problem in our country. This has led most of the youth to move abroad for employment causing indigenous knowledge and practices to diminish. Our government not being interested in indigenous architecture, people find less scope in indigenous knowledge which has resulted in loss of indigenous construction architecture practices.

Today most of the people are interested in modern homes and only few shows willingness to live in sustainable building. People are attracted towards western style in all aspects, architecture being one of them. They love to live in building made of modern materials like glass, fiber boards, aluminum, steel as it looks fancy and this is the problem that people are more attracted to fancy look. Even architects and designers do not consider sustainable design principles especially those related to construction materials and techniques which actually help to reach sustainable buildings and communities.

After 2015 earthquake most of the town suffered a lot among which Sankharapur municipality is the one. Before earthquake there were traditional buildings made of indigenous materials and technology which carried cultural identity of that region. But after earthquake modern buildings made of industrial materials are growing affecting the livelihood of Sankharapur. Indigenous knowledge are dying and people are attracted towards modern material changing

the cultural landscape of that community. Therefore, this thesis tries to find out the answers of following research questions:

- What is the relationship between indigenous material and sustainable livelihood?
- What are the impacts of indigenous knowledge and resources to the economic, environmental, social and cultural identity of a community?
- How does the indigenous materials compare to current industrial materials promotes sustainable livelihood development of a community?
- What are the differences in livelihood of Sankharapur Municipality before and after earthquake?

### **1.3 Objectives of the study**

The main objective is to identify the impacts of using natural building materials in construction on livelihoods. The specific objectives of this study are to find out the answers of the following questions:

- To identify the relationship between sustainable livelihood and indigenous knowledge and resources.
- To identify the impacts of indigenous knowledge and resources to the economic, environmental, social and cultural identity of a community?
- To examine the contribution of indigenous materials to sustainable livelihood development of a community compared to current industrial materials.
- To compare the sustainable livelihood of Sankharapur municipality before and after earthquake.

### **1.4 Scope of the Study**

This research focuses on the study of the indigenous materials and its impact on sustainable livelihood. This will help the local people to understand the significance of indigenous material and its proper construction technique for making community self-sustained and independent. If they know the proper application of local materials and their benefits, they do not have to rely on modern industrial materials and they can make the building more economical. For example, the traditional Newari building made up of sundried bricks and mud are thermally sound (cool

in summer and warm in winter). Unlike modern concrete builds which relies on cooling/heating electronic goods which consume more energy. Indigenous buildings made of local materials are climate responsive enhancing thermal comfort inside the building. This study will highlight the benefits of using indigenous materials hence contributing on the environmental protections. This will motivate local community, government, planners, architects and policy makers to launch further program to encourage the use of indigenous materials in local level. Various NGOs and INGOs and government planner may get positive feedback with the particular focus on using local materials to bring sustainable changes in rural livelihood. By teaching suitable application methods of indigenous materials it can build economically viable opportunities.

### **1.5 Limitation of the study**

This research discusses the use of indigenous materials in construction with focus on Sankharapur municipality based on data availability of primary sources (questionnaire). However, the study has some limitations as mentioned below:

- The traditional buildings are totally damaged so the data has to be collected based on their past experience.
- The findings of this research were based on a case study and do not necessarily represents the regional or national scenario but the findings can be used as reference for similar types of study in near future.

### **1.6 Organization of the study**

In order to answer the research questions, this study will propose to conduct the following: first of all, it will recognize the livelihood assets presented by DFID of the study area. Their livelihood on their past experience will be analysed and then current status of livelihood will be assessed by using the indicators taking sustainable livelihood guidance sheet by UNDP as a frame of reference.

Therefore, sustainable livelihood framework as defined by DFID with some modification and considerations will be used as the main analytical framework. This framework depicts stakeholders as operating in a context of vulnerability, within which they have access to certain

assets. By establishing sustainability of livelihoods and its measurement in a more abstract, theoretical manner, the proposed study would proceed by applying this concept to Sankharapur Municipality. Utilizing the insights and experience, as well as accessibility to ground projects and documents, these theoretical concepts will be applied to assess the livelihoods of SM before and after earthquake. In doing so, not only problems will be presented but thorough analysis and evaluation of the problem will be done. In an attempt to rate these indicators, which were previously mentioned, diagnostic toolkit provided by "Healthy Cities in Asia, A Diagnostic Manual" (Brewer, et al., 1995) will be used to evaluate the conditions of livelihood.

The thesis has been divided into six chapters. Chapter one covers the introduction part with research questions and objectives of the study. It explains the scope and limitation of the study. Chapter two covers review of literature. It explains about the concepts and theories of sustainable livelihoods, sustainable livelihood framework and pentagon of assets presented by DFID. It explains about the indigenous knowledge, construction practices and technology and its impacts on sustainability of livelihoods. Chapter three covers research methodology with brief description of nature and sources of data and information. It describes about the techniques and tools used for data collection. Chapter four gives brief description of Sankharapur municipality, construction practices before and after earthquake. It gives light on government policies to retain and promote indigenous materials. On Chapter five analysis and interpretation of data collected from study area is done. This chapter describes relationship between sustainable livelihood and indigenous knowledge and resources, impacts of indigenous knowledge and resources to the socio cultural, economic and environmental aspects of a community. The comparison of livelihood of Sankharapur municipality is done before and after earthquake in this chapter. Summary of findings, conclusions and recommendations are outlined in chapter six.

## **CHAPTER TWO**

### **REVIEW OF LITERATURE**

#### **2.1 Concepts and Theories of Sustainable Livelihood**

In this section, the concepts theories and models related to sustainable livelihood and indigenous architecture, its impacts on socio-economic and environment has been discussed, analysed and presented.

“A livelihood comprises the capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural base” (DFID, 2001).

A Sustainable livelihoods approach identifies poverty as a condition of insecurity or vulnerability to stresses and shocks, rather than merely lack of wealth. This approach also believes that one should maintain or enhance capabilities and assets both now and, in the future, while not undermining the natural resource base (Meikle & Bannister, 2003).

The concept of Sustainable Livelihood (SL) is an attempt to go beyond the conventional definitions and approaches to poverty eradication. These had been found to be too narrow because they focused only on certain aspects or manifestations of poverty, such as low income, or did not consider other vital aspects of poverty such as vulnerability and social exclusion. It is now recognized that more attention must be paid to the various factors and processes which either constrain or enhance poor people’s ability to make a living in an economically, ecologically, and socially sustainable manner.

The livelihood framework captures all the dimension of poverty in the perspectives of the poor themselves. This is contrast from the poverty indicator that measures poverty based on the household consumption. Meikle & Bannister (2003) argues that poverty is not solely means a low income, but the livelihood framework has integrated a broader concept of deprivation and insecurity. Deprivation means when someone is unable to reach the certain level of functioning or capability. The poverty includes physical weakness, isolation, vulnerability and

powerlessness in addition to the lack of income and assets. However, in livelihood framework, poverty is characterized as not only lack of assets and inability to accumulate it, but the lack of choice with alternative coping strategies that enable them to survive but not to improve their welfare (Chamber, 1983). In some community, the households might not have cash or savings but they may have other assets or capital such as health, knowledge and skills, friends and family and natural resources around them in order to survive and improve their well beings and livelihoods.

## **2.2 Sustainable livelihood Approach (SLA) framework**

The Livelihoods framework encompasses the skills, assets (both material and social) and the approaches which will be used by individuals and communities in order to survive. The sustainability element implies that these individuals or communities can confront and overcome moments of stress and/or crisis, and that they are able to maintain or even improve current and future skills and assets without exploiting their supply of natural resources. In order to better understand the ways in which people develop and maintain their livelihoods, the Swift River Local Advisory Committee, with the help of the Institute of Development Studies, built a tool known as the Sustainable Livelihoods Framework (SLF). It is an analytical framework used to understand the various factors which can affect choices around subsistence, and to examine how these factors interact amongst themselves (Desiree, 2017).

At its core is the assessment of the different capitals that are deemed to underpin livelihood at the level of the individual, household, village or group. These capitals are classified as human, social, physical, natural and financial. They are then assessed in terms of their vulnerability to shocks and the institutional context within which they exist. Once this is understood then interventions can be put in place to enhance livelihoods and their sustainability, perhaps by increasing the capital available or by reducing vulnerability. Thus, the process is about understanding the current situation and developing suggestions for improvement based upon that understanding. The SLA is meant to avoid a situation where intervention is unguided giving little positive impact or is at worst detrimental. (Morse & McNamara, 2013)

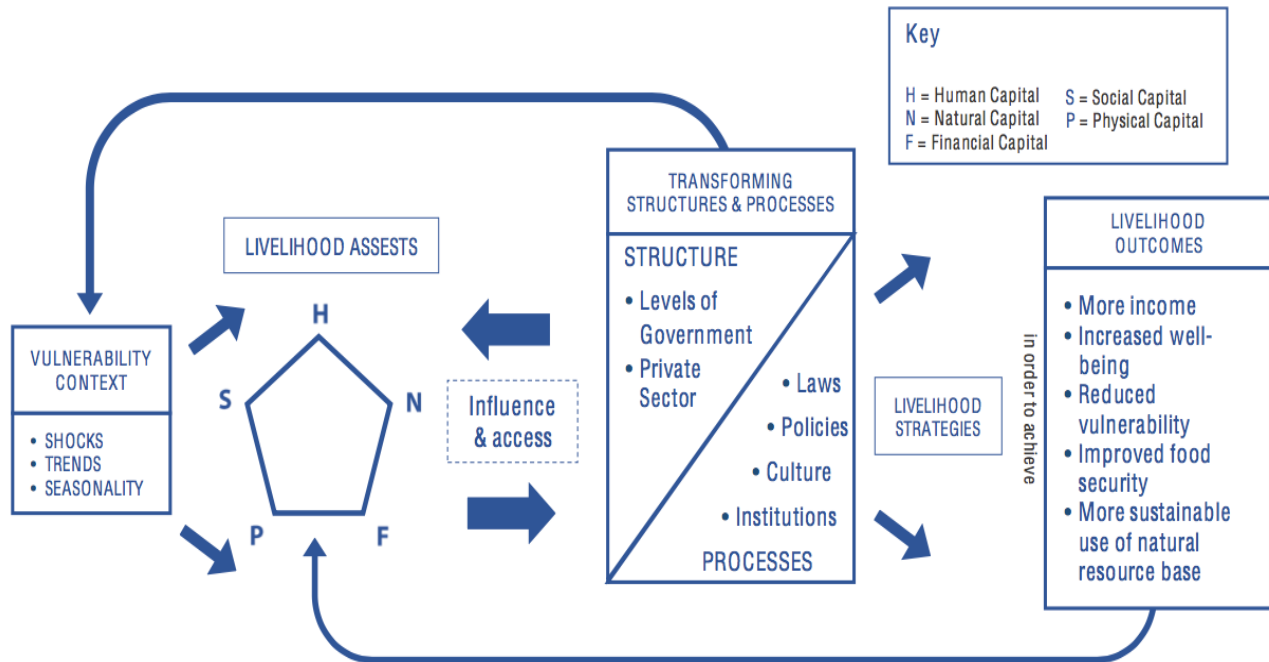
There are different approaches to achieve sustainable livelihood. But the common between various approaches as noted by Roe (1998) is a call to reduce the complexity and certainty that gives rise to demands for sustainable livelihoods in the first place. Sustainable livelihoods can thus be seen as a way of thinking about the objective, scope and priorities for development in order to enhance progress in poverty elimination.

The sustainable livelihoods approach is a holistic approach that tries to capture, and provide a means of understanding, the fundamental causes and dimensions of poverty without collapsing the focus onto just a few factors (e.g. economic issues, food security, etc.). In addition, it tries to sketch out the relationships between the different aspects of poverty, allowing for more effective prioritization of action at an operational level.

The SLF adopts a systems approach to its understanding of livelihoods, and provides a way of conceptualising this through:

- The goods or capital which people need;
- The means by which people earn a living;
- The context for which a particular kind support is designed;
- Any factors which could strengthen subsistence resilience to moments of stress and crisis.

Figure 1. Sustainable Livelihoods Framework graph from DFID(1991)



In a nutshell, the main elements of the SLF can be summarised as follows:

“...The framework depicts stakeholders as operating in a context of vulnerability, within which they have access to certain assets. Assets gain weight and value through the prevailing social, institutional and organizational environment (policies, institutions and processes). This context decisively shapes the livelihood strategies that are open to people in pursuit of their self-defined beneficial livelihood outcomes.” (Kollmair & Gamper, 2002)

The SL approach nevertheless offers both a conceptual and programming framework for sustainable poverty reduction. Unlike more traditional approaches that have sought to tackle poverty by identifying and addressing needs of poor people, the SL approach seeks to improve their lives by building on what they have their assets (UNDP, 2017).

As expounded by UNDP an SL approach:

- (i) Captures the importance of the micro-level institutional context in mediating the impacts of the macro-level economic and institutional environment on the well-being of particular individuals and social groups;
- (ii) situates assets in their broader context, focusing on their contribution to realizing the livelihood outcomes of the poor; and
- (iii) encapsulates the dynamics and multiple dimensions of poverty, ill-being and deprivation (both material dimensions such as low income/ consumption levels, and non-material dimensions such as powerlessness and social exclusion).

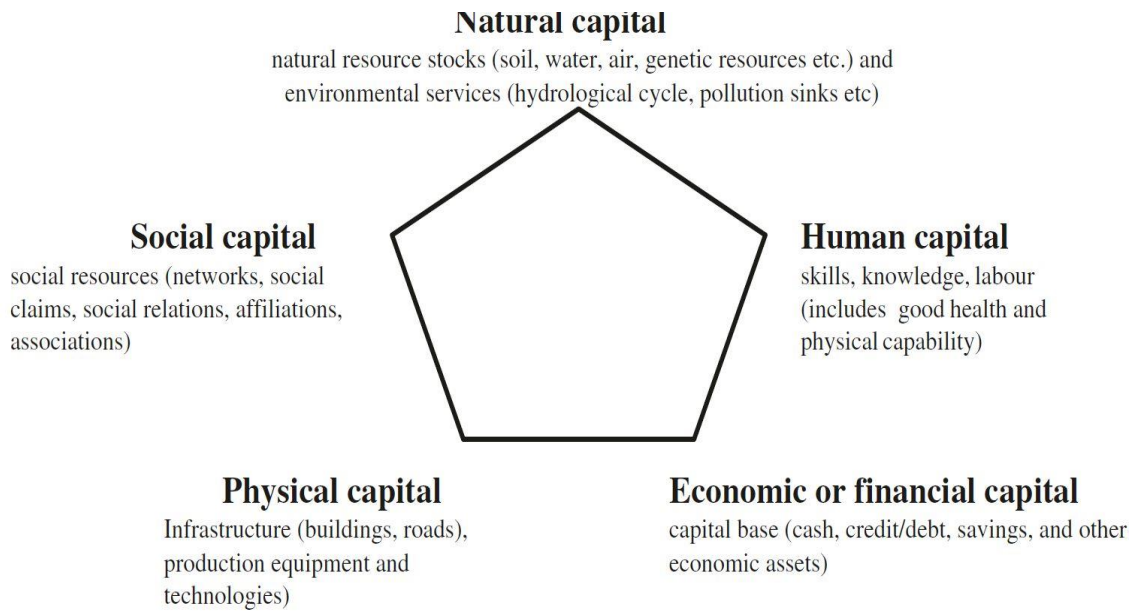
(Majale, 2002)

### **2.3 The sustainable Livelihood Framework Pentagon**

The assets or capitals are those that people draw upon to make a living (Guidance note on recovery, UNDP, 2001). The ability to pursue different livelihood strategies is dependent on the basic material and social, tangible and intangible assets that people have in their possession (Scoones, IDS working paper 72, 1998). Assets are of special interest for empirical research to ascertain, if those, who could escape from poverty, started off with a combination of capital, and if such a combination would be transferable to other livelihood settings (Kollmair & Gamper, 2002). The five different types of capitals form the core of livelihood resources namely human, physical, social, financial and natural. These capitals constitute the actual building blocks for livelihoods

The Pentagon of assets capital was developed in order to facilitate the visual presentation of information on peoples assets, (or the focus of different project interventions) highlighting the interlinks between the different assets. The pentagon grid can be used as a schematic demonstration of variations which exist regarding capital access. The central point of the pentagon, where the different triangles meet, represents zero access to assets, whilst the outside edges represent the greatest access.

**Figure 2. SLF Pentagon of assets**



*Source : DFID, 1991*

For example, if the triangle tip of a shape within the pentagon moves towards or away from the external line labelled “physical capital”, this indicates that a project places a stronger or weaker emphasis on this kind of capital. On the other hand, if the internal shape forms a regular pentagon, it indicates that a project gives equal weighting to all forms of capital. (Desiree, 2017)

**i. Human Capital**

It represents the abilities, experience, work skills and the physical state of good health which, when combined, allow populations to engage with different strategies and fulfil their own objectives for their livelihoods.

**ii. Social Capital:**

It refers to the social resources, which populations will rely on when seeking their objectives relating to livelihoods (in the present study this refers specifically to local social capital, this

being networks, associations, local authorities, local officials and broader population receiving program assistance).

**iii. Natural Capital:**

It is the term used to refer to the stocks of naturally occurring resources (soil, water, air, genetic resources, etc.) which can be used as inputs to create additional benefits, such as food chains, protection against soil or coastal erosion, and other natural resources which can support livelihoods.

**iv. Physical Capital:**

This refers to the basic infrastructure and production inputs needed to support livelihoods.

**v. Financial Capital:**

This refers to the financial resources which populations employ to achieve their objectives regarding livelihoods.

Overall, the researcher have therefore presented conceptual framework of SLF which will be used for capturing the many complexities of livelihoods, and the constraints and opportunities that they are subjected to site. As, these constraints and opportunities are shaped by numerous factors, ranging from global or national level trends and structures over which individuals have no control, and may not even be aware of, to more local norms and institutions and, finally, the assets to which the households or individual has direct access. For now, the researcher will use the household as a unit of analysis with primary focus on relationship of local communities with Indigenous knowledge, resources and construction practices.

Overall, the use of the Sustainable livelihoods framework allows for a holistic assessment of sustainable livelihood and its relationship to indigenous building resources of Sankharapur Municipality. The researcher have therefore presented conceptual framework of SLF which will be used for capturing the many complexities of livelihoods, and the constraints and opportunities that they are subjected to site. As, these constraints and opportunities are shaped

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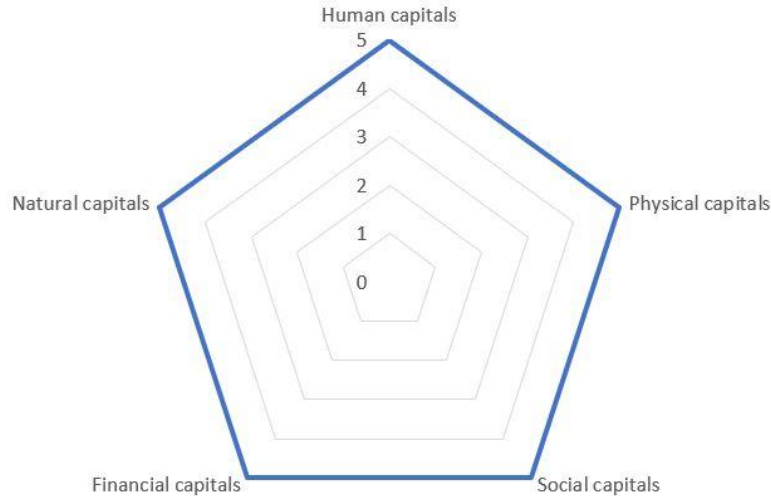
For now, the researcher will use the household as a unit of analysis with primary focus on relationship of local communities with Indigenous knowledge, resources and construction practices. In addition to this, "Healthy Cities in Asia, A Diagnostic Manual" (Brewer, et al.,

1995) provides a diagnostic toolkit for evaluating conditions that affect the health of urban Asian cities. It allows planners to weigh the actual data of a city ranked on a three-point scale for each core indicator of specific concerns as shown in the table next to figure 3. The midpoint of the scale represents the minimum acceptable condition for a place. The two levels below the midpoint reflect increasing poor conditions and the two levels above the midpoint reflect an increasingly good or desirable condition for overall sustainability and human welfare. These levels are then portrayed through radar plotting to illustrate the real situation of the city in a

SCALE	
2.4-3.0	Healthy
1.8-2.4	Moderately Healthy
1.2-1.8	Borderline
0.6-1.2	Moderately Unhealthy
0-0.6	Unhealthy

**Figure 3: Showing ranking system in three point scale**

graphical, easy to understand manner. Figure 4 shows the radar with dividing lines representing the categories within domains. Thus, the researcher will refer to the livelihood capital presented in the diagnostic manual according to the localized needs of Sankharapur municipality. Once data are gathered for a particular capital, it will be scaled from one to five and then plotted on the lines representing the assets to diagnose the Sustainable livelihood of that community before and after earthquake. However, this research quantifies the asset pentagon of Sustainability Livelihood and thus does not operationalise the entire approach, and the quantification is entirely context-specific.



**Figure 4: Radar plot showing Sustainable Livelihood capitals**

## **2.4 Indigenous Knowledge and Construction practices**

Indigenous knowledge refers to as matured long-standing traditions and practices of certain regional, indigenous, or local communities. It also encompasses the wisdom, knowledge, belief and teachings of these communities. In most situation these knowledges has been orally passed for generations from person to person. Some forms of them are expressed through stories, legends, folklore, rituals, songs and even laws (Acharya & Shrivastava, 2008).

The indigenous people use their knowledge to interpret their relationship with the local environment. Indigenous knowledge is a holistic approach of management of natural resources with conservation and sustainability as the core values. Indigenous knowledge bonds the community in a normative contract. Traditionally, they are known to be capable and skilled in the arts and crafts of wood, bamboo and metal, stones, bricks as well pottery.

In this context of research, indigenous knowledge is a composite but holistic set of know-how, expertise, skills derived from different sources, such as the parents, indigenous experts (elders), empirical trials and even scientific information. Indigenous knowledge appears as encoded messages and value laden, while scientific knowledge is dependent on test. Both are not always perfect, yet useful and should not be rejected in entirety. Indigenous knowledge involves

experiential learning process, in itself is scientific but yet to be explored and documented. (Mazlan & Siti, 2012)

The indigenous buildings of Kathmandu are well assembled and they show harmonized combination of the materials. The structures in building are well fixed by means of *chuku* (peg) and *sa*: (joints) and by means of tightening of materials like *tei kachi* (rope of bamboo). *Ata or apa* (brick) used on the buildings are also flexible in nature. The single piece can be removed or replaced in case of damage or decay. The construction practice of traditional buildings use only natural materials from foundation to roof.

### 2.4.1 Indigenous materials

Mostly used indigenous materials in construction of traditional building are:

#### **Brick:**

Brick is one of major construction materials used extensive in architectural structure in Kathmandu from the ancient time. The traditional Newari houses irrespective to a town or a village usually made of walls kiln baked bricks or has a special finish. Typically, two types of bricks were found in use, firstly an ordinary sun-dried bricks that measures 210 x 105 x 50 mm, and secondly the specially fired bricks, called "dachi- appā " with the same dimensions but in the shape of a trapezoidal cross section. The dachi- appā is particularly used in the houses that belong to royal courtiers and the better off families on the outer course of the facade.



**Photo 1: Making of Bricks using clay**

*Source: Traditional Materials and Construction Technologies used in the Kathmandu Valley, 2003*

### **Roofing tile (Āypā):**

The *āypā* is a traditional roofing tile made of clay baked in kiln measuring of 190x90x18 mm. The tile is made with a mould designed to form a small groove on one side in the longitudinal direction, while on the other side a second groove is made by hand with help of water after the tile has been taken out from the mould. These grooves are meant to interlocking of the tiles in roofing (Bonapace, Caterina, & Valerio, 2003).



**Photo 2:Clay Roofing tiles**

### **Clay:**

Clay is most widely used as building materials from very remote past. Traditional houses are predominant used clay to join brick or stone mason either for walls and roofing. There are different types of clay used in the construction work, they are grey/black clay, which is commonly used for making bricks and tiles. Similarly, grey and brown clays are best for quality clay plaster and grey clays are used to make mortar, while red clay is used to make paves. White clay locally known as *takichā* (pure kaolin) is used for internal and external paintings. It is believed that yellow clay consists of water resistant property so is used in between joints of trapezoidal-cut bricks to stop water seepage inside the walls (Bonapace and Sestini, 2003:24).

### **Wood:**

Wood is one of the oldest construction materials used in elsewhere. It is extensively used in traditional houses in Kathmandu valley. The main wooden elements in the traditional houses consists of doors, windows, joists, struts, tympanums, purlin, rafter, beams, column, door leaves, stairways, etc. Move over in traditional houses, wooden nails or peg or wedges are used to connect or joint different elements of the wooden structure.

### **Stone:**

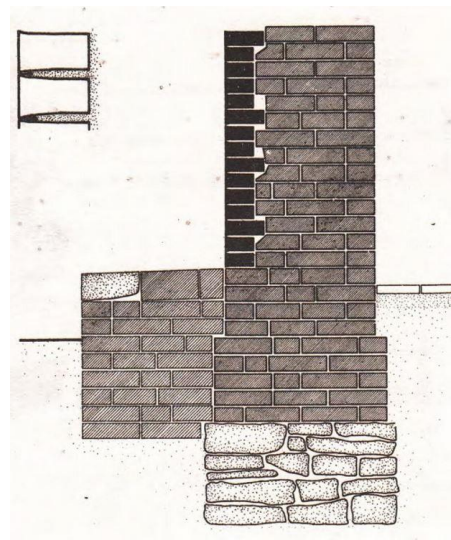
The use of stone in the traditional Newari houses is limited to the foundations and the base stone locally known as *ilohan* to erect columns on the ground floor of the quadrangular houses of royalties, nobilities and royal courtiers. The stones used in the foundation of the houses are generally natural and/or irregular shaped ones joined with clay mortar. Besides that, irregular shaped or natural stone are used for raising the plinth of the houses as well.

### **Lime:**

Lime is locally known as *sankhvā* is a chemical compound produced by burning limestone following a specific technique. It is primarily used as mortar for extra strength and exterior plastering. Lime mixed mortar locally known as *bajra*, which means "strong", has greater binding capacity. It is prepared with one portion of lime and two portion of pounded brick-dust (*surki*) which is stirred to mix intimately. The use of lime in Kathmandu valley is still obscure. Neils Gutschow (1987) is of opinion that *bajra* was used since early 19<sup>th</sup> century. (Maharjan K. B., 2010)

## **2.4.2 Indigenous construction technology**

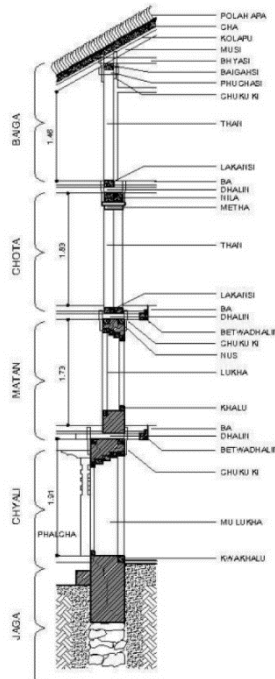
The basic foundation of traditional buildings consists of a few layers of natural stone (large pebbles or broken stone), this is followed by brickwork which gradually attains the wall thickness of the ground floor and which continues into the superstructure without any dampproof layer. Despite the poor quality of the soil in most parts of the valley, the foundation of one to four storey buildings are not much deeper than 60-80 cm and wider than 70cm (Korn, 1977). The major building material is sundried brick, burnt brick, mud mortar, mud plaster, clay tile, timber and stone. The thick load bearing wall of 450 to 600 mm built with multilayer of Burnt Red brick (*pakki apa*), Sun dried brick (*kachi apa*)



**Figure 5: Section through wall, foundation and plinth**

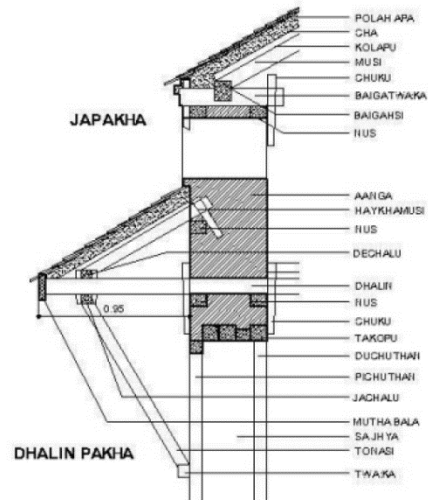
*Source: Korn, 1977*

and mud plaster placed from outside to inside in external walls. One layer of burnt bricks are used to exposed for weather resistance whereas sun dried bricks are use in  $\frac{3}{4}$  part of wall in inner side. Mostly the central load bearing wall consists of 450 mm built with only Sun dried brick (kachi apa) and mud plaster.



**Figure 7: Detail section of Dathu anga**

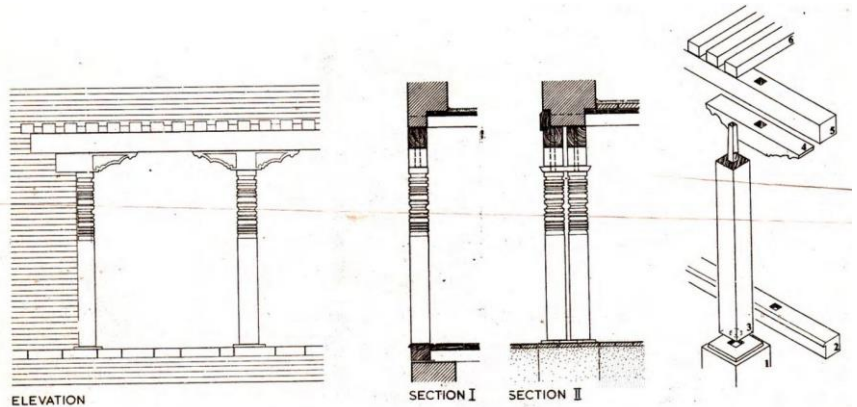
*Source: Suwal,2014*



**Figure 6: Detail of Japakha and dhalin pakha**

*Source: Suwal,2014*

Single or double post support the upper brickwork, where an opening is required for design reasons or because of the usage of space behind. If the front or back load bearing wall of building is removed in order to provide a shop or a workshop, a double row of wooden post is used. Usually a dressed natural stone (*ilohan*) or a wooden threshold (*lakansin*) supports the wooden post(Than) and wooden bracket (Meth) which transport the load from the lintel (Nina) and beams (Dhalin) on to the posts. A

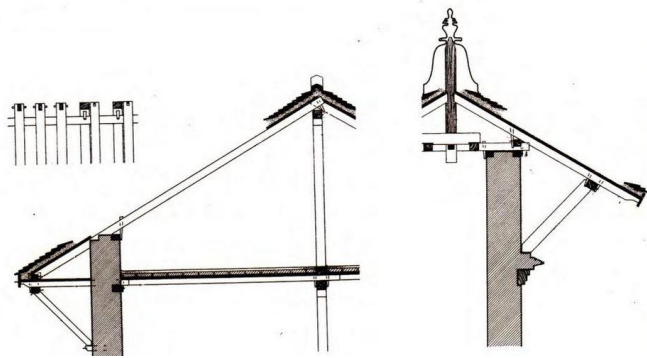


**Figure 8: Assembly of wooden post, lintels and beams**

*Source: Korn,1977*

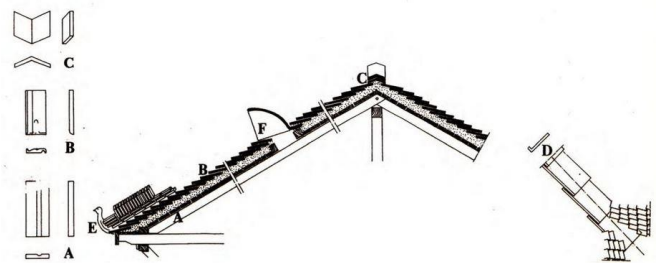
long peg (*sa*), extending from the post, passes through the bracket into the beam and holds the three structural element in position.

The most striking of architectural features in traditional Newari buildings are the huge projecting roofs set one above another. They protect the walls of brick and mud mortar from the powerful monsoon rain and strong sunlight. Pitched roofs are of a purlined construction where the rafters of topmost roof meet at a point on a central post (*than*). The ridge piece (*dhuri*) rests on a row of simple vertical post (*dhuri thans*). Wooden nails (*chukus*) keep the various components in place. Rafters (*musins*) and even floor beams (*dhalins*) are set at intervals of 10cm-15cm depending on the rafter or beam sections and are normally laid flat. The roofs are covered with special types of tiles called *jhingati* (Korn, 1977).



**Figure 9: Sections showing typical roof details**

Source: Korn,1977



**Figure 10: Traditional roof**

Source: Korn,1977

## 2.5 Characteristics of Indigenous Knowledge and Building

According to (EMA, 2019), Indigenous knowledge refers to the understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings. For rural and indigenous peoples, local knowledge informs decision-making about fundamental aspects of day-to-day life. This knowledge is integral to a cultural complex that also encompasses language, systems of classification, resource use practices, social interactions, ritual and spirituality.

Indigenous knowledge provides the basis for problem-solving strategies for local communities, especially the poor. It represents an important component of global knowledge on development issues. IK is an underutilised resource in the development process. Learning from IK, by investigating first what local communities know and have, can improve understanding of local conditions and to provide a productive context for activities designed to help the communities. Understanding IK can increase responsiveness to clients. Sharing IK within and across communities can help enhance cross – cultural understanding and promote the cultural dimension of development.

**1. Local:** It is rooted to a particular set of experiences, and generated by people living in those places. It has been said that transferring that knowledge to other places runs the risk of dislocating it.

**2. Orally-** transmitted, or transmitted through imitation and demonstration. Writing it down changes some of its fundamental properties.

3. The consequence of practical engagement in everyday life, and is constantly reinforced by experience and trial and error. This experience is characteristically the product of many generations of intelligent reasoning, and since its failure has immediate consequence for the lives of its practitioners its success is very often a good measure of Darwinian fitness. It is, as Hunn (1993:13) neatly puts it, “tested in the rigorous laboratory of survival”

4. Characteristically shared to a much greater degree than other forms of knowledge, including global science. This is why it is sometimes called “people’s science”, an appellation which also arises from its generation in contexts of everyday production. However, its distribution is still, segmentary, that is socially clustered (Hobart 1993). It is usually asymmetrically distributed within a population, by gender and age, for example, and preserved through distribution in the memories of different individual. Specialists may exist by virtue of experience, but also by virtue of ritual or political authority.

5. Focused on particular individuals and may achieve a degree of coherence in rituals and other symbolic constructs, its distribution is always fragmentary: it does not exist in its totality or individual, Indeed, to considerable extent it is devolved not in individuals at all, but in the practices and interactions in which people engage themselves engage.

### 2.5.1 Physical Character of building

Most of the traditional houses (Newari buildings) are three or four storied high between 1.8 to 2.4m connected by narrow and steep wooden staircase. The plan is usually of simple rectangular from depth about 6m and length varying from 3m to 10m consist of chheli (ground floor), matan (first floor), chota (second floor) and sometimes buigal (terrace). Exterior walls were usually found to be constructed as thick layers up to the third storey and subsequently reduced in upper storey.

Wolfgang Korn elaborates a characteristic and universal feature of this kind of design is the vertical room arrangement, which is not dependent on the size of the house, security considerations and the need to use a little irrigable land for building purposes, caused the Newar house to be vertically oriented.

The facades of traditional Newari buildings are generally symmetrical and contain finely detailed and carved windows and doors. Symmetry is achieved on a central axis on each succeeding floor with the central window of each floor emphasized by both its size and



Photo 3: Traditional roof structure



Photo 4: Traditional Newari House

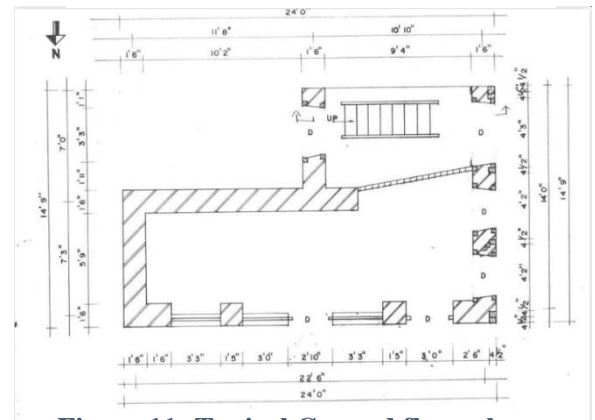


Figure 11: Typical Ground floor plan of Newari house

quality of detail (Pokharel, Maharjan, Joshi, & Maharjan, 2015)

## 2.5.2 Socio-cultural character of building

Each floor have given floor specific name such as *Chheli* - the ground floor, *mātan* - the first floor, *chvata* - the second floor and *baiga*, the attic. The usage of floor seems to be varied depending on socio-economic status of the inhabitants. The usage of two floors namely *mātan* and *baiga*, seems to be similar across all social strata. Mostly commonly *mātan* is used as bedroom, sitting room, and treasure room and *baiga* is used as kitchen and *pujā kvathā* (worship room). However, the usage of two remaining floors namely *Chheli* and *chvata* found to be varied depending on the occupation of the inhabitants. The *Chheli* is found to be used as storage of agricultural implements, manure, farm products and livestock amongst the farming community, whereas occupational castes such as *Nakarmis* (Iron smith), *Tāmtrakār* (Coppersmith) and *Silpakār* (Wood carver) ground floor for their occupational workshops is generally used as family gathering, holding feast primarily across all social strata. But the farming communities use to store their farm products such as paddy, maize and so on. Similarly this floor is used for household activities such as weaving, knitting, spinning, etc.

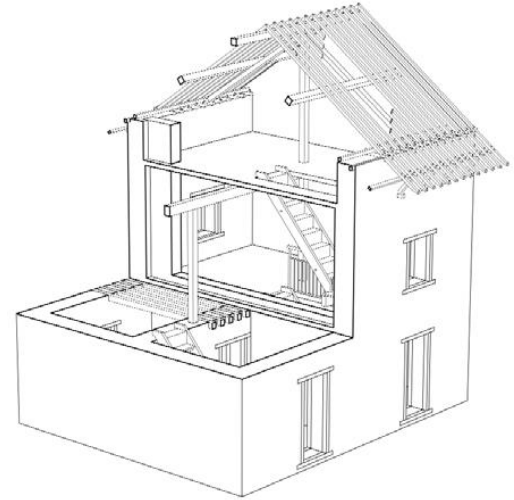


Figure 13: Axonometric view of Newari House

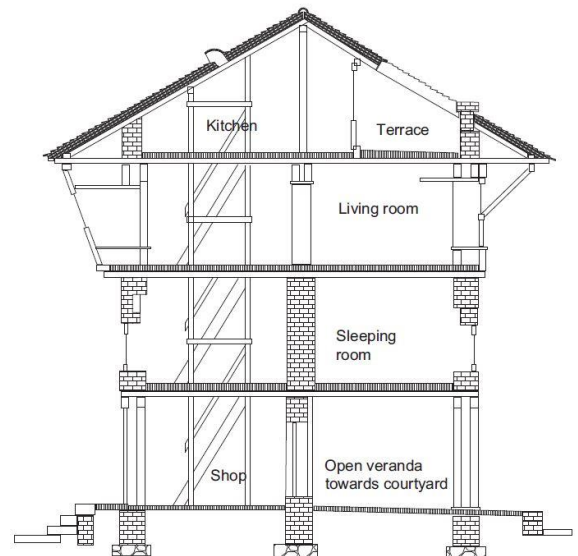


Figure 12: Section of Newari House

Source: *Traditional materials and construction technologies used in the Kathmandu valley, 2003*

Moreover business community used it for shops and warehouses of their merchandise goods. The aristocrats and royal courtyards use as store, room for guards, performing some household

rituals, etc. The *chvata* being the widest space within the house is generally used as family gathering, holding feast primarily across all social strata. But the farming communities use to store their farm products such as paddy, maize and so on. Similarly, this floor is used for household activities such as weaving, knitting, spinning, etc (Maharjan, 2008).

**Table 2.1: Description of Building materials**

Structural Element	Building materials
Wall Frame	Brick bonded with mud mortar forming ordinary masonry. Typically, two types of bricks: ordinary sun-dried bricks of dimensions 210 x 105 x 50 mm, and fired bricks, called "dachi aapa" with the same dimensions but in the shape of a trapezoidal cross section, so that the mud bed-joint is partially covered externally by the brick.
Foundations	Shallow Foundation: Rubble stone, fieldstone strip footing
Floors	Timber joists (dimensions 100 x 70 mm) run from wall to wall at closely spaced intervals of 150 to 200 mm. Above the joists either planks or a bamboo chirpat are covered by compressed mud.
Roof	Timber joists (dimensions 100 x 70 mm) run from wall to wall at closely spaced intervals of 150 to 200 mm. Above the joists either planks or a bamboo chirpat are covered by compressed mud.
Other	The timber frame (dalan) is made of twin columns, surmounted by a capital upon which sits a double beam. Adjacent timber frames are usually connected only at the level of the beam. The columns usually have a square cross section (about 100 x 100 mm minimum and 150 x 150 mm maximum) and are pinned to the ground, 100 to 150 mm apart.

Source : D'Ayala & Bajracharya

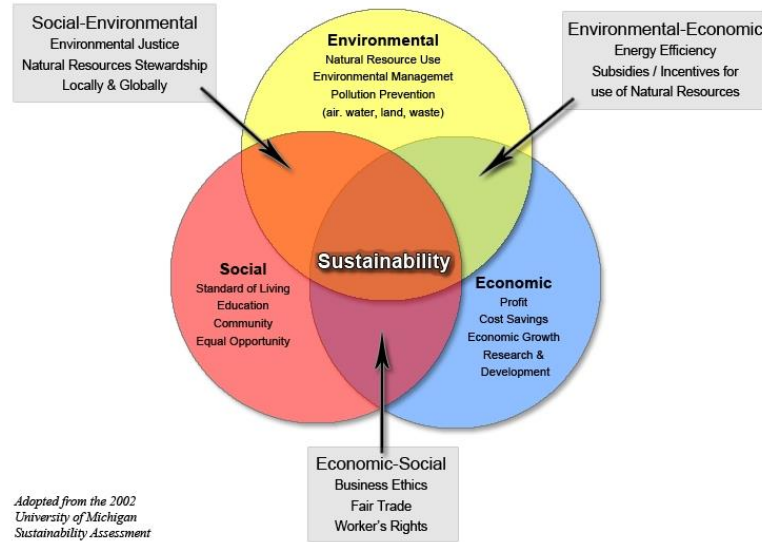
## 2.6 Indigenous Architecture (IA) and Sustainable Design

Local and traditional construction products derived from the connection between human and the environment reflect the culture of the human life. Buildings which are derived from the local and traditional construction products conform to topography, local climate (the wind, solar radiation, air movements, temperature, humidity) and landscape. During the ancient times, the materials which were required to put up structures were obtained from the environments in each region that the communities lived in. Buildings that are designed in accordance with a community's culture, lifestyle and the physical and climatic conditions of such communities are called indigenous architecture.

Indigenous architecture establishes a harmonious relationship between climate, architecture and people. Indigenous architectural products could be associated with sustainable architectural principles. This is because the common goal of sustainable design and indigenous architecture is to produce environmentally friendly constructions that are compatible with the surrounding conditions and that can last for many years. Indigenous Architecture does not only apply to spatial items that meet the physical needs of individuals, but also responds to their social, cultural and emotional needs (Gür, 2000).

Prior to explaining the principles of sustainable design in architecture, it is proper to explain what sustainability means. An overview of the concepts of sustainability was provided by Andrew Dobson, based on four questions, 1. What to sustain, 2. Why, 3. for Whom, and 4. Substitutability (Dobson 1996, 1998). The word 'Sustainable' "is often used to characterize a technology with a lower environmental impact on a single environmental problem (e.g., climate change, water resource use, etc.), often quantified in terms of reduced resource use or pollution emissions as a fraction or percentage" (Levin 2015, p. 1). Sustainability should address the complex interactions among socio-ecological systems (Ostrom, 2009). The most famous definition of the concept came from World Commission on Environment and Development that defined Sustainable development as "development that meets the needs of

the present without compromising the ability of future generations to meet their own needs.”  
 (WCED 1987, p. 41).



**Figure 14: The Three Spheres of Sustainability**

Sustainable architecture design strategy comprises has three important pillars, i.e. social, economic and environmental context. Moreover, while architectural design tries to respect environmental concepts, it does not differentiate the specifications of these built environments with that of society’s social and economic data. From this point of view, it is proper to explain what social and economic sustainability means in the context of architectural design.

The Young Foundation describes social sustainability as a process for creating sustainable successful places that promote wellbeing, by understanding what people need from the places they live and work. Social sustainability combines design of the physical realm with design of the social world – infrastructure to support social and cultural life, social amenities, systems for citizen engagement and space for people and places to evolve (Woodcraft, Bacon, Caistor, & Hackett, 2011).

According to Kahn (1995), social sustainability encompasses notions of equity, empowerment, accessibility, participation, sharing and cultural identity. It seeks to preserve the environment through economic growth. A critical look at these definitions shows that, social sustainability is tightly linked to economic sustainability. Economic sustainability implies a system of production that satisfies present consumption levels without compromising future needs. Today, however, a realization has emerged that natural resources are not infinite. This has strained people to adopt sustainability at every point in life.

In indigenous architecture, users not only design and build but at the same time adapt improvable and continuous design processes to their lives in their own built environments that they develop according to their needs. Needs that arise or disappear are reflected directly and quickly by the users in the design of the buildings. Needs in the perspective of indigenous architecture do not precede aesthetic concerns. Humans have environmental concerns that would allow them to continue their lives before aesthetic sensitivities when constructing their buildings. Indigenous constructions are simple, easy to understand and can easily integrate with nature. Building forms could be shaped by different parameters such as local materials, social and economic facts of the community, natural environment, or the reflection of events in social memory. Indigenous heritage represents a great resource that has significant potential to define sustainable design principles.

*Indigenous architecture is composed of traditional buildings, which represent a morphological response to both environmental and climatic constraints, as well as to the socio-economic and cultural characteristics of societies. Additionally, the materials and architectural components used are climate responsive and tailored according to distinct locations, and have therefore adapted to seismic, geographic and topographical features, as well as to local climates. Besides, it is a cost-effective architecture, both in economic and social terms, self-sufficient as regards natural and knowledge resources and with a low environmental impact, and therefore, with a sustainable input. (Correia et al. 2014, p. 17)*

Moreover, Durability and versatility are the important features of indigenous architecture (Rudofsky 1964). The basic goal in indigenous architecture is to produce easy and functional buildings. Needs in the perspective of indigenous architecture do not precede aesthetic concerns. Humans have environmental concerns that would allow them to continue their lives before aesthetic sensitivities when constructing their buildings. Indigenous constructions are

simple, easy to understand and can easily integrate with nature. Building forms could be shaped by different parameters such as local materials, social and economic facts of the community, natural environment, or the reflection of events in social memory. Thus, the most important factors that form the indigenous architecture and sustainable design are the natural, economic and socio-cultural conditions of the region.

### 2.6.1 Environmental aspects

According to Fernandes, Mateus, & Braganca (2014), Indigenous materials and techniques have from the sustainability point of view several advantages that should be promoted. Among these, environmental issues stand out, but there are also social and economic benefits. In this sense, it is pertinent to highlight some of the advantages of using certain types of indigenous materials in opposition to current industrially-produced ones as shown in table 2.2.

**Table 2.2: Embodied Energy and Global warming potential of some indigenous and conventional building materials**

Material	Embodied energy	Global Warming Potencial
	(MJ eq./m3)	(kg CO2 eq./m3)
Granite*	1300	26
Timber*	1058.88	57.7
Rammed earth*	942.5	37.7
Straw*	65	0.65
Concrete	1449.63	264
Steel (sections)	182286	2035800
Brick, perforated	4245	357
Ceramic tiles	22185	1167
Roof tiles	5865	535.5
Polystyrene XPS	3271.13	341.25

*Sources: Bragança & Mateus 2011; \*Berge 2009.*

Fernandes, Mateus, & Braganca (2014) highlights that the most relevant environmental advantages related to local materials are:

- no need of transportation;
- less energy intensive production process and consequently lower embodied energy and CO<sub>2</sub> emissions;
- they are natural materials, often organic, renewable and biodegradable, with a life cycle from “cradle to cradle”;
- low environmental impact during maintenance operations.

Some advantages of traditional buildings are (Wargocki, 1999)

- i) strong thermal inertia
- ii) ability to influence the quality of indoor air, since it has no VOCs associated;
- iii) hygroscopic inertia, ie, acting as moisture regulators, retaining it in the appropriate proportions to human health (from 40 to 60%), contributing to the stability of the indoor microclimate;
- iv) low embodied energy;
- v) low carbon emissions and low environmental impact;
- vi) low cost material;
- vii) if performed on raw earth it can be reused indefinitely.

Many studies and researches have proven that the thermal performance of traditional dwellings is better than that of modern dwellings. According to Bajracharya (2014), the traditional Newari houses provides a year-round comfortable indoor environment in summer as well as winter whereas the new houses fails to deliver similar thermal performance.

Figure 17, shows that the mean indoor and outdoor air temperatures of traditional buildings in all four seasons over one-year period with 95% confidence interval. The most of traditional building indoor air temperature was lower than outdoor during daytime in the summer. The outdoor mean maximum air temperature ranges from 25 to 28°C whereas indoor mean maximum air temperatures range from 25 to 26°C. During winter, most of traditional buildings indoor air temperature was either same or higher than outdoor air temperatures. The outdoor mean maximum air temperature ranges from 11 to 14°C whereas indoor mean maximum air temperatures range from 12 to 15°C during morning and evening. The comfort temperature of

Kathmandu is 15°C in winter and 26°C in summer (Rijal et al. 2010 )(see appendix 4). The result shows that the traditional residential building maintains comfort temperature in summer and within nearly comfort range in winter without any mechanically heated or cooled. (Bajracharya, 2014).

Tiwari et al. (2004) states that there is a general perception that traditional architecture is better in terms of thermal environment than contemporary architecture. The findings show that people are well adapted to the thermal environment of traditional houses; as a result the adaptive neutral temperature is lower than the thermal comfort standard.

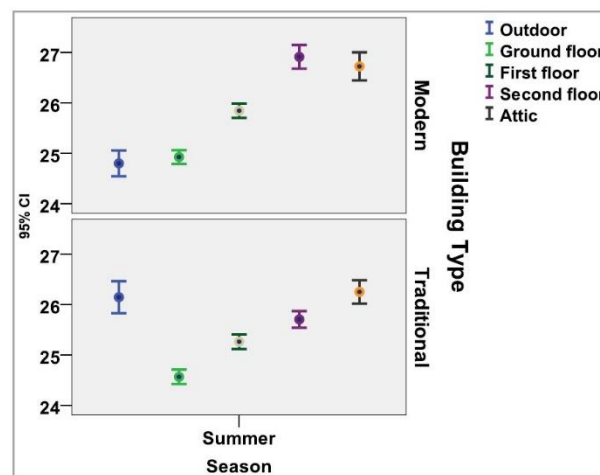


Figure 15: Comparison of indoor and outdoor air temperature in traditional and modern residential buildings

Source : Bajracharya, 2014

## 2.6.2 Socio-Economic aspects

Edum Fotwe, (2009) defined a set of social parameters to be considered for improving the sustainability of the built environment, such as: employment; health; safety; wellbeing; education and training skills; and culture/heritage.

Regarding employment, several studies report the great need of more and skilled workmanship as a disadvantage of traditional construction techniques. But taking into account that the direct cost of these materials and structures is often inferior to that of conventional building systems,

the allocation of the structure cost to manpower seems to be an advantage. The distribution of the income among more stakeholders is socially fairer than just allocating it to the price of a material. The local production of materials is not only economically cheaper, as it also enables creating jobs for unemployed people (Sanya, 2007) cited in Pacheco-Torgal & Jalali 2012).

Additionally, the need for skilled workmanship leads to education and training on these indigenous building systems, contributing not only to improve the qualifications of the several construction stakeholders but also to preserve and continue a local heritage and cultural legacy. The education in indigenous building systems is also crucial for politicians, sociologists and economists who make decisions about the built environment (Oliver, 2006)

The fact that these materials came from the same local climatic conditions where they were applied has the following advantages: greater adaptability, economy and increased durability (Singh, 2011).

In matters of health, advantages are mainly related to the fact that these materials are of natural origin, with low toxicity, no volatile organic compounds, some of them with properties capable of regulating the temperature and indoor air quality (Berge, 2009).

In terms of economy, Goodman (1968 cited in Berge 2009) argues that an industry of ecological construction must have their production units near the place of consumption, using local renewable resources, focusing on processes that require little energy and produce reduced pollution. Furthermore he argues that decentralization can increase corporate decision-making centers and have a clearer idea of the context in which they labor, especially relationships between decision-makers and local resources. In this sense Oliver, (2006) also argues that the discourse on sustainability is too oriented at the cities scale, requiring the implementation of decentralization policies in economies that contribute to the regeneration of rural areas. The redevelopment of these areas could be a way to stop the expansion of cities.

## **2.7 Conclusions**

From the review of literature, it can be concluded that employment, health, wellbeing, safety, skills and culture/heritage can be considered as a parameter of sustainable livelihood. Furthermore, it made clear that sustainability can be achieved from the assets on what we have. It has given light that traditional buildings bring positive impact on socio-economic, environmental and cultural aspects which are the pillars of sustainable livelihoods.

Overall the researcher has presented the conceptual framework to assess the health of livelihood in 3-point scale of Sankharapur municipality considering five assets as the indicator of assessment.

## **CHAPTER THREE**

### **METHODOLOGY**

The research methodology applied in this thesis is based on mixed methods approach which involved integrating quantitative and qualitative information for better understanding of use and potential of indigenous materials. Most of the primary data were collected through structured questionnaire, however some semi-structured or informal interviews were also conducted to receive qualitative information. The study of use and advantages of indigenous material was carried out entirely from secondary sources like published journals and previous researchers.

#### **3.1 Research Design**

The research design of the study is descriptive and analytical to examine the role of indigenous materials in Income generating Activities. Mixed methods approach was used in this research due to uncertainty of types of data availability. According to John Creswell, “*Mixed methods research is a method for conducting research that involves collecting, analysing, and integrating quantitative and qualitative research in a single study or a longitudinal program of inquiry.*” This study has described the past and present status of construction practices and its impact on socio economic environment. This study has also assessed and explored the role of indigenous materials on sustainable livelihood in different economic classes. The Research is designed to provide qualitative and quantitative information about economic impact of local people. Socio-economic and demographics data are collected through both qualitative as well as quantitative primary and secondary data.

#### **3.2 Nature and Sources of data and information**

For the purpose of this study both quantitative and qualitative data were collected. Primary and secondary sources were used for data collection. The primary data were collected from the household level. Based on research objectives some structured questionnaire, key informant

interview and observation checklist were developed to collect primary data. The secondary data were collected from different articles, institutional publications, government and nongovernmental reports, newspaper etc.

40 household from ward no. 7 of SM was selected randomly under the sample size.

### **3.3 Study population (Universe, sample and sampling procedure)**

According to a survey by NSET (August, 2015), out of about one thousand buildings in Sankhu, traditional buildings accounted for 70%, modern buildings for 24%, and the rest were neo-classical buildings (1%) and others (5%). Out of 631 traditional buildings, 93% of the buildings suffered substantial damage and more, including complete destruction of 70% traditional buildings. In contrast, out of 217 neoclassical buildings, 22% suffered substantial damage and more including complete collapse of 5%. Out of 5 modern buildings, 60% suffered substantial damage including complete destruction of 40% (Shrestha, Bajracharya, Bajracharya, Shrestha, & Maharjan, 2016).

After the earthquake 200 households of ward no. 7 are currently living in newly constructed house. Universe of the research includes all the households of Sankharapur Municipality of ward no. 7. To identify the households to be surveyed, simple random sampling method was applied and collect the information about the status of livelihoods before and after earthquake. Out of total 200 households of ward no. 7, 40 households were randomly selected for the questionnaire survey which accounts for 20% of total universe. Hence total of 8 households were identified for detailed interview, and 3 groups for FGD with the help of committee and local enumerator.

### **3.4 Techniques and tools of Data Collection**

#### **3.4.1 Household Survey:**

Survey research is used to collect information about the use of indigenous knowledge. Questionnaires containing both structured and unstructured questions were used to conduct survey. Structured questions will be used to collect the primary data by visiting door to door respondents. Separate questionnaire was administered to all total 40 households' sample. Questions for the sample households have been filled up with the help of the concerned household member. The format of questions to conduct survey has been attached in annex I.

**Table 3.1: Framework of the study**

S.No.	Livelihood capitals	Indicator used
1.	Human capitals	<ul style="list-style-type: none"><li>i. Condition of awareness regarding indigenous materials</li><li>ii. Health conditions influenced by buildings</li><li>iii. Employment conditions in the family</li></ul>
2.	Physical capital	<ul style="list-style-type: none"><li>i. Access to buildings</li><li>ii. Effectiveness of construction</li><li>iii. Access to indigenous knowledge and construction technology</li></ul>
3.	Social capitals	<ul style="list-style-type: none"><li>i. Social relations among people</li><li>ii. Access to guthi</li><li>iii. Relation to social neighborhood</li></ul>
4.	Natural capitals	<ul style="list-style-type: none"><li>i. Access to land and natural resources</li><li>ii. Access to water</li><li>iii. Access to clean environment</li></ul>
5.	Financial capitals	<ul style="list-style-type: none"><li>i. Increment in employment opportunities</li><li>ii. Status of maintenance and operational cost of building</li><li>iv. Status of income and economic assets</li></ul>

Taking the reference of sustainable livelihoods guidance sheet by UNDP, indicators were developed under different capitals. Based on these indicators' questions were asked to 40 HH sample.

### **3.4.2 Interview:**

Interview is especially done for collecting first hand data. Interview schedule were prepared based on the objectives of the research study containing both closed as well as open-ended questions. Interviews were taken to 8 local people of the Shankharapur municipality to gather reliable data necessary for the study. The qualitative data will also be collected in order to gather background information; past history, status and social activities of the study group.

### **3.4.3 Focused Group Discussion (FGD)**

FGD was conducted to 3 groups among the informants selected randomly of SM. It enabled to collect ample data required for the exposition of authenticities related to changing socio-cultural status.

### **3.4.4 Observation:**

It is used to collect the noticeable information such as local materials used in buildings and its functional use and its relationship to social and economic wellbeing. The data collected through observations have been used to support the structured data in relevant place in the text. Especially qualitative information like status, life style, social and household activities and behaviors of the study area had been observed. Checklist are made before doing research and after thorough observation what are missing on the site are noted and what are the impacts of existing conditions on the environment are recorded.

### **3.5 Data Processing**

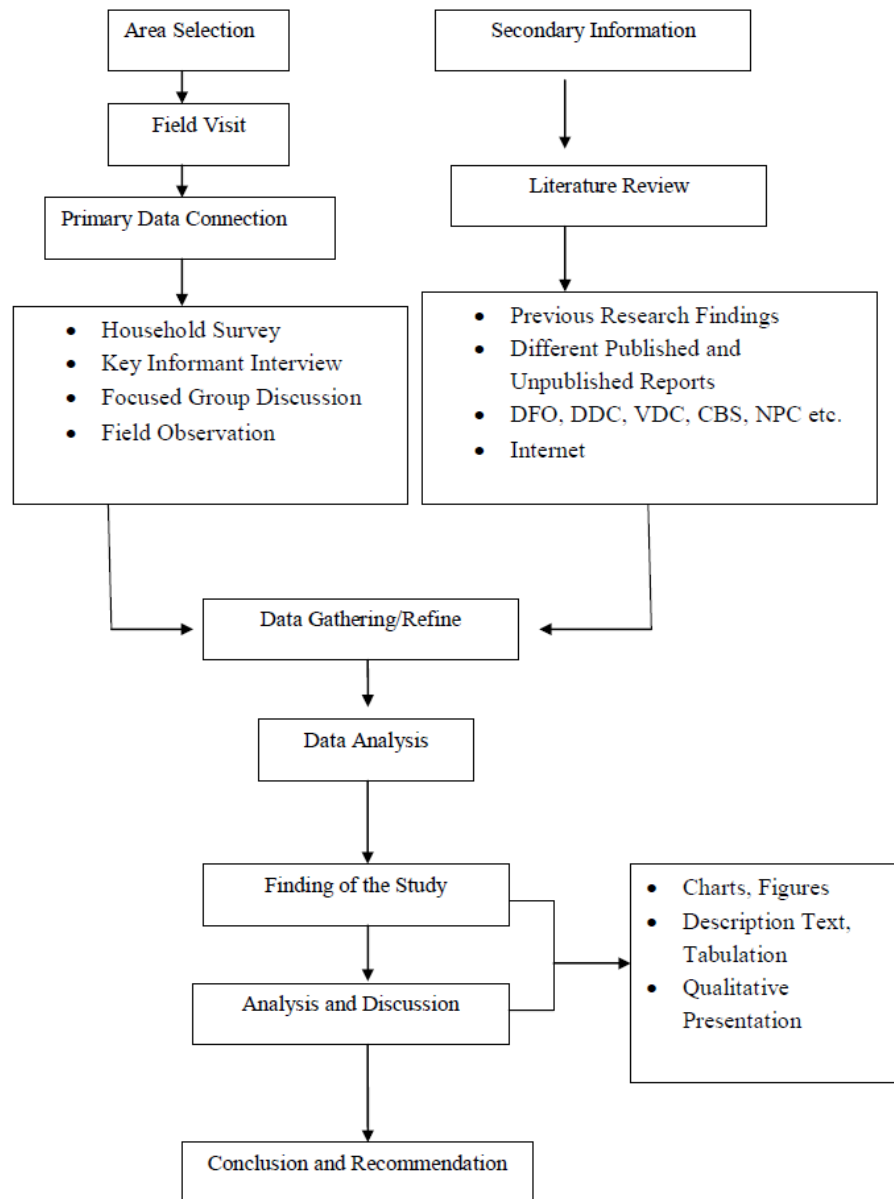
The sources of primary data are the structured household survey, interview with responsible stakeholders and direct observation at the sites. The questionnaire for household survey were prepared to identify the benefits of traditional buildings from local peoples' perspective at the local level. Some unstructured or open interviews were also carried out according to site situation. The medium used to collect primary information were filing out the questionnaire, taking note on paper, audio recorder, digital photographs and video recording. The main source of secondary data are collected from the various Government and Non-government Reports and many other scientific journals. The secondary data sources were mainly the published scientific papers related to indigenous architecture and sustainable livelihood and master thesis and dissertation done by previous researcher.

### **3.6 Methods of Analysis**

Data analysis and interpretation is an important stage of the research process. The purpose of analysing the data is to change it from an unprocessed form to an understandable presentation. Raw data conveys little information as such. It must, therefore, be compiled, analysed, and interpreted

carefully and meaningfully. After collecting the desired information or data through HHs questionnaire, interviews and observation checklist they were checked, verified manually to reduce possible error and categorized in different relevant headings and subheadings. Similarly, the data was tabulated in a master chart, table and figure (bar diagram, pie and column chart etc). Then, the raw data was processed with the help of excel sheet. It was kept on the sequential order based on the nature of the objectives. Finally, the data was analysed and interpreted. After analysing and interpreting the data, information will be drawn and recommendations will be made.

**Figure 16: Research Methodology**



# CHAPTER FOUR

## DESCRIPTION OF STUDY AREA

### 4.1 Background

The 2015 April-May Nepal Earthquakes caused huge loss of lives and properties in the country. About 9,000 casualties; 22,300 injuries, 8 million directly affected people (or 1/3rd of the national population), over half a million collapsed houses, and a drop by over 1.5 percentage points in gross domestic product (NPC, 2015). Although the most affected regions were rural areas located outside the Kathmandu Valley, the latter also witnessed about 1700 casualties, 13,000 injuries, and 724,00 collapsed houses. Several traditional buildings and monuments, world-renowned for indigenous Newari architecture, in the Kathmandu Valley were literally razed to the ground, completely changing the built form of several ancient towns such as Bungamati, Khokana, Lubhu, and most notably Sankharapur municipality (Sankhu).

As a town known for its heritage in the form of traditional architecture and built environment, the reconstruction of Sankharapur municipality could go either way: its historical built form could be adhered to, or there could be a departure in favour of ‘modern’ development. The complete collapse of traditional buildings has left a false impression that traditional building technology is not safe against earthquakes. However, these very buildings built with indigenous and ingenious building technology earlier survived the powerful 1934 Bihar Earthquake.

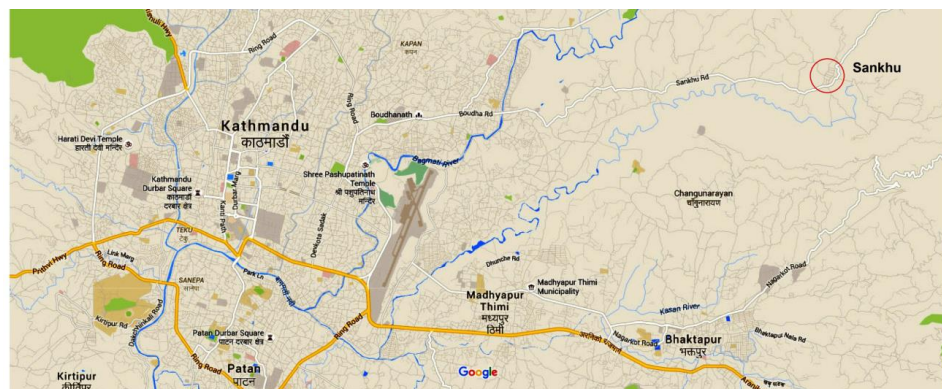


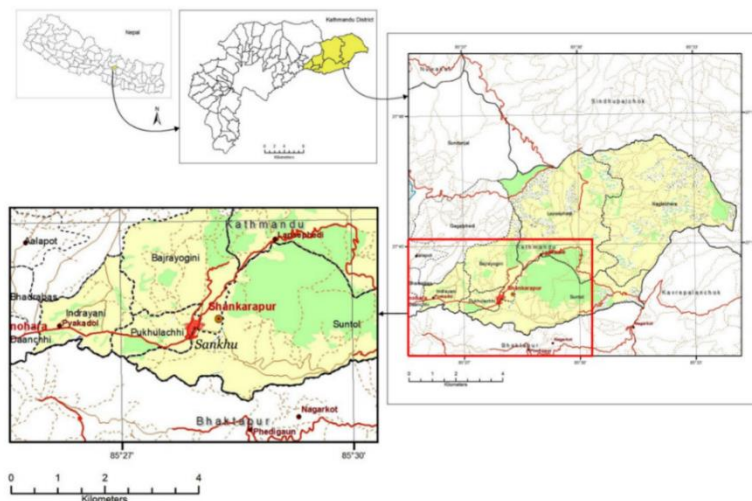
Figure 17: Location Map of Sankharapur municipality

Source: Google Map

## 4.2 Physical Settings of Sankharapur municipality

Sankharapur municipality is an ancient town populated mostly by the Newars and is situated about 20km northeast of the Kathmandu valley. It is also called sakwo in Newari. This settlement was established by Lichhavis on the bank of salinadi river. Until recently, the town was a part of the three Village Development Committees (VDCs) – Pukhulachhi, Suntol and Vajrayogini. It now forms the historic core area of recently declared Sankharapur municipality. This municipality extends to Sindhupalchok, Kavrepalanchok and Bhaktapur district in east, Kageshowri manhara municipality in West, Shivapuri national park in North and Chagunarayan municipality on south. At the time of the 2011 Nepal census it had a population of 4333 living in 928 individual households. It spreads in an area of 60.21 sq.km.

Once flourished as a trade post on the route to Tibet, Sankharapur municipality began to lose competitive advantage with the loss of this route in the late 1950s with further damage caused by the construction of Arniko Highway that now linked Kathmandu to the Tibetan border via Bhaktapur. Though most of the smaller traditional towns depended heavily on agriculture, Sankharapur municipality has historically been relatively less dependent on agriculture. Even in a survey conducted by HMG/N (1969), about 30 percent of the households reported non-agricultural occupation (e.g., commerce, wage employment or industries) as their primary occupation. The loss of trade to Tibet led to an increasing number of families seeking employment elsewhere, and even permanently migrating to other towns.

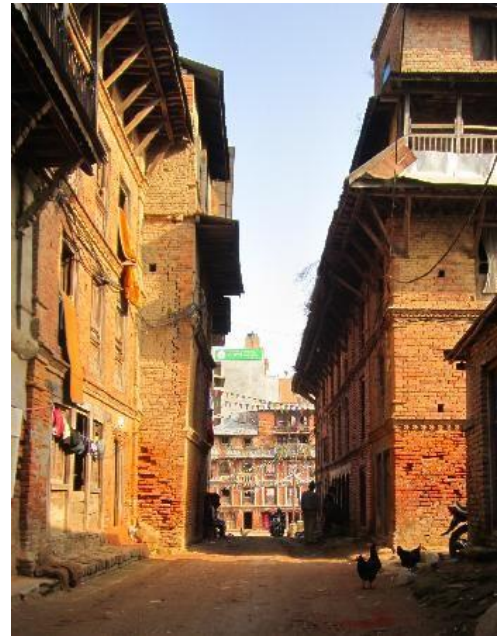


**Figure 18: Regional Map of Sankharapur municipality**

*Source: Ministry of Federal Affairs and Local Development, GIS and Map Center.*

### 4.3 Settlement Pattern of Sankharapur municipality

Like any other ancient town in the Kathmandu Valley, Sankharapur municipality is a compact settlement. Aside from the historic necessity for defense and the need for proximity to cultivated farmlands, the compact form of vertically oriented living in Sankharapur municipality – or any Newar town for that matter – is strongly motivated by concerns to preserve rich farmlands and minimize their use for residential purposes. With the abundance of clay in those times, houses have been uniformly built of burnt and unburnt clay bricks. The streets are mostly brick paved and the houses, of rather uniform height seldom exceeding 3 ½ stories, built on either side of the street have at least the brick walls of the compounds adjoining. The forest around the Sankharapur municipality becomes a huge source of timber that made timber easily available which were found in most of the buildings for construction. Houses are closely spaced built back to back with only a narrow lane between the two solid walls. (Shrestha, Joshi, Amatya, & Bajracharya, 2015)



**Photo 5: Narrow street of Sankharapur municipality**

With compact city arrangement, houses built together sharing a single wall and separating the buildings by a narrow sheet as shown in photo 5 explores more social characteristics of settlement pattern. Buildings facing each other makes easy to socialise among people. According to scholar the settlement pattern of Sankharapur forms a conch shell.



**Figure 19: Streetscape of Sankharapur municipality before earthquake**

As shown in figure 19. The settlement planning is such that there are big or small open spaces in front of the clusters of houses which provides a common platform for social events like jattras, feast or any community programme which will create a more supportive and cohesive social environment.

**Figure 20: The Base map of Sankharapur municipality**



Source : NSET,2015

#### 4.4 Traditional Residential Buildings of Sankharapur municipality

Most of the traditional residential buildings that exist today in the Sankharapur Municipality are from the Malla period, representing "the craft and architecture of the cultural renaissance of that period, which began around the beginning of the 15th century and survived the beginning of the Shah period, but rapidly faded during the Rana period (1845-1951 AD)" (Korn, 1977). Built, owned and resided by the Newar households using local materials and techniques, these buildings are also known as Newar houses.

The architectural design of the traditional Newari houses are more or less similar in every Newar settlement, and so are here in Sankharapur municipality. Use of the same elementary materials like baked and unbaked bricks, clay and wood, the two to five storey compact, linearly arranged houses, a central wall (*dathu anga*) believed to make it strong and dividing the house into two facades, the slope roofs with jhingati tiles, etc are found in all the old houses which survived in the 1934 earthquake. Also they have the ground floor (*chhindhi*), first floor (*mattan*), second floor (*chotan*), top floor (*baigah*), the courtyard behind for solid waste disposal site (*saga*), open latrines (*mala*), main gate (*mulukha*), storage rooms (*dhuku*), traditional wood stove (*bhutu*) and the place of worship (*puja kuthi*) in almost every houses. Very few houses have fourth floor (*pyetan*) and the fifth floor (*nyatan*). Thus every basic necessity for a house is fulfilled and the air and human circulation too, is very systematic. (Bassi, 2008).

The usage of floor seems to be varied depending on socio-economic status of the inhabitants. The usage of two floors namely *mātan* and *baiga*, seems to be similar across all social strata. Most commonly *mātan* is used as bedroom, sitting room, and treasure room and *baiga* is used as kitchen and *pujā kvathā* (worship room). However, the usage of two remaining floors namely *Chheli* and *chvata* found to be varied depending on the occupation of the inhabitants. The *Chheli* is found to be used as storage of agricultural implements, manure, farm products and livestock amongst the farming community, whereas occupational caste groups use it for their occupational workshops. Similarly, business community used it for shops and warehouses

of their merchandise goods. The aristocrats and royal courtyards use as store, room for guards, performing some household rituals, etc. The chvata being the widest space within the house is generally used as family gathering, holding feast primarily across all social strata. But the farming communities use to store their farm products such as paddy, maize and so on. Similarly this floor is used for household activities such as weaving, knitting, spinning, etc.

The roof is most important components of any house which is meant to protect the entire house from rain and weather. Like in other traditional buildings the roofs in the buildings of Sankharapur are slopped down on two sides about 30 to 45 degree at front and the rear elevation and projected at both sides for about 2.5 to 3 feet. The traditional tiled roof is made with combination of timber and thick layer of clay. The entire roof is supported by number of load bearing wooden columns. Most commonly the dwelling houses are roofed with āypā with grooves on both sides one on the upper face and another on the reverse so that they can be linked together. However, now-a-days tiled roofs are replaced with corrugated sheets and/or RCC slabs.

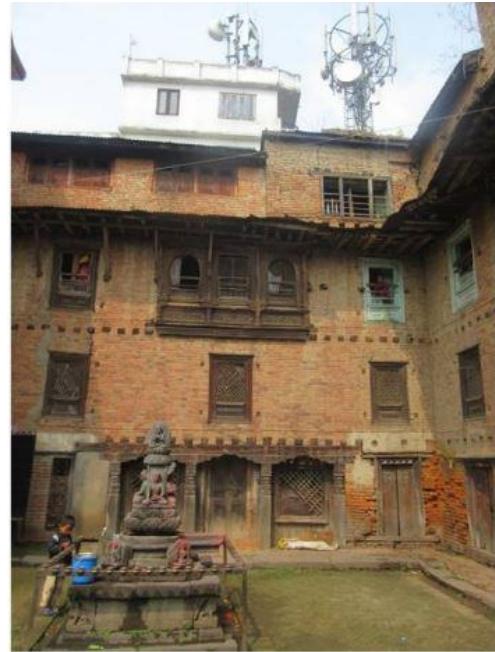


**Figure 21: Sectional view of typical Newari house**

*Source: Korn (1977)*

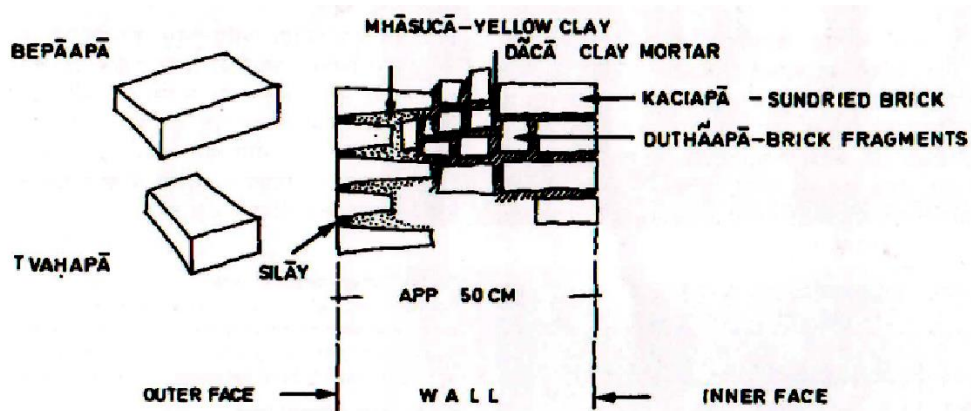
## 4.5 Construction practices of Sankharapur municipality

The traditional houses are known for indigenous and ingenious construction technology using mostly locally available materials. There is a uniformity in building materials used: wood, mud, baked bricks and tiles produced locally. The Newar buildings are also appreciated for the rich brick work and wood carvings in windows. In addition, the construction technology is rich enough to allow repair or maintenance of building elements without significantly dismantling structures. But such technology has mostly lost with time although there have been some attempts to record and revive traditional techniques.



**Photo 6: Functional courtyard in Newari settlement**

From foundations to roof, materials generally consist of stones, clay and wood. They use natural stones, pebbles or broken stones for foundations and burnt or sun-dried bricks made from clay for walls. Sun dried bricks are used for inner walls and burnt bricks are used for outer wall because of their more resistance to weathering.



**Figure 22: Three layered brick wall constructions**

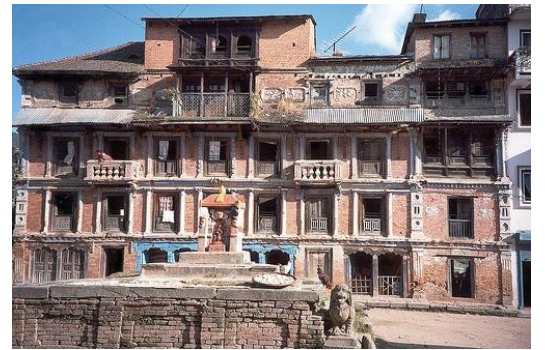
*Source: Korn (1977)*

The traditional Newari house depends on its own weight for stability. But the walls bear a tremendous load. To avoid weakening of the structure, the number of ground level openings is kept to a minimum. When large openings are required, massive beams and posts made of wood are provided to bear loads. The flooring materials consist of packed earth and mud plaster. The floor joists are covered with narrow planks of thin bamboo reeds of various thickness. The packed earth is then carefully laid on top, leveled and a fine coat of mud plaster is applied. The doors and window are all made of wood usually with carved motifs of flowers, serpents or dragons, done with both artistic and religious motives. The easy availability of wood had made the local crafts person explore the art in doors and windows.

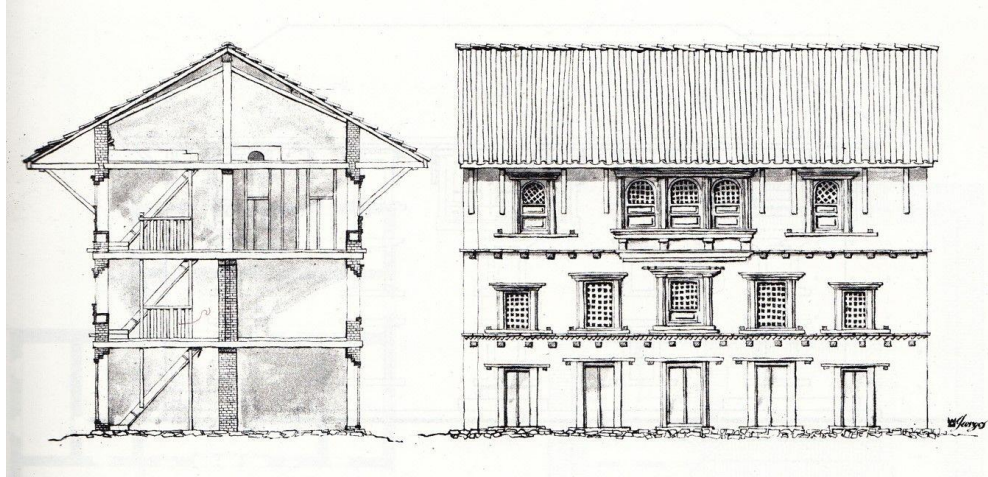
The roofs are usually symmetrical and owing to the rainy climate, pitched at about 30 degree. For roofing, flat red tiles or jhingatis are widely used. Tiling involves a simple procedure: the beams and roof rafters are positioned, spaced and covered with a layer of narrow wood planks over which mud is laid down to serve as a base for the tiles. The projections of roof protect the mud walls from the adverse effects of weather. (Shrestha, Bajracharya, Bajracharya, Shrestha, & Maharjan, 2016)



**Photo 7: Typical Newari style window**



**Photo 8: Traditional residential buildings of Sankharapur**



**Figure 23: Typical elevation & section of Newari House of sankharapur**

The wall thickness of Newari buildings are thick with mud plaster from inside which makes room warm in winter and cool in summer. The experience of local people says that they don't have to use heating or cooling equipment during winter and summer. The thick walls and floors prevent sun heat to pass inside and controls the higher temperature to go outside making it comfortable place to live in. Not only the architecture of the buildings but the settlement pattern of traditional houses maintains the temperature inside and outside making it comfortable.

#### **4.6 Current construction practices after earthquake**

Sankharapur municipality is recovering from earthquake and the structural materials they are using after earthquake are all modern. Cement, Sand, Steel reinforcement are used for the construction and exposed bricks are used in the elevation. For the foundation, RCC (reinforced cement concrete) footing are used replacing thick stone walls which were used in traditional buildings. Timber post, sill and lintels are replaced by RCC column and RCC lintel and sill band. Mud flooring has been replaced by cement sand flooring with ceramic tiles as a floor finishing. The traditional way of smoothing the floor using the



**Photo 9: Modern house construction after earthquake in Sankharapur municipality**

mixture of cow dung and clay has been diminishing by the introduction of modern materials. The roof has been replaced by RCC slab which used to be slope roof supported by wood with clay tiles over it. However, the current construction practices show the local materials being replaced by modern industrial materials. The limited size of land has encouraged the house owner to use modern materials as using local materials like stone walls or brick walls required thick walls making rooms smaller. After the division of property among the brothers, the scarcity of land had brought the necessity to increase the space vertically which ultimately requires to use modern technology. The desire of local people to live in modern houses has led the local people adopt modern construction practices.

#### **4.7 Current Government policies to retain and promote Indigenous materials**

Sankharapur municipality as by my findings is not found serious to revive its lost glory. It has set rule of not to plaster from outside and clay bricks have to be exposed on the front façade but only inside the town enclosed by 4 gates. But this rule is not found to be implemented effectively. Only wooden windows are allowed, the division of which should be odd in number as per the traditional style. No shutters are allowed and for the rentable space on ground floor wooden doors should be used as in traditional buildings. Sankharapur municipality is providing 50 cft. wood in subsidized rate to earthquake victim to encourage using wood. Similarly, it offers discount in taxes to earthquake victim if used brick exposed façade. However, the available rules are not enough to promote indigenous architecture.

#### **4.8 Conclusion**

All the buildings in Sankharapur were built of indigenous building materials before earthquake. They resemble to traditional Newari architecture. The settlement pattern and indigenous practices used in building has a potential to uplift socio-economic, environmental and cultural aspect of the municipality making the livelihood sustainable. After the earthquake the overall landscape of Sankhu has transformed to modern with traditional skin without giving concerns to it cultural identity. In the next chapter the comparison will be made on the livelihood of Sankharapur based on the five assets of the pentagon before and after earthquake.

## CHAPTER FIVE

### ANALYSIS AND IINTERPRETATION OF DATA

The collected data were edited, coded, classified and converted into presentable form like table, figure, charts. The chapter as a whole has been organised as follows:

- 5.1 Relationship between sustainable livelihood and indigenous knowledge and resources.
- 5.2 Impacts of indigenous knowledge and resources to the socio-economic, environmental and cultural identity of a community
- 5.3 Contribution of indigenous materials to sustainable livelihood development of a community compared to current industrial materials
- 5.4 Comparison of the livelihood of Sankharapur municipality before and after earthquake.
- 5.5 Current status of indigenous materials and Livelihoods
- 5.6 Indigenous buildings and sustainability
- 5.7 Current government policies to retain and promote indigenous materials
- 5.8 Challenges of using Indigenous materials
- 5.9 Conclusions

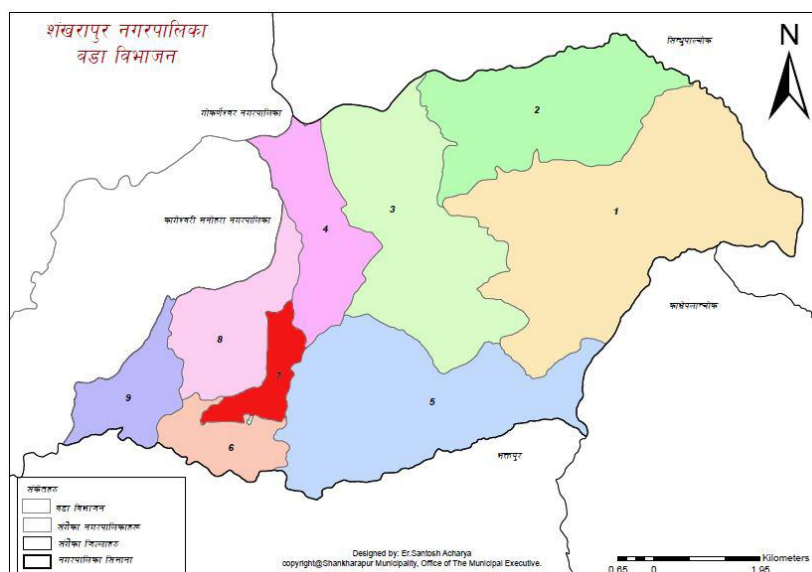


Figure 24: Regional Map of Sankharapur municipality

## **5.1 Relationship between sustainable livelihood and indigenous knowledge and resources.**

Indigenous buildings are less vulnerable to earthquake. The construction technology of using wooden band in lintel and sill in indigenous knowledge is followed in today's engineering practice to make buildings more resilient to earthquake. The special wooden chukuls were used to fix the joints which makes building intact and safe from earthquake. The thermal performance of traditional buildings are good compared to modern buildings. The thermal conductivity of indigenous materials like sundried bricks, timber, adobe, stone are lower than that of industrial materials which helps to maintain comfortable temperature inside the building resulting in less use of thermal appliance. Less use in thermal appliance means less energy consumption which ultimately results in low operational cost of the building.

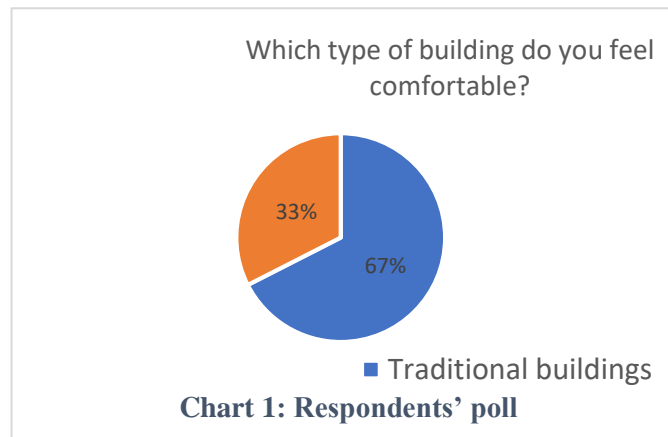
Indigenous knowledge are so advanced that they use open concept in planning of buildings. The staircase are open to adjacent rooms which contributes in maximum social interaction within the family. The long narrow windows are another social feature which allows for maximum social connections to neighbourhood. The indigenous knowledge use entirely natural materials which in other hand is biodegradable. It will help in reusing of such materials after it is dismantled. In the last earthquake in SM maximum wood were reused for making doors and windows and debris of mud were dumped into the farmland. If it were a concrete building then it will be a different scenario. Indigenous knowledge allows complete participation of local people resulting in higher employment opportunities for local people. Local people are familiar with indigenous knowledge and technology. So for the construction of indigenous buildings maximum local people will get to involve which helps in improving the economic status of the people.

As indigenous buildings use natural materials there is no need of transportation which helps in reduce cost of the building. Involvement of local people, low cost of materials reduces the overall cost of the building. Good performance of buildings results in low operational and maintenance cost.

## 5.2 Impacts of indigenous knowledge and resources to the socio-cultural, economic and environmental aspects of a community

### 5.2.1 Socio-cultural perspective

From the questionnaire, it was found that that all the construction of traditional buildings were used using local building materials by the involvement of local manpower. Whereas for the constructions of modern houses using modern materials, non-local people were hired in the construction process. Local people are very much familiar with local materials and local construction techniques. But if they use modern materials, they are unaware of it and its technology and they have to hire technician from outside. For example if they use aluminium window instead of wooden they have to bring technical person from outside. Thus, using local materials and techniques creates employment opportunities for local people. Even during maintenance most of the house owner themselves do maintenance work in traditional buildings but nowadays they are living in modern houses which used modern



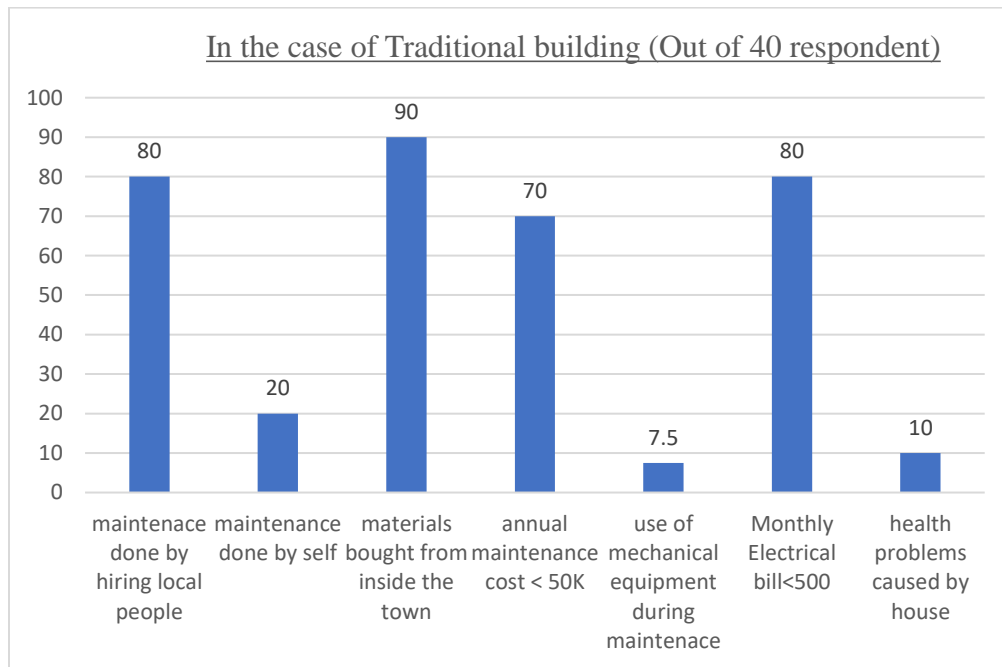
materials like glass, CGI, aluminium so they need to hire labours for maintenance from outside. It is observed that indigenous buildings enhance socialization among people through its architecture. Long windows with seating of brick walls enables easy view of outside during jattras. It enables to easily communicate with neighbourhood.

It was also observed that people get health related problems in modern house like they get common cold, joint pain due to cement flooring which keeps floor colder. The traditional settlement have compact planning with large wall thickness built with mud mortar and mud



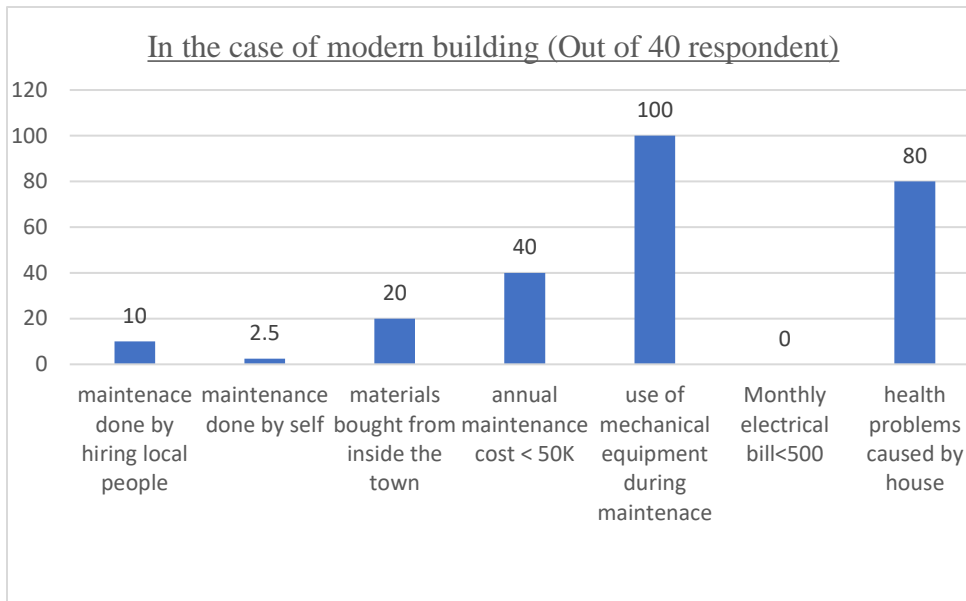
flooring which keeps building warm. The thermal performance of traditional building maintains comfort while living inside the building.

The questionnaire result shows that people find old buildings physically and mentally comfortable. Hence buildings which used natural building materials are efficient and are good in ventilation systems as compared to modern buildings. Such type of building can keep inhabitants healthy, happy, satisfied and well-being which can also be considered as a social dimension for sustainable livelihoods. Chart 1, 2 and 3 show the comparative study by using core parameters of Traditional and Modern buildings and its impact on Social Sustainability.



**Chart 2: Result of living in traditional building**

The questionnaire was asked to 40 respondents. Out of 40 respondents, 80% told us that maintenance work was done by hiring local people and 20% respondents told us to be done by themselves. 90% respondents told that materials were bought from inside the town. 70% respondents told that their annual maintenance cost was below 50 thousand and 7.5% respondents told to use mechanical equipment and remaining 80% don't use mechanical equipment but used manual tools during maintenance work. 90% respondents don't have any health problems by the house but 10% had some kind of allergies by the dust in traditional buildings.



**Chart 3: Result of living in modern building**

In modern houses out of 40 only 10% respondents told to hire local people for maintenance and remaining 90% hired non local people and just 2.5% respondent told to do by themselves. 80% of respondents bought materials from outside the town and 20% from inside the town. 40% have annual maintenance cost below 50 thousand and 60% had above it. They had to hire non local people and buy materials from outside the town which might had caused increased the maintenance cost. All the 100% respondents told to use mechanical equipment and all have monthly electrical bill above 500. 80% respondents told that they had health problems because of house.

### 5.2.2 Economic Perspective

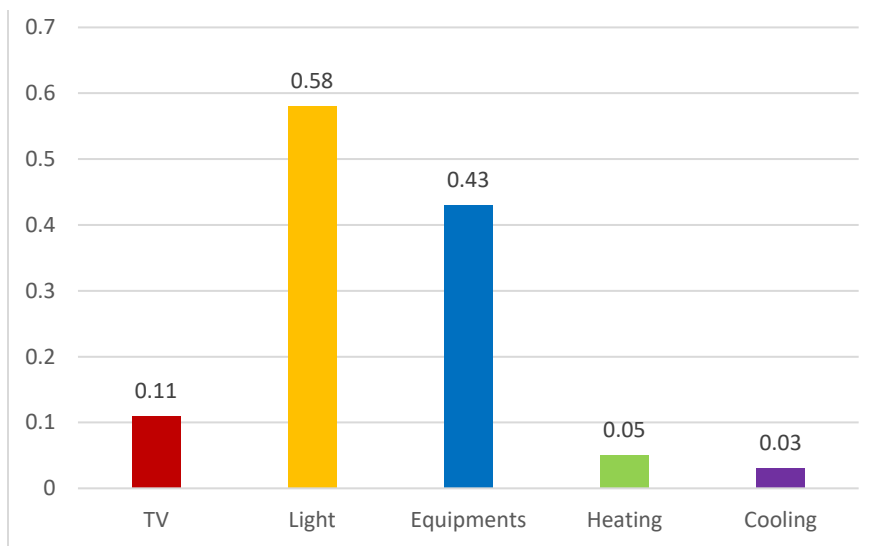
The questionnaire result shows that construction cost of building is too low when used natural building materials. Such materials are found locally and hence saves transportation cost. For the maintenance work self or local people were involved in traditional buildings and maintenance cost is also low. Local people are mobilized for the construction and maintenance work which makes building cost lower and in other hand creates employment opportunities to local people. Mobilization of local people creates scope of using indigenous materials and techniques. It will create opportunity of learning and teaching of indigenous knowledge.

People will be interested on such knowledge which will contribute in opening of training institution or colleges. This will create learning environment making more people skilled.

As the traditional building are thermally comfortable, no heating or cooling appliance need to be used during winter and summer reducing the operational cost of the building but the case is just opposite in modern buildings (see chart 4 & 5). The thermal conductivity of earth is lower than burnt brick which is again lower than other modern materials as shown in table 5.1. This proves the thermal performance of traditional building is better which makes the inhabitant comfortable inside during summer and winter making them not to use any electrical appliance. This will reduce monthly energy consumption keeping electrical bill down.

**Table 5.1: Thermal conductivities of some building materials (Givoni, 1998)**

Material	Metric (W/m.C) Thermal Conductivity
Dense concrete	1.7
Concrete blocks	1.3
Face Bricks	1.3
Common Bricks	0.7
Cement mortar	0.8
Stucco/Interior Plaster	0.7
Softwood (fir, pine)	0.12
Hardwood (oak, redwood)	0.12
Gypsum/Plaster Boards	0.16
Plywood	0.12

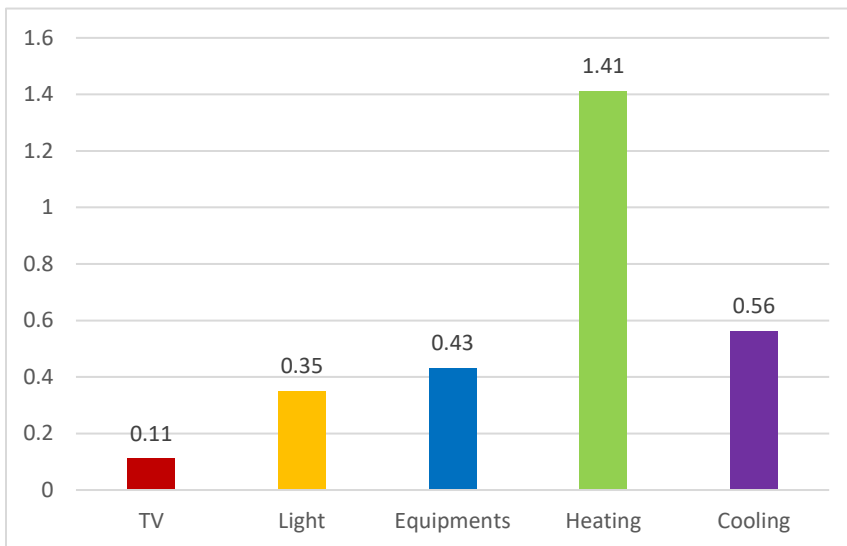


**Chart 4: Average Energy consumption per household in traditional buildings**

Indigenous buildings have intrinsic value. Using indigenous materials give a cultural identity to the place promoting tourism industry. Old buildings attract people which eventually generate income generating opportunities as the traditional buildings becomes the choice of tourist for night stay. More income generating opportunities less youth moving abroad for employment. This will strengthen socio-cultural life as people can live with their family and can participate in their cultural practices.

In the words of Nobel Prize Laureate Robert Merton Solow (Licciardi and Amirtahmasebi, 2012):

*“Over the long term, places with strong, distinctive identities are more likely to prosper than places without them. Every place must identify its strongest most distinctive features and develop them or run the risk of being all things to all persons and nothing special to any Livability is not a middle-class luxury. It is an economic imperative.”* – Robert Merton Solow.



**Chart 5: Average Energy consumption per household in modern buildings**

### 5.2.3 Environmental perspective

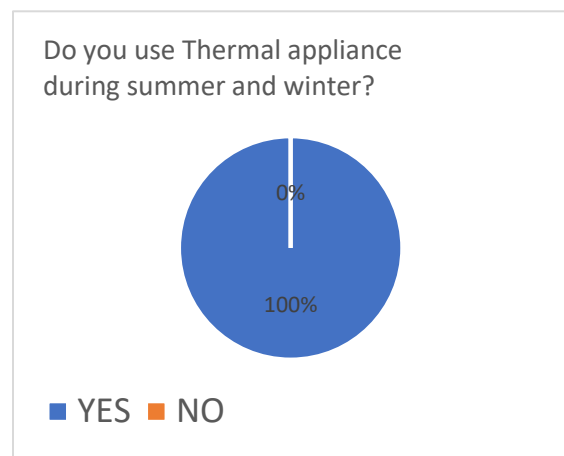
When people used local materials for construction then there is no need of transportation. There will be less energy intensive production process and consequently lower embodied energy and CO2 emissions. Natural materials have low environment impact as it emits low VOC compared to modern industrial materials. Modern materials when gets heated at certain room temperature emits harmful chemicals which gets homogenized with surrounding environment affecting the

health of the surrounding people. During the questionnaire it was observed that people living in modern homes have modern health issues than number of people who used to live in traditional building. If we look and analyse at production level of modern materials, lots of energy are consumed for the manufacturing and production process. Again the transportation to construction site consumes extra energy and pollutes the environment creating health problems to the people.

Modern building materials contains dangerous volatile organic compounds (VOC). From insulations and wood panels to varnishes and sealants, numerous building materials emit toxic compounds at certain room temperature. In new buildings and new construction materials, for example, VOC emissions vary from 0.5 to 19 mg/m<sup>3</sup>. In old buildings, on the other hand, levels range between 0.2 and 1.7 mg/m<sup>3</sup>. Adverse health effects due to exposure to volatile organic compounds can occur above 3 mg/m<sup>3</sup>. Common health problems include asthma, skin irritation, headaches, nausea, confusion, and eye irritation. Such emissions impact the indoor air quality polluting the environment and making the people unhealthy.



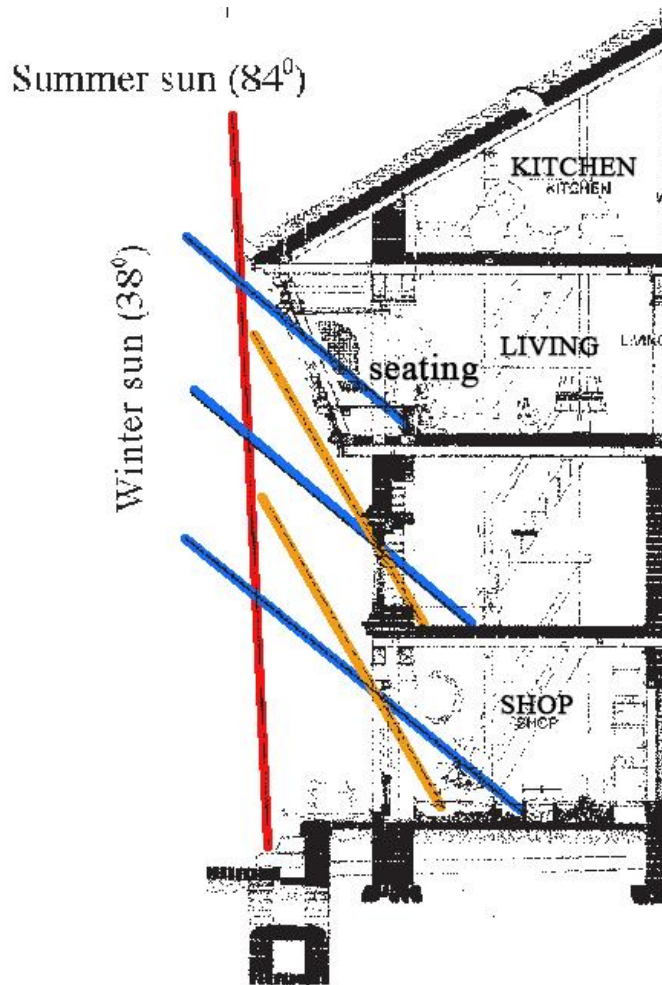
**Chart 6: % showing thermal appliance user in summer and winter for indigenous building**



**Chart 7: % showing thermal appliance user in summer & winter for modern building**

When interviewing Roshan Shrestha, one of the earthquake victim, about how buildings debris were managed, they told me that most of the wood were reused for making door and window frames and debris from brick and mud mortar were either used of raising plinth for newly constructing building and some were disposed in their own farmland. This gives the clear view of sustainable nature of such local materials.

**Figure 25: Arrangement of Openings in a Traditional Building and Solar Penetration through Windows in Different Seasons**

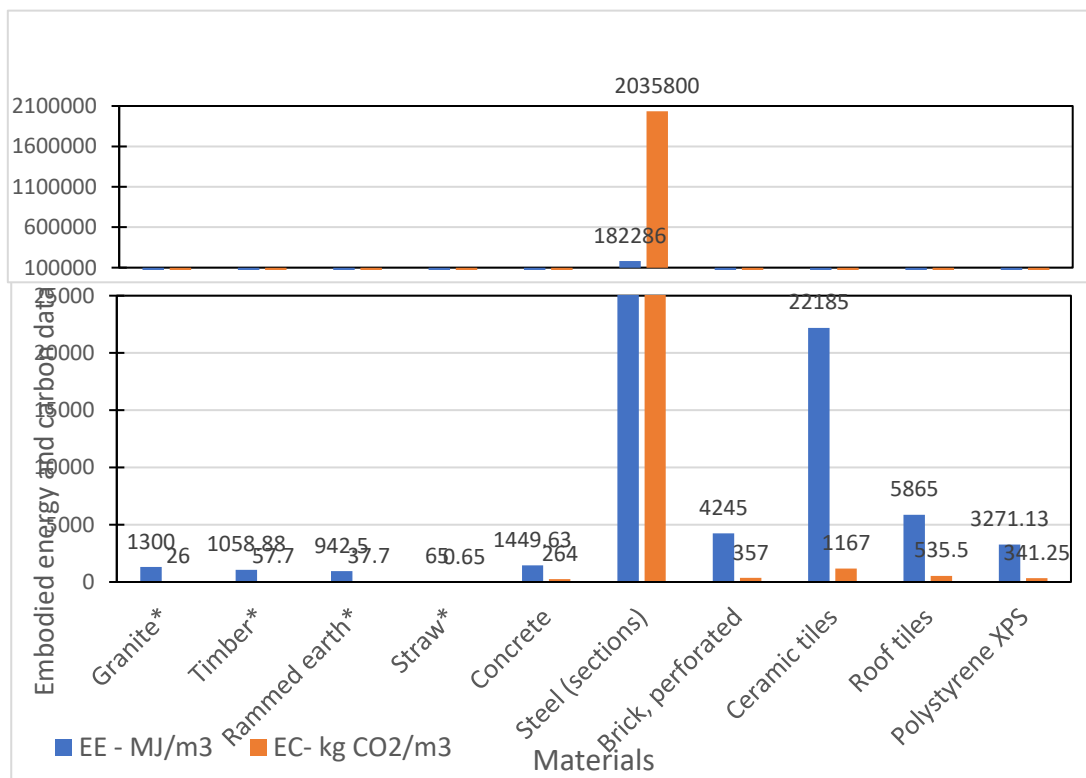


From Figure 25 it is clear that roof projection of traditional buildings are enough to block summer sun casting shadows on the building making it cooler. Similarly, openings are so arranged that winter sun can penetrate inside the building through window making it warm. This type of arrangement makes traditional building healthy to live in. Not only from thermal point of view, from social perspective it offers comfortable environment as it has open planning which makes easy interaction among family members. Also, the projected window with built in seating offers easy view to outside. During social functions like jatra this offers comfortable seating area. This kind of knowledge and practice helps in the individual to lower their operational and maintenance cost making such building economically sound.

### 5.3 Contribution of indigenous materials to sustainable livelihood development of a community compared to current industrial materials

Current industrial materials have many environmental impacts. The embodied energy and CO<sub>2</sub> emissions of industrial materials are too high during manufacturing process compared to indigenous materials. From extraction of raw materials to production and transportation of such materials from industries to site consumes lots of energy along with high CO<sub>2</sub> emissions which are responsible for global warming as shown in Figure 26.

Chart 8: Embodied Energy and Global warming potential



Sources: Bragança & Mateus 2011; \*Berge 2009.

Modern building materials contains dangerous volatile organic compounds (VOC). From insulations and wood panels to varnishes and sealants, numerous building materials emit toxic compounds at certain room temperature. In new buildings and new construction materials, for example, VOC emissions vary from 0.5 to 19 mg/m<sup>3</sup>. In old buildings, on the other hand, levels range between 0.2 and 1.7 mg/m<sup>3</sup>. Adverse health effects due to exposure to volatile

organic compounds can occur above 3 mg/m<sup>3</sup>. Common health problems include asthma, skin irritation, headaches, nausea, confusion, and eye irritation. Such emissions impact the indoor air quality polluting the environment and making the people unhealthy.

## **5.4 Comparison of the livelihood of Sankharapur municipality before and after earthquake.**

The status of livelihood capitals in the study site was assessed applying the judgmental scoring method in which the changes brought about in five different capitals after the earthquake to the household were studied. The livelihood assessment is done after earthquake where they are living in modern buildings and on the basis of their past experience before earthquake where they used to live in traditional houses, livelihood assessment is done of that time also and the comparison was made. The changes in each capitals were studied on the basis of three indicators for each capitals. The average scores were then plotted in a spider web diagram which is as shown below in figure 13.

### **5.4.1 After earthquake when living in modern buildings**

The indicator used to assess human capitals were condition of awareness regarding indigenous materials, techniques and practices, health conditions influenced by buildings and employment conditions in the family each of which got the average scores of 0.75, 0.325 and 0.4 respectively. The total score for the human capital was found to be 1.475.

Similarly, the physical capital was assessed based on indicators like access to buildings, effectiveness of construction and access to indigenous knowledge and construction technology. The average scores for each of the indicators were found to be 0.525, 0.25 and 0.35 respectively. The total score for physical capital was 1.125.

Like in assessing social capitals, relation among community people, access to guthi and relation to social neighborhood were the indicators used and the average score for each of these indicators were 0.4, 0.55, and 0.375 respectively. The total score for social capital was 1.325. Likewise, among the three indicators used to assess the status of financial capitals, increment in employment opportunities got and average score of 0.55, status of maintenance and operational cost of building got 0.3 and status of income and economic assets got 0.725. Thus, the total score for financial capital was 1.525.

And, access to land and natural resources, access to water and access to clean environment, were used as indicators to assess the status of natural capitals and each of these had the average scores of 0.475, 0.325 and 0.20 respectively. Thus, total score for natural capital was 1.0.

#### **5.4.2 Before earthquake when living in traditional buildings**

The indicator used to assess human capitals were condition of awareness regarding indigenous materials, techniques and practices, health conditions influenced by buildings and employment conditions in the family each of which got the average scores of 0.625, 0.65 and 0.6 respectively. The total score for the human capital was found to be 1.875.

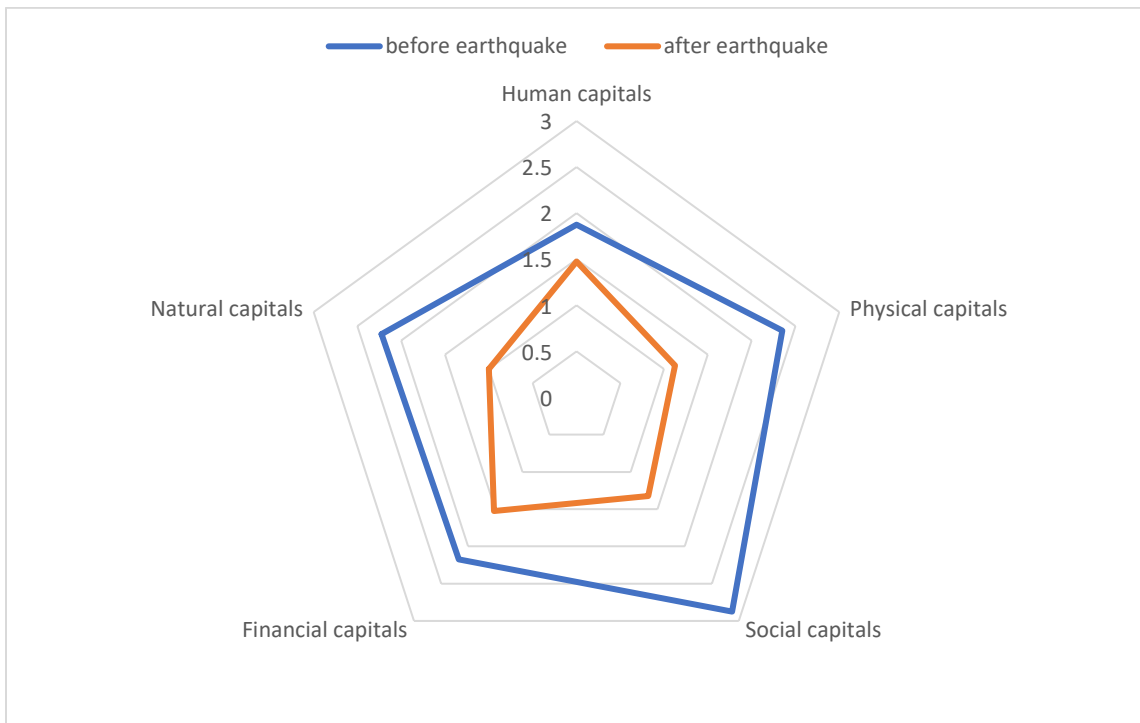
Similarly, the physical capital was assessed based on indicators like access to buildings, effectiveness of construction and access to indigenous knowledge and construction technology. The average scores for each of the indicators were found to be 1, 0.6 and 0.75 respectively. The total score for physical capital was 2.35.

Like in assessing social capitals, relation among community people, access to guthi and relation to social neighbourhood were the indicators used and the average score for each of these indicators were 1, 1, and 0.875 respectively. The total score for social capital was 2.875. Likewise, among the three indicators used to assess the status of financial capitals, increment in employment opportunities got and average score of 0.7, status of maintenance and operational cost of building got 0.775 and status of income and economic assets got 0.7. Thus, the total score for financial capital was 2.175.

And, access to land and natural resources, access to water and access to clean environment, were used as indicators to assess the status of natural capitals and each of these had the average scores of 0.875, 0.575 and 0.775 respectively. Thus, total score for natural capital was 2.225. The total scores of the five different livelihood capitals assessed before and after earthquake living in modern and traditional buildings were presented in table

**Figure 26: Livelihood capitals assessment scores & grading**

S.No.	Livelihood capitals	Scores		Grading	
		Traditional buildings		Modern buildings	
1	Human capitals	1.875	<i>Borderline</i>	1.475	<i>Moderately healthy</i>
2	Physical capitals	2.35	<i>Moderately healthy</i>	1.125	<i>Borderline</i>
3	Social capitals	2.875	<i>Healthy</i>	1.325	<i>Borderline</i>
4	Financial capitals	2.175	<i>Moderately healthy</i>	1.525	<i>Borderline</i>
5	Natural capitals	2.225	<i>Moderately healthy</i>	1.0	<i>Borderline</i>



**Figure 27: Radar plot comparison before & after earthquake**

The result shows that the livelihood before earthquake while living in indigenous buildings were good but is declining in all capitals after earthquake when living in modern buildings. The social capitals were healthy and human, physical, financial and natural capitals were moderately healthy before earthquake. After earthquake physical and Natural capitals are moderately unhealthy whereas human, social and financial capitals got grading of borderline.

## **5.5 Current status of Natural building materials and livelihoods**

The Government rules of using bricks exposed façade inside the town only (enclosed by 4 gates) has at least encouraged the locals to use brick. But outside the town people are using cement plaster to cover bricks. Some are using modern ceramic tiles. They use RCC dhalan for floor which in traditional buildings used to be mud flooring supported by wooden beams(dalin). They use wooden doors and windows inside the town but aluminium windows outside the town. So it seems that where the municipality rules are applicable they use natural materials but where its not applicable they go for modern materials. Bricks and wood are the only natural building materials they are using currently but construction technology are modern. The reason for this is the cost of natural materials are high and very difficult to afford for middle class family. The indigenous construction knowledge is slowly dying and hence people are moving to Kathmandu for trade or job. Some have small business in Kathmandu. The main occupation of people of Sankharapur municipality is trade and business. After the earthquake people built their house in their farmland outside the town which has caused some people to leave celebrating jatras and other rituals. The tamang are the main ethnic groups who are migrating to Sankharapur. So sometimes there is a conflict between Newar and Tamang community which has influenced the social life as per the local people. The local people are also losing land assets as they are selling their land to outsiders mainly to Tamang and they are moving to Kathmandu. The cultural landscape has totally changed after earthquake. Before earthquake there were traditional buildings made of bricks, timber, slope roof with jhingati tiles but now it has been replaced by modern buildings with traditional look only.

## **5.6 Indigenous buildings and Sustainability**

### **5.5.1 Basis of assessment of sustainable Buildings**

Understanding the field and the content of the local culture is very important to successfully transfer and perform technologies. If we want new technologies and new usage to be acceptable and workable, we need to put them together in a line of people who probably use these technologies and usage, people's expectations, needs, knowledge and culture is very important for this purpose. If we want a technique or method to be acceptable by people and perform a

sustainable architecture which can answer the particulars above, the following criteria and standards could be the basis of assessment about sustainable architecture (Norton, 1999):

- A perfect usage of existing materials and local transportations
- Using recourses which are available and enough to fulfill general and essential demands without damaging the environment
- Being independent through unavailable equipment
- Using those kinds of skills which effectively developed and trained in the society
- Using those kinds of skills whose results are corresponding to the social, economic, environmental, and local fields
- Skills whose results are valuable
- Skills which work through local weather effects
- Skills which are flexible through local demands and habits
- Skills which could be repeated by indigenous people

Many sustainable buildings compliance with these standards are gained by local creativities. What really is sustainable needs a long time to be understood, one need to spend time to develop and increase abilities in order to prove an idea or be tasted for a building system to be sustainable. (Amiri & Vatandoost, 2017)

### **5.5.2 The features of Sustainable buildings**

- Paying attention to human life, preservation of it in the current time and future
- Using materials which are humanized with the environment during producing, using and even destroying time
- Minimum usage of fuel energy and maximum usage of natural energy
- Minimum environment degradation
- Physical and mental important of human life and other organization
- Being in a harmony with the local nature

The purpose of designing these kinds of buildings is to reduce damaging environment includes the following rules:

- Using less nonrenewable resources

- Developing natural environment
- Omit or reduce the usage of toxic or harmful substances on nature in the building
- industries

Building techniques tries to assure integrated quality in economic, social and environmental fields. Rational use building proper management leads us to save the limited natural resources and helps us to reduce energy consumption and improves environmental quality. Quality is the base of sustainable development design. Good quality could not be achieved without paying attention to the nature and also perennial materials should be used as more as possible. Achieving high quality standards, safety and comfort which in fact ensures human heatheness is one of the most important purposes of sustainable architecture which can be gained by efficient management and using the latest technologies.

According to this, the following principles should be obeyed in this kind of architecture.

- Understanding the sense of place, universe space and not disturbing in it
- Using natural energies like solar and wind energy
- Using natural-local materials which are recyclable and durable
- Collect and use water, especially rain water and use water of lakes and oceans
- Prepare insulation of the building, thermal and sound insulation
- Available natural ventilation through the roof
- Proper lightening and proper design of the openings. (Gorji, Yusof, & Ali, 2010)

The photo shown is of the shrestha house, patan which gives a finest example of sustainability of indigenous building. Adaptive reuse of such heritage buildings can secure access to financial resources, supports multiple livelihood strategies and promotes equitable access to competitive markets for all.



**Photo 10: The shrestha house, patan**

## **5.7 Current Government policies to retain and promote Indigenous materials**

Actually, Sankharapur municipality is not found serious in promoting indigenous materials and technology. The only rules they have put forward is to use bricks in front façade and wood for outer doors and windows. Municipality is providing 50 cubic feet of wood to earthquake victims in subsidized rate and rupees 3 lakhs in installment for using bricks in front. This is only for earthquake victim and non-victims have to afford by themselves which is discouraging other people to use natural materials. Current government policies are found limited only to earthquake victims but not implemented strictly.

## **5.8 Challenges of using Indigenous Materials**

Despite of many advantages of indigenous materials there are some challenges of using it. Timber being a sustainable material it requires a lot of treatment and maintenance. Water affects timber, termites can attack it. So to protect it, additional funds need to be spent increasing the cost. Sun dried bricks, mud mortar when gets moist, vegetation grows on the surface. To prevent vegetation growth it requires treatment. If mud are consistently wet or relentlessly exposed to high-humidity areas such a showers and sinks without adequate protection, a conventional house will also easily host insects and is susceptible to mold, too, if not built right. Using indigenous materials demand for extra-thick wall occupying more interior space. It will make room size smaller, so to counteract it people increase the footprint of the buildings increasing the overall cost. Stones too are susceptible to moisture damage. Dressed stones looks good aesthetically and they are strong too. Dressing of stones requires skilled manpower which consumes more time and cost. Stone being heavy either need vehicles for transportation or manually carried to the site. If manually carried it requires lot of manpower and time. Nowadays because of improper management of natural resources construction cost is high if build with indigenous style.

## **5.9 Conclusions**

Indigenous buildings meet parameters of sustainability. People love to live in old buildings if they have easy services like toilet, proper drainage line which is found not enough nowadays

because of changing lifestyle. People have lower maintenance cost and high employment opportunities for local people in such buildings. Social life is good as the settlement pattern is such that all the buildings are joined together facing each other giving space for interactions. It has less impact on environment as all the materials are natural. Providing comfort, reducing expenses, keeping healthy, making social, all these parameters contributes in making livelihood sustainable. Hence indigenous knowledge and practices gives best output to human beings than any modern materials. If there could be anything that can protect our earth is only by the use of indigenous materials and practices.

## **CHAPTER SIX**

### **SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS**

#### **6.1 Summary of Findings**

The aim of this thesis was to examine the relationship between indigenous materials and its impact on the sustainable livelihood and to find out the potential of natural building materials in building construction through case study of Sankharapur municipality. Another objective of study was to make livelihood assessment of Sankharapur municipality before and after earthquake. Before earthquake there were traditional indigenous buildings made of local materials in Sankharapur municipality. After 2072 earthquake about 90% of buildings were totally damaged and remaining buildings were made unsafe to live. Now after earthquake the construction practice is modern using more industrial materials and only few natural materials.

This study also aimed at investigating the various ecological lessons of indigenous architecture studying a case of Sankharapur municipality. It is observed that the basis of sustainable livelihoods and the main goals of the indigenous architecture are both in the same direction. Social, economic and environmental concerns that are the pillars of sustainable livelihood can at the same time be easily understand in the buildings which are designed and built by locals using indigenous materials and technology.

Sustainable design in Sankharapur municipality was part of the daily lives of the local people but the scenario now is different after earthquake. After the earthquake it is observed that Sankharapur is losing its cultural heritage landscape and is turning into another concrete jungle with traditional skin. This thesis encourages looking to the past for future solutions in a realistic manner. It is also acknowledged that there are certain limitations, such as how dwelling use has changed over time. People now use them for a variety of purposes including sleeping, working, and relaxing. They are used continuously, intermittently and year-round. People require and expect privacy, daylight and natural ventilation. It is for this reason that indigenous

strategies will still need to be supplemented with modern technologies, to ensure these needs and conditions are met at all times.

Further research should be conducted in better quantifying the effects of indigenous design strategy implementation and introducing it into educational curriculums so future generations can benefit from the wisdom of the past.

## **6.2 Conclusions**

Indigenous knowledge and resources are advanced in many ways. Indigenous buildings are resilient to vulnerability context like earthquake. They are environment friendly. They are economical, durable and carries cultural identity. Indigenous buildings are very good in thermal performance. This makes such buildings comfortable to live. Use of indigenous materials in building construction preserves indigenous knowledge and technology and also provides employment opportunities to local people which helps in improving the economy of the community. Such buildings have no impacts on environment. They offer maximum social interactions within the family in the micro level. On macro level traditional town planning consists of open spaces, water spouts, public buildings which are meant for social gatherings and also used for socialization which in modern society found to be lacking.

The livelihood are influenced by the knowledge which we use. The knowledge and resources of past had influenced the livelihood in positive ways. Before earthquake in SM people were happy, satisfied and financial conditions were also good. There were clean natural environment, clean water services and air quality were good. More people were involved in jattras and nakhas which is found to be declining after earthquake. People are migrating to Kathmandu for employment and for better education. Hence considering five assets of livelihood, it was found better before earthquake.

In conclusion, combining appropriate indigenous building methods with contemporary technologies will result in resource savings, enrichment of culture, a stronger sense of place, and provide a more comfortable living environment for generations to come pushing the livelihood in a sustainable path.

### 6.3 Recommendations

From the above findings and conclusions following recommendations are made:

- It is recommended to develop policies like subsidizing tax on using indigenous materials and techniques that encourages local people to adopt such knowledge.
- Municipality should do the proper zoning of the area to residential zone, heritage zone, commercial zone, urban expansion zone and set byelaws to compulsory build buildings using indigenous style at least in heritage zone.
- The local government should conduct programmes to make people aware of the benefits of using indigenous knowledge and practices.
- Municipality should prepare a masterplan to develop it as a tourist destination and they should also build tourist infrastructures following indigenous style which will encourage local people to adopt indigenous knowledge.
- Local media should give information on indigenous material and technology and its various advantages based on hard facts of material quality, performance, construction and recurrent costs as an awareness campaign.
- Local government should conduct training programme for construction technology based on indigenous knowledge by skilled local people which will help preserve indigenous knowledge and in other hand creates employment opportunities for local people.
- The survived indigenous building should be adapted to reuse as a hotels or community library or any community buildings which will set a living example of advantages of indigenous knowledge.
- Municipality should encourage the architects and engineers to design as per the indigenous style.
- Local communities should organize monthly events to attract tourist in which local homes should be used to offer BnB (bed n breakfast) that will make people aware that indigenous buildings comes in first choice for tourist.
- The local people with indigenous knowledge should be honored by the local government to encourage people to learn it and to convey it to future generations.
- Public buildings should be build using indigenous knowledge that will encourage people to use it for their private buildings as well.

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## ANNEX 1 – Questionnaire

Name of House owner:

Name of respondent:

Surveyor name:

Ward no.

Date:

1. Building type
  - i. Traditional house House
  - ii. Modified traditional house
  - iii. Modern
2. Building construction type
  - i. Load bearing structure
  - ii. RCC frame structure
  - iii. Timber
  - iv. Prefab structure
3. Building materials type
  - i. Stone masonry with mud/cement mortar
  - ii. Sun dried brick masonry with mud/cement mortar
  - iii. Burnt brick masonry with mud/cement mortar
  - iv. Others
4. Types of building materials used
  - i. Natural building materials
  - ii. Industrial materials
  - iii. Half natural half industrial materials
5. Building story
  - i. 1-2
  - ii. 2-3
  - iii. 3-4
  - iv. More than 4
6. No. of family members
  - i. 2-4
  - ii. 4-6
  - iii. 6-8
  - iv. More than 8
7. Building materials used
  - i. Stone
  - ii. Timber
  - iii. Earth
  - iv. Bamboo
  - iv. Bricks
  - vi. Steel
  - vii. Cement
  - viii. Sand
  - ix. Aluminium
  - x. Others
8. Where are the construction workers from?
  - i. Local people
  - ii. Non local people
9. What type of maintenance do you think you will be doing within 5 years?
  - i. None
  - ii. Roof leakage
  - iii. Openings (door/window)
  - v. Beam/ Pillar (in traditional) Wall/floor maintenance
  - vi. others
10. Where do you get materials incase of renovation or maintenance
  - i. All from Inside the town
  - ii. All from Outside the town
  - iii. More than 50% inside the town
  - iv. More than 50% outside the town

11. What are the average maintenance cost of building?
  - i. < 1lakh
  - ii. >1 lakh<2 lakh
  - iii. > 2 lakh
  - iv. Others....
12. What type of tools are used for renovation of maintenance?
  - i. Machinery tools
  - ii. Manual tools
13. Do you use equipment while constructing buildings?
  - i. Yes
  - ii. No
14. If yes how does the equipment operate
  - i. Electricity
  - ii. Petrol/diesel
  - iii. Manually
15. What are the cost of construction of buildings?
  - i. 10lakh-20lakh
  - ii. 20 lakh – 40 lakh
  - iii. 40 lakh – 80 lakh
  - iv. More than 80 lakh
16. Does government subsidize on tax while using local materials?
  - i. Yes
  - ii. No
17. Does government subsidize on tax while using modern materials?
  - i. Yes
  - ii. No
18. How is maintenance done?
  - i. By local people
  - ii. By non local people
  - iii. By self
19. What is the average electricity monthly bill?
  - i. Less than 1000
  - ii. 1000-2000
  - iii. More than 2000
20. What type of heating equipment used during winter?
  - i. Electric heater
  - ii. Gas heater
  - iii. Natural wood
  - iv. None
21. What type of cooling equipment used during summer?
  - i. Fan
  - ii. AC
  - iii. Cooler
  - iv. None
22. Which type of home is thermally sound?
  - i. Traditional house
  - ii. Modern house
  - iii. None
23. Do you feel comfortable in old house or in new house
  - i. Old house
  - ii. New house
24. Which type of home do you prefer?
  - i. Traditional house

- ii. Modern house
25. Do you think your family members get health problems because of the house?
- i. Yes
  - ii. No
26. What is the annual average medicinal expenses?
- i. Below 50 thousand
  - ii. 50 thousand -1 lakh
  - iii. More than 1 lakh
27. What type ho health problems are often seen in family members?
- i. Fever
  - ii. Common cold & cough
  - iii. Others
28. Do anyone in your family have indigenou knowledge of construction?
- i. Yes
  - ii. No
29. Do you celebrate jatras?
- i. Yes
  - ii. No
30. Are you the member of Guthi?
- i. Yes
  - ii. No

## ANNEX 2: Framework for Livelihood Assessment

S.No.	Questions	Answers	Scores
<b>1</b>	<b>Human capitals</b>		
1.1	condition of awareness regarding indigeneous knowledge and governemnt policies to preserve it.	a. High	1
		b. not aware	-1
		c. Low	0
1.2	Health problems caused by buildings	a. No	1
		b. Yes	-1
		c. Neutral	0
1.3	status of indigenous knowledge in family	a. Increased	1
		b. Decreased	-1
		c. As it is	0
<b>2</b>	<b>Physical capitals</b>		
2.1	Access to own buildings	a. Yes	1
		b. No	-1
		c. Not consistent	0
2.2	Effectiveness of construction	a. Yes	1
		b. No	-1
		c. Not consistent	0
2.3	condition of usage of courtyard or open space.	a. Increased	1
		b. Decreased	-1
		c. As it is	0
<b>3</b>	<b>Social capitals</b>		
3.1	Social relations among community people	a. Improved	1
		b. Worsened	-1
		c. No change	0
3.2	conditions of participation in social events like jatras.	a. Improved	1
		b. Worsened	-1
		c. No change	0
3.3	conditions of inviting people to home for social gathering	a. Increased	1
		b. Decreased	-1
		c. As it is	0
<b>4</b>	<b>Financial capitals</b>		
4.1	Income generation conditions within the building	a. Increased	1
		b. Decreased	-1
		c. As it is	0
4.2	status of maintenance and operational cost of building	a. Low	1
		b. High	-1
		c. As it is	0
4.3	status of income, saving and economic assets	a. Increased	1
		b. Decreased	-1
		c. As it is	0

<b>5</b>		<b>Natural Capitals</b>	
5.1	Access to land and agriculture	a. Yes	1
		b. No	-1
		c. Not consistent	0
5.2	Access to water resources	a. Yes	1
		b. No	-1
		c. Not consistent	0
5.3	Access to clean environment	a. Yes	1
		b. No	-1
		c. Not consistent	0

### ANNEX 3 - Livelihood Assessment before Earthquake

S.N	Livelihood capitals	Respondents																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<b>1</b>	<b>Human Capitals</b>																				
1.1	condition of awareness regarding indigeneous knowledge and governemnt policies to preserve it.	1	1	1	1	1	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1
1.2	Health conditions influenced by buildings	0	0	1	1	0	1	0	1	0	1	0	1	1	1	0	1	0	0	1	1
1.3	status of indigenous knowledge in family	1	1	0	1	0	1	0	1	0	1	0	0	1	1	1	0	1	0	1	0
<b>2</b>	<b>Physical capitals</b>																				
2.1	Access to own buildings	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2.2	Effectiveness of construction	1	1	1	0	1	1	0	1	1	0	1	1	1	0	0	1	0	0	1	1
2.3	condition of usage of courtyard or open space.	1	1	1	0	1	1	1	1	0	1	1	1	1	0	1	0	1	1	1	1
<b>3</b>	<b>Social capitals</b>																				
3.1	Social relations among community people	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3.2	conditions of participation in social events like jatras.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3.3	conditions of inviting people to home for social gathering	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
<b>4</b>	<b>Financial capitals</b>																				
4.1	Income generation conditions within the building	1	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1	1	1	1	1
4.2	status of maintenance and operational cost of building	1	1	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	0	1	1
4.3	status of income, saving and economic assets	1	0	1	1	1	0	1	0	1	1	1	1	1	0	1	1	0	1	1	-1
<b>5</b>	<b>Natural Capitals</b>																				
5.1	Access to land and agriculture	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1
5.2	Access to water resources	1	0	1	1	1	0	1	1	0	0	1	0	1	1	0	1	0	1	0	1
5.3	Access to clean environment	1	0	1	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0

**ANNEX 3 – cont.....**

S.N	Livelihood capitals	Respondents																				Average score	Total Score	
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40			
<b>1</b>	<b>Human Capitals</b>																							
1.1	condition of awareness regarding indigeneous knowledge and govermemnt policies to preserve it.	0	1	0	1	0	0	1	0	1	1	1	0	1	0	0	1	1	0	1	1	0.625	1.875	
1.2	Health conditions influenced by buildings	0	1	1	1	1	1	0	0	0	1	0	1	1	1	1	1	1	1	1	1	0.65		
1.3	status of indigenous knowledge in family	0	1	1	0	1	0	1	0	1	1	0	1	1	1	1	1	0	1	0	1	0.6		
<b>2</b>	<b>Physical capitals</b>																							
2.1	Access to own buildings	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2.35
2.2	Effectiveness of construction	1	1	1	0	1	1	0	1	0	0	0	0	1	1	1	1	0	0	0	1	0.6		
2.3	condition of usage of courtyard or open space.	1	0	1	1	1	1	0	1	0	1	1	1	1	0	0	1	1	1	1	0	0.75		
<b>3</b>	<b>Social capitals</b>																							
3.1	Social relations among community people	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2.875
3.2	conditions of participation in social events like jatras.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
3.3	conditions of inviting people to home for social gathering	1	0	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	0	1	1	0.875		
<b>4</b>	<b>Financial capitals</b>																							
4.1	Income generation conditions within the building	0	1	0	1	1	1	0	0	1	1	0	1	1	0	1	1	0	1	1	0	0.7	2.175	
4.2	status of maintenance and operational cost of building	1	0	1	0	1	0	1	1	1	1	1	1	1	1	0	1	1	0	1	0	0.775		
4.3	status of income, saving and economic assets	1	1	1	0	1	1	0	1	1	1	1	1	1	-1	1	0	1	1	1	1	0.7		
<b>5</b>	<b>Natural Capitals</b>																							
5.1	Access to land and agriculture	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0.875	2.225	
5.2	Access to water resources	1	0	1	1	0	1	0	1	1	0	1	0	1	0	1	0	1	0	1	0	0.575		
5.3	Access to clean environment	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0	1	0.775		

## ANNEX 4 – Livelihood Assessment after Earthquake

S.N	Livelihood capitals	Respondents																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<b>1</b>	<b>Human Capitals</b>																				
1.1	condition of awareness regarding indigeneous knowledge and governemnt policies to preserve it.	1	0	1	1	1	0	1	1	0	1	1	1	1	1	1	1	0	1	1	1
1.2	Health conditions influenced by buildings	-1	0	1	1	0	1	0	0	1	1	0	1	1	0	1	-1	1	0	1	0
1.3	status of indigenous knowledge in family	0	1	-1	1	0	1	0	-1	1	0	0	1	0	1	0	1	-1	1	0	1
<b>2</b>	<b>Physical capitals</b>																				
2.1	Access to own buildings	1	0	1	1	1	-1	1	0	1	1	1	0	1	1	-1	1	1	-1	1	1
2.2	Effectiveness of construction	-1	-1	1	0	1	1	0	1	1	1	1	-1	0	0	1	1	0	1	-1	-1
2.3	condition of usage of courtyard or open space.	0	0	1	0	1	1	1	0	1	0	1	1	1	0	0	0	1	1	-1	1
<b>3</b>	<b>Social capitals</b>																				
3.1	Social relations among community people	1	0	1	0	1	1	-1	1	0	0	1	1	0	1	1	0	1	-1	1	0
3.2	conditions of participation in social events like jatras.	1	1	0	1	-1	0	1	0	1	0	1	0	1	0	1	1	1	1	0	1
3.3	conditions of inviting people to home for social gathering	1	-1	1	0	-1	1	0	1	0	1	0	1	0	0	-1	1	1	0	1	0
<b>4</b>	<b>Financial capitals</b>																				
4.1	Income generation conditions within the building	1	0	1	1	0	0	1	0	1	1	0	1	0	0	1	1	0	1	1	0
4.2	status of maintenance and operational cost of building	1	1	-1	1	0	1	0	1	0	0	0	0	0	1	-1	0	1	0	1	-1
4.3	status of income, saving and economic assets	1	0	1	1	1	0	1	0	1	1	1	1	0	0	1	1	0	1	1	1
<b>5</b>	<b>Natural Capitals</b>																				
5.1	Access to land and agriculture	1	-1	1	1	0	1	1	0	1	1	0	1	0	1	0	1	1	0	1	0
5.2	Access to water resources	1	0	1	1	1	0	-1	1	0	0	1	0	1	1	0	1	0	1	-1	1
5.3	Access to clean environment	0	0	1	-1	0	1	0	-1	0	0	0	1	0	-1	0	1	0	0	1	0

**ANNEX 4 – cont....**

S.N	Livelihood capitals	Respondents																				Average score	Total Score
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40		
<b>1</b>	<b>Human Capitals</b>																						
1.1	condition of awareness regarding indigeneous knowledge and governemnt policies to preserve it.	0	1	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0.75	1.475
1.2	Health conditions influenced by buildings	-1	0	1	0	0	1	0	1	0	1	0	-1	0	1	1	0	1	-1	0	1	0.325	
1.3	status of indigenou knowledge in family	0	1	1	1	0	0	1	-1	1	1	1	1	-1	0	1	0	1	0	1	1	0.4	
<b>2</b>	<b>Physical capitals</b>																						
2.1	Access to own buildings	-1	1	1	0	1	1	1	0	1	-1	1	1	0	1	1	-1	1	0	1	1	0.525	1.125
2.2	Effectiveness of construction	-1	1	1	1	1	1	-1	-1	0	0	1	0	-1	1	1	1	-1	0	0	1	0.25	
2.3	condition of usage of courtyard or open space.	0	-1	0	1	-1	1	-1	0	0	1	1	1	1	0	-1	1	1	-1	1	0	0.35	
<b>3</b>	<b>Social capitals</b>																						
3.1	Social relations among community people	1	0	1	1	0	-1	1	0	-1	0	0	1	-1	1	1	0	1	1	0	1	0.4	1.325
3.2	conditions of participation in social events like jatras.	1	-1	1	0	1	1	0	1	0	1	0	1	1	1	-1	1	0	1	1	1	0.55	
3.3	conditions of inviting people to home for social gathering	1	0	1	1	0	0	1	1	0	1	-1	1	0	1	0	1	-1	0	1	1	0.375	
<b>4</b>	<b>Financial capitals</b>																						
4.1	Income generation conditions within the building	0	1	0	-1	1	1	0	0	1	1	0	1	1	0	1	0	0	1	1	0	0.5	1.525
4.2	status of maintenance and operational cost of building	0	0	1	0	1	0	1	-1	1	0	1	1	0	1	0	-1	1	0	0	1	0.3	
4.3	status of income, saving and economic assets	1	1	1	0	1	1	0	1	0	1	1	1	1	1	1	0	1	0	1	1	0.725	
<b>5</b>	<b>Natural Capitals</b>																						
5.1	Access to land and agriculture	0	-1	1	0	1	0	1	0	1	1	0	1	1	0	1	-1	0	1	0	1	0.475	1
5.2	Access to water resources	1	0	1	-1	0	1	0	0	0	0	1	0	0	0	-1	0	1	0	1	0	0.325	
5.3	Access to clean environment	1	0	-1	0	1	1	1	0	1	1	0	-1	0	1	0	1	0	-1	0	1	0.2	

**ANNEX: 5 Adaptive Indoor Comfort Temperatures and Comfort Zone from Nicol and Rijal  
comfort temperature (Tc) in summer and winter for Kathmandu**

S.No.	Thermal	Thermal	Nicol	Tc (°C)	Rijal	Tc (°C)	Comfort	Remarks
	Sensation	Scale	Summer	Winter	Summer	Winter	Category	
1	Hot	3	32	*	32	*	Very Uncomfortable	
2	Warm	2	30	*	30	*	Uncomfortable	
3	Slightly Warm	1	28	*	28	*	Comfortable	Comfort Zone
4	Neutral	0	26	19	26	15	Very Comfortable	
5	Slightly Cool	-1	*	17	*	13	Comfortable	
6	Cool	-2	*	15	*	11	Uncomfortable	
7	Cold	-3	*	13	*	9	Very Uncomfortable	