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# The Effectiveness of Green Building Rating System for the Environmental management in Nepal

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**Abstract**
One of the major industries that significantly contributes to socioeconomic prosperity in developing nations like Nepal is the building sector. It is the main source of trash generation and one of the biggest polluters of our environment, contributing to significant carbon footprints and greenhouse gas emissions. Ecological principles of resource efficiency provide the foundation of sustainable construction. It is constantly in charge of maintaining a safe constructed environment. Therefore, the establishment of required criteria in Nepal through the use of the green building rating system as a measurement tool is crucial in pushing the building and construction industry towards environmental sustainability. The technique of planning, developing, and running facilities so as to minimize their impact on the environment has given rise to the field of "green building design," which is a developing area within architectural design. The building materials used nowadays ought to be cutting edge and sustainable. Both the public and commercial sectors need to support the green building concept because buildings are one of the main sources of greenhouse gas emissions and carbon dioxide. As a result, a green building grading system that adequately addresses Nepal's evolving needs must be created.

**Keywords**
Contribute, Socio-economic, Footprints, Measuring tool, Sustainability, Consumption, Chronic

## 1. Introduction

Buildings are one of the biggest sources of GHG emissions, and they consume a lot of energy. The incorporation of eco-friendly features in buildings can lead to significant reductions in water usage, energy consumption, and greenhouse gas (GHG) emissions. Nonetheless, it is often perceived to be costly by both private and public entities. While initial investments are typically considered, the long-term savings can more than offset the initial expenditure. The materials used in construction should be sustainable, and it should not affect the ability of the future generations to achieve their goals. The development of green building solutions will have to be carried out to meet the needs of the future

The majority of engineers, architects, designers, technicians, and general public in Nepal are not familiar with the notion of green building. Raising awareness is crucial for sustainable development in order to guarantee that structures are resource- and energy-efficient as well as environmentally benign. Globally, and especially in developing nations like India, Mexico, Brazil, Malaysia, Indonesia, and South Africa, there is a growing trend toward green building. 28% of architects, contractors, engineers, and building owners worldwide place a high priority on building projects that are sustainable, according to the 2013 Smart Market Report. This figure will rise in the future for the "Green Movement" at the same time.

Land is occupied by the construction industry, which also uses energy, water, technology, chemicals, and minerals to produce building materials. As such, consideration must be given to its effects on the environment. Human civilizations are the end customers of the products produced by the construction process, and a sizable labor force, both skilled and unskilled, is employed in construction activity. As a result, the social dimensions of construction hold significant value. Since construction is a process with many steps, sustainable construction should incorporate sustainable labor and professional practices, sustainable labor and professional practices, sustainable planning, financing and investment, sustainable materials, sustainable tools, technology, and methods, sustainable ownership and use, sustainable institute, and sustainable products.

While the LEED certification process is widely acknowledged as a mark of sustainability performance, the Green Building Rating System offers the foundation for environmentally friendly, cost-effective, efficient, and less carbon-intensive buildings. The Green Building Rating System (GBRS), the regulating instrument, and green building construction can help address these issues. The Green Building Rating System facilitates the transition of the building sector to sustainable growth. A minimum required regulation for rating systems exists in many industrialized and developing nations. Building ratings assist users in understanding how much energy is consumed by their homes and in lowering both consumption and costs associated with energy use. The answer to energy optimization for Nepal's building industry will be GBRS.

## 2. Objective

The specific objectives of this research is:

- To analyze the effectiveness of green building rating system on environmental management.

## 3. Research Question

To adequately achieve above objective, the research question was formulated as:

- What is the effectiveness of green building rating system on environmental management?

## 4. Methodology

The methodical process of outlining research questions, objectives, data collection techniques, data analysis procedures, and defining findings and discussions is known as research methodology. Throughout the entire study, both a quantitative and qualitative method served as the foundation. Regarding green construction projects, a quantitative survey with 35 respondents and a qualitative one with 20 professionals, clients, consultants, contractors, and LEED specialists were conducted. The number of finished green construction projects was the basis for selecting the study population for the investigation.

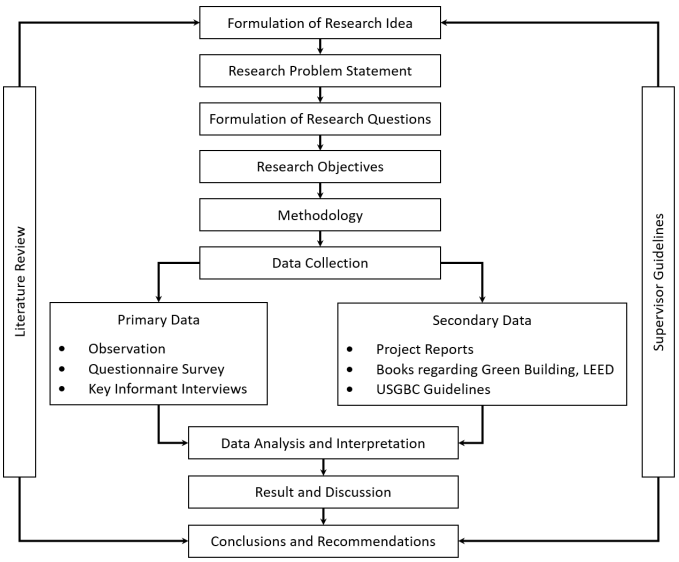


**Figure 4.1:** Methodological Framework of Research

Depending on the features and level of expertise involved in the particular project, the sample number selection differed among projects. The company chiefs involved in the green projects, as well as the clients, consultants, and contractors, made up the research population. The foundation of this study was primary data. Field observation, questionnaire surveys, and key informant interviews (KII) were used to gather primary data. For this research, field observation was conducted by visiting two non-rated and four rated buildings.

A series of distinct questionnaires was created for the purpose of surveying clients, consultants, and contractors involved in green building projects. The questions addressed topics such as the environmental impact of green building construction, challenges, opportunities, and the suitability of the green building rating system in the Kathmandu Valley. Similar to this, a series of open-ended questions with an emphasis on key informants were produced for KII. Twenty-two experts in total were chosen for KII. Thus, original data on the development of green buildings and their effects on the environment, as well as the difficulties, opportunities, and suitability of the green building rating system in the Kathmandu Valley, were gathered. Secondary data were acquired via websites, published documents, government acts and regulations, technical support documents, reports, published journals, publications, past theses and dissertations, conference papers, and national and international articles.

**Table 4.1:** List of the client, consultant and contractor respondents

| S.N. | Project Name | Representatives | | | |
|---|---|---|---|---|---|
| | | Client | Consultant | Contractor | Total |
| 1 | Crystal Palace (Tahachal, Kathmandu) | 1 | 2 | 1 | 4 |
| 2 | Central Park Apartment (Bishalnagar, Kathmandu) | 2 | 2 | 1 | 5 |
| 3 | Hama Iron and Steel Building (Kamaladi, Kathmandu) | 2 | 3 | 3 | 8 |
| 4 | Siddhi Poly Path Lab (Dillibazar, Kathmandu) | 2 | 3 | 3 | 8 |
| 5 | Mato Ghar (Budhanilkantha, Kathmandu) | 2 | 2 | 2 | 6 |
| 6 | Pyramid House (Thaiba, Lalitpur) | 1 | 2 | 1 | 4 |
| Total | | 10 | 14 | 11 | 35 |

### 4.1 Sample size

The sample size for this study was 35 respondents, or the entire population from all six studies. Depending on the features and level of expertise involved in the particular project, the sample number selection differed among projects.

The Microsoft Excel program was used for data analysis based on the questionnaire responses, and the Simple Weightage Method was used to score the elements overall. A number of preparatory procedures were modified before to the start of the analysis, including data editing, filling in blank responses, data classification, data file creation, and a few relative computations. These protocols were created to guarantee data consistency and enable insightful result interpretation. The degree to which the findings or conclusions generated from the study questionnaire align with reality is measured as validity. The absence of systematic mistakes in the measurement device is a sign of high validity. The results

obtained from the questionnaire survey in this thesis concurred with the findings of earlier studies. With the assistance of LEED professionals, architects, and engineers working on green building projects, the questionnaire was created. and lastly given direction and approval by the manager. A reliability test was conducted on the set of questionnaires that were developed and used in this study. There were 69 questions in the questionnaire set. The questionnaire was subjected to the Cronbach's alpha test by importing an excel sheet into SPSS in order to determine internal consistency. The resultant Cronbach's Alpha Value was 0.963, indicating an outstanding range of results.

**Table 4.2:** The Cronbach's Alpha Level of Reliability Check (Source: Bujang, et. al., 2018)

| Cronbach's Alpha Value | Internal Consistency |
|---|---|
| $\alpha \geq 0.9$ | Excellent |
| $0.9 > \alpha \geq 0.8$ | Good |
| $0.8 > \alpha \geq 0.7$ | Acceptable |
| $0.7 > \alpha \geq 0.6$ | Questionable |
| $0.6 > \alpha \geq 0.5$ | Poor |
| $0.5 > \alpha$ | Unacceptable |

## 5. Study Area

The Kathmandu Valley was chosen as the research's study region. Two buildings with the application of green technology only, but not applied for LEED certification as non-rated buildings, were taken as study projects. Four green building projects applied for LEED certification as rated within the Kathmandu and Lalitpur district. The study was carried out in various corporate buildings and flats with LEED credits because there aren't many projects that use green technology and apply for LEED certification.

**Table 5.1:** List of projects registered for LEED certification

| SN | Building | Location | Building Type | Owner / Owner type | LEED | Total Buildup Area (sq. ft.) | Registered Date |
|---|---|---|---|---|---|---|---|
| 1 | Central Park Apartment | Bishalnagar, Kathmandu | Apartment | Clean Developers Pvt. Ltd. / Investor | LEED CS 2.0 | 73,286 | 23/06/2009 |
| 2 | Butwal Power Company Office Building | Kathmandu | Office | Butwal Power Company Ltd./ Corporate | LEED NC, 2009 | 56,760 | 16/06/2010 |
| 3 | Crystal Palace | Tahachal, Kathmandu | Apartment | Technical Interface / Investor | LEED NC, 2009 | 325,392 | 18/06/2010 |
| 4 | Hama Iron and Steel Corporate Building | Kamaladi, Ganesthan | Office | Hama Iron & Steel Pvt. Ltd. / Investor | LEED NC, 2009 | 68,942 | 23/08/2010 |
| 5 | Siddhi Poly Path Lab | Dilli Bazaar, Kathmandu | Healthcare | Siddhi Polyclinic / Investor | LEED NC, 2009 | 10,196 | 05/09/2010 |
| 6 | Corporate Office of Sipradi | Thapathali, Kathmandu | Office | Sipradi Trading Pvt. Ltd. | LEED NC, 2009 | 36,196 | 23/02/2013 |
| 7 | Annex Block | Kathmandu Mall, Sundhara | Religious Worship | Happy Science International | LEED NC, 2009 | 5,940 | 19/05/2013 |
| 8 | Happy Science Temple | Kathmandu Mall, Sundhara | Religious Worship | Happy Science Japan | LEED NC, 2009 | 13,364 | 02/06/2013 |
| 9 | Buddha Lifestyle Scheme | Kathmandu Plaza, Kamaladi | Office | Buddha Lifestyle Pvt. Ltd. | LEED NC, 2009 | 33,304 | 16/05/2014 |
| 10 | Marriot Hotel | Thamel | Lodging | Everest Hospitality and Hotel Pvt. Ltd. | LEED NC, 2009 | 265,103 | 16/12/2015 |
| 11 | Soaltee Westened Premiere | Nepalgunj | Lodging | Soaltee Sibkrim Hotels & Resorts Pvt. Ltd. | LEED NC, 2009 | 84,034 | 10/21/2016 |

## 6. Case Studies

Case study of four numbers of green rated building and two numbers of non – rated building of Kathmandu and Lalitpur district were done. Its comparison helped to know the present green building scenarios inside Kathmandu Valley. For the rated building, Crystal City at Tahachal, Hama Iron and Steel building at Kamaladi, Siddhi Poly Path Lab at Dillibazar and Central Park Apartment, Bishalnagar were selected. But due to numerous reasons including high cost, time to time design change and building use requirements from client, lack of confident Heating, ventilation and air conditioning (HVAC) team these buildings were unable to get LEED certificate.

**Figure 6.1:** Crystal City Apartment, Tahachal (Source: crystalcitytahachal.com.np)

**Figure 6.2:** Crystal City Apartment, Tahachal (Source: crystalcitytahachal.com.np)

**Figure 6.3:** Central Park Apartment, Bishalnagar (Picture source: centralparkapartment.com.np)

**Figure 6.4:** Siddhi Poly Path Lab, Charkhal (Picture source: Siddhilab.com.np)

**Green Building Vital Features:**

In case studies, it was discovered that in order for a building to receive a LEED rating, a variety of sustainable construction characteristics had been implemented, such as:

- Photovoltaic System
- Insulated Walls and apertures
- HVAC VRV System
- Circulation and Recovery of Winter Heat
- Techniques for Energy-Efficient Lighting
- Ventilation via Thermal Displacement
- Eco-Friendly Cooling Agent
- Pergola Roof
- Using glass as much as possible for daylighting
- Constructing an Energy Management System.

Today's planners are debating the idea of "green homes" in an effort to design healthier and more resource-efficient structures as the effects of buildings on the environment become more evident. In particular, architecture firms have been leading the way in the construction of green buildings and attempting to validate the green structures they create in order to inspire the building sector to move toward sustainable development. Such structures are not subject to any particular laws or guidelines during their design or construction, and Nepal does not currently have a green building grading system in place to assess their attributes. Consequently, consultants that genuinely care about the environment and wish to work on green initiatives.

**Figure 6.5:** Matoghar, Budhanilkantha (Picture source: Prabal Thapa Architects)

**Figure 6.6:** Pyramid House, Thaiba (Picture source: Innovative Createers Pvt. Ltd.)

## 7. Summary of Findings

Green building techniques can be incorporated into buildings at any stage, including design, construction, rehabilitation, and deconstruction, according to the study's findings. Nonetheless, if the design and construction teams adopt an integrated strategy from the very beginning of a building project, the greatest advantages can be realized. Since LEED is the only instrument in the green building grading system that makes the claim that it can be used for any building, almost all consultants in Nepal used it for their projects. Passive design buildings are a desirable alternative for the Kathmandu Valley and should be included in construction ordinances, according to the case study of both rated and non-rated buildings. However, the country's biggest problem is that the ordinances aren't followed, making it difficult to check.

In terms of environmental difficulties, GBRS for Nepal, particularly for the Kathmandu Valley, will be highly effective. Even if the percentage is small, the Kathmandu Valley is expanding in its ability to contribute to global warming and climate change. Generally speaking, building designers should start by adhering to environmental rules, which are often overlooked in ordinary building designs. The properties' value is increased by GBRS. After a building receives certification, its value rises as well; this benefits both the seller and the prospective buyer since the structure's selling price rises with logical amenities and services.

## 8. Observation, Study and Analysis

### 8.1 Scoring according to the priority

#### 8.1.1 Category A: Waste Management

Figure 8.1 shows highest weightage value of 36.25 for waste water treatment, secondly promote composting of solid waste with value 34.125, efficient waste segregation with 23.85,waste reduction during construction with value 21.6, for irrigation re-use of waste water on site with value 5.1 and least for protection from heavy storm design with value 2.9.


**Figure 8.1:** Category A - Waste Management

#### 8.1.2 Category B: Energy Optimization

Figure 8.2 shows the highest weightage value of 69.75 for climate responsive building design, secondly use of renewable energy with value 48.375, and for Day Lighting it's 32.725, energy efficient lighting with 22.5, efficient heating cooling equipment's with value 14.8, solar power energy with 7.42 and least value of 0.25 for improved cooking stove.

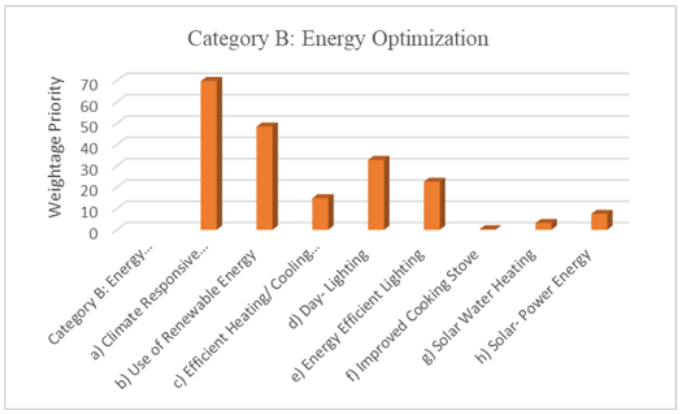


**Figure 8.2:** Category B - Energy Optimization

#### 8.1.3 Category C: Water Management

Figure 8.2 shows highest weightage value of 51.90 for ground water recharge technique, secondly use of water efficient equipment with value 32.78, rain water harvesting with value 32.6, for reduce paved area the value is 18.85, septic tank/ waste water treatment technology with value 5.3 and storm water design with proper drainage system with value 2.6.

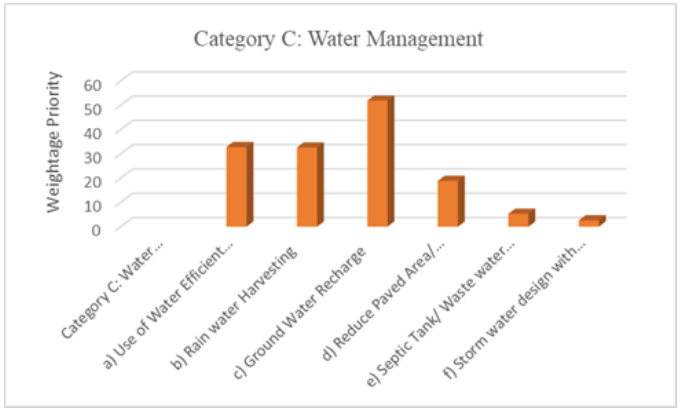


**Figure 8.3:** Category C-Water Management

#### 8.1.4 Category D: Building Materials

Figure 8.4 shows highest weightage value of 53.8 for materials with low environmental impacts, secondly 45.56 for local materials, re-use of materials with value 32.34, low embodied energy of materials with value 27.04, use of recycled materials with value 26.52, solar water heating with value 10.1, energy efficient lighting 8.55 and solar power energy with value 1.03.

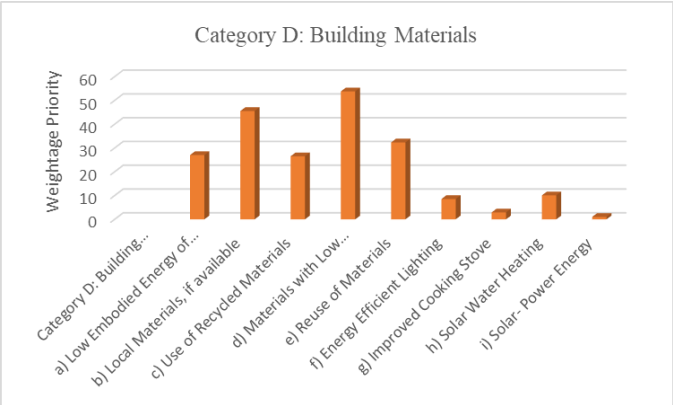


**Figure 8.4:** Category D-Building Materials

Most of the expertise said that green materials are not easily available, therefore the building cost also raise for the arrangements due to transportation. If locally available materials can be used then the cost of the building get lower.

## 8.2 Effective KII Responses

Experts involved in different green projects including 22 specialists, architects, civil engineers, environmentalists, experts on climate change, contractors, and corporate heads, participated in the KII study project. Very useful and efficient data were gathered during KII. The majority of respondents shared a similar perspective on Nepal's introduction of a Green Building Rating System. A few noteworthy and well-chosen conversations from KII are included below:

### 8.2.1 Discussions for effectiveness of Green Building Rating System on Environmental Management in Nepal

A) Discussion 1: Programs for awareness are required. There are no environmental or Green Building Rating System awareness programs in place. Since the GBRS is only widely known among a small number of technical experts in Nepal, strategies should be developed for the country's general population.

B) Discussion 2: Nepal ought to establish a contextual GBRS of its own, using a few credits and prerequisites from "LEED" to address green standards. It is possible to adopt GBRS in Nepal, and it will be highly beneficial for the future green movement.

C) Discussion 3: When it comes to environmental difficulties, GBRS for Nepal, particularly for the Kathmandu Valley, will be quite beneficial. Even if the percentage is small, the Kathmandu Valley is expanding in its ability to contribute to global warming and climate change.

D) Discussion 4: A building's LEED accreditation is comparable to a hotel's star rating. For Nepal, the capital should be the first place to start because of the country's enormous population and expanding construction industry. To encourage users and inspire others, communities should offer incentives to users and make tax credits available to those who make their building green.

E) Discussion 5: For future environmentally friendly green building designs and Net Carbon building designs, GBRS will be very useful to the designers. Generally speaking, building designers should start by adhering to environmental rules, which are often overlooked in ordinary building designs.

F) Discussion 6: Due to regional variations in local material availability, construction technology, and geography, Nepal should implement the Green Building Rating System in accordance with the climate and topography of its three regions. Various locally obtainable materials may be used.

G) Discussion 7: Since GBRS focuses on reducing GHG and CO2 footprints, it is extremely useful and in great demand among designers, experts, and planners for the rise in environmentally sound buildings.

H) Discussion 8: The Green Building Rating System (GBRS) in Kathmandu is very applicable and will work well since it addresses the urgent issues of the current situation in the Kathmandu Valley, which include waste management, grey water treatment, waste water reuse, and material reuse under various criteria.

# 9. Conclusion

From the case studies, analysis, qualitative and quantitative datas, the identified barriers of Green Building Rating System implementation in Nepal and its applicability are found out to be:

- Cost of Implementation: The analysis revealed that the primary obstacle to its adaptation is the cost of implementation. Consultants and investors continue to believe that the add-on value is excessive given the project's scope, and investors are still uneasy about the investment's payback rates.
- Accebility of Technologies and Green Materials: These resources represent yet another major obstacle to their adoption. Since Nepal's green building industry is still in its infancy, professionals and consultants find it extremely challenging to locate the necessary green materials and technologies. The Nepali market already has Indian materials like paint, coatings, glue, and water-efficient fixtures, so this trend will gradually shift in the direction of greater sustainability in the future.
- Not Relevance to Nepal Context: The third major obstacle is that a lot of people involved in the building sector continue to believe that some LEED principles don't apply to Nepal. They believe that LEED, or any other green building grading system, is designed to fit the specific needs of the nation in which it is implemented. They are irrelevant in the various countries because of the diverse contexts, climatic conditions, and cultural values. They made the compelling argument that either LEED should be adjusted for Nepal's needs, as India did for LEED-India, or we should create our own BRS that takes into account our unique context, culture, and climate.

- Lack of Awareness: The fourth major obstacle is a lack of awareness and knowledge among investors, government agencies, consultants, project managers, and other construction disciplines regarding the green building rating system and the benefits it could provide to the project through implementation. This leads to a lack of sustainable development. Consultants should inform investors of the project's benefits in terms of energy, water, and indoor air quality as well as the financial advantages of operation and maintenance. They should also highlight the project's added value in the future market due to its green features. Governmental organizations ought to incentivize them with subsidies, insurance, and other benefits.

- No Bylaws and Standards: In Nepal, there are presently no standards or ordinances pertaining to sustainable or green building. The majority of municipalities first showed concern for the environment by including tiny foundational elements in their design drawings, such the requirement that small residential structures have at least two trees planted in them, the usage of septic tanks, and now RP. Open space creation by the reduction of building footprints. The majority of these points are still only in the sketch; during construction, clients changed these only insofar as it affected their financial worth. The worst thing is that there isn't a mechanism in place to oversee implementation.

## 10. Recommendation

### 10.1 Perception and Awareness

Based on the survey, it is evident that architect consultants possess a thorough understanding of green construction practices and are advocating for prompt action to raise awareness of cultural and social issues. Every area of the construction industry needs to be aware of the major participants, which include Architects/Consultants, Manufacturers, Contractors, and Clients (Owner).

**Recommendation:**

- Academically – Passive design architecture, building services, and other topics are already covered in architectural curricula. However, the courses' foundation is relatively old technology. Our academic system still lacks exposure to the much-achieved technology and improvised courses. Courses that correspond to the most advanced practices now used in the developed world should include instruction on green construction. In order for upcoming professionals to be informed about this step toward environmental sustainability.

- Professionally – Green building approaches require the knowledge and education of building practitioners, particularly those in the construction industry. All employees and practitioners should have access to training and workshops. If there is a lack of awareness among all personnel participating in green building, then green building programs will not be successful. One crucial first step in modernizing the construction industry is to educate owners and investors about the advantages of green building. They must to be informed about the long-term financial advantages of green technologies as well as their initial high costs.

- Government Level – By enhancing local obligatory codes, providing awareness training, and enforcing green practices, at the very least in public buildings, the government should support green buildings.

### 10.2 Teamwork Culture

The research makes it abundantly evident that every team member must contribute in order for the green project to be successful. However, because most projects are carried out using the traditional design approach, which requires each team member to work alone and lacks integration between consultants and contractors, Nepal lacks a culture of teamwork.

**Recommendation:**

- The main problem in Nepal is that project teams — which include the client, architects and designers, civil engineers, MEP, HVAC, and contractors — do not communicate or coordinate well, which makes the project suffer greatly. This void should be filled by designating a specific group or individual to handle coordination and communication.

- Because we still lack a culture of appropriate documentation and because we lack the necessary software and documentation tools, we operate on relatively antiquated technology compared to other nations. As a result, there is always a risk of losing or omitting important data and information. Now is the perfect opportunity to use software and tools for cooperation and documentation.

- We still have a culture where missing deadlines and miscommunication among team members is normal, and we consistently overspend on our projects in terms of both time and money.

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