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A Study of Challenges and Opportunities of Energy Efficient Housing in Kathmandu: Architects' Perspective

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Abstract
Efficiency is 'the strategy' for sustainable future, the pursuit of twenty-first century humanity. In the global context of population growth, urbanization, and substantial changes in lifestyle, growing share of energy and other resources used by building sector has become crucial concern of sustainable development. Green buildings and energy efficient housing have appeared in recent time as solutions to increasing energy consumption by ever-growing housing need. Rise of housing need in Nepal is critical as the country faces similar global pattern of change. National urban development strategy sets promotion of innovative, economic and environment friendly buildings as strategy to achieve affordable, adequate and safe house for all urban dwellers whereas energy efficient building design and construction is the desired energy state. Greater understanding of the stakeholders of housing developments and their perspectives on energy efficiency is important since those involved in residential design play key roles in enhancing energy efficiency. This explorative research aims to identify the issues in residential projects to incorporate energy efficiency principles from the perspective of architects in Kathmandu. Theoretical sampling is done to construct substantive theories on "what issues are faced by architects while incorporating EE principles and technologies in residential project". Secondly, an opinion survey is conducted to cross-validate the theorized statements among random samples of stakeholders of residential development in Kathmandu. Architects were found to view the attitude of society towards design envisage as the major challenge of project potential. Economical barriers were lesser detrimental than regulatory barriers. Inclusion of EE in building codes was a common agenda with merely 8% of the architect respondent disagreeing. It is recommended that mandatory energy guidelines for public building ensuring enough examples are available for public awareness, and innovative incorporation of energy regulations for public to motivate positive change is necessary.

Keywords
Energy Efficient Housing – Architects – Drivers and Barriers

1. Introduction

Building houses was the point of departure for primal human civilization to the formal human civilization. Building house or housing referred in a collective meaning, is not just about building a physical structure since it interrelates with various aspects of human society[1]. From the early times housing has been seen as the indicator of socio-economic progress. In the later of nineteenth century with growing problems in the great cities as a consequence of modernization and urbanization, theorists were led towards more environment responsive approach towards city planning and housing [2].

The globally pursued overarching principle of sustainable development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" points towards conscious use of resources that are available. Creating low energy, ecological housing and living in harmony with the environment has become key component of sustainability [1].

Energy consumption by building sector is one of constantly questioned area since it is directly related to the environmental impacts it generates. Building sector alone is responsible for almost 40% of total global CO2 emissions while residential buildings alone expend more than one third of total primary energy annually. Energy Efficient Building design and constructions have emerged as the solution to the

increasing energy consumption and environmental impacts of building sector. Studies have shown that building energy codes have helped save 6-22% of average annual energy consumption in buildings of the European Union [3] and 106 million tons of oil equivalent between 1992 and 2012 in cumulative energy savings in the United States [4]. Yet effectiveness of the building energy codes depend on their implementation which is affected by presence of implementation institution, nature of codes, coverage of the codes ranging from national to local governmental level, training for technical human resource, rigorousness in building check, and incentives/ punishment policies [5].

The low energy building construction has been of lesser importance in the developing countries' development agendas where the population growth and urbanization rate are remarkably high. The worlds' population was expected reach 4.6 billion by 2020 with staggering 93 % of this increase occurring in the developing countries. [6]. UN has mentioned that more than half of the worlds' population lives in cities at present and by 2030, it is projected that 6 out of 10 people will be urban dwellers [7]. The case is very much similar in Nepal with high rate of urban population growth and inadequately facilitated state of housing with only 30% of households remarked safe houses [8]. Housing policies are mostly concerned at management of the slums and squatters and increasing accessibility to decent housing [9]. Growing urban housing need in most of the urban centers as they face 5.3 % annual growth rate of urban centers has brought forth many energy related issues. Mostly urban, domestic users consumed almost half of the total electricity supply in FY 2015/16 and the demand of electricity is expected to grow at 5.4 AAGR in 2010-35 [10]. With changing trend of residential construction practice from traditional to modern materials the energy prior to operation of residential buildings have changed significantly [11].

2. Need and Importance of Research

The baseline report of Nepal prepared for sustainable goal, [12] has targets set for 2030 of reaching 60 % of safe households while increasing the number of planned cities to 60 from 10. Recent national urban development strategy aims to achieve affordable, adequate and safe housing by advancing research for innovative, economic and environment friendly building design and preparing models and guidelines for energy efficient building design and construction for all ecological regions [13]. Yet the present building codes are limited to safety requirements, space requirements, structural codes, and approval procedures primarily related to RCC construction technology [14] and building permit system in Nepal does not address energy efficiency.

The need for greater understanding of professionals and their communication/collaboration with clients were identified as important factors impacting development [15]. Those involved in the design and construction practice therefore have key roles in the process of enhancing energy efficiency. The identification of issues faced by design professionals that derails energy efficiency of housing stock would be a crucial step towards achieving national targets of sustainable development.

3. Research Design and Methodology

Theoretical framework of energy efficiency status in present housing scenario was constructed based on extensive literature study on drivers and barriers of energy efficient building development. Based on the framework, nature of data and tools required to gather those data were determined.

The data collection for the qualitative assessment of energy efficiency scenario of housing was designed to be conducted in two major components:

1. Formulation of a substantive theory based on theoretical sampling method.
2. Cross-verification of substantive theories by conducting survey among related stakeholders to determine significance and agreement level.

3.1 Theoretical Sampling

Grounded theory is built upon two key concepts [16] comparative analysis i.e. simultaneous data collection and analysis and theoretical sampling i.e. envisaging decisions on which data and where to find them by ongoing interpretation of data and emerging conceptual categories. Theoretical sampling is the process of data collection for generating theory whereby the analyst jointly collects codes and analyses data and decides what data to collect next and where to find them, in order to develop a theory as it emerges. [16] The process of data collection is controlled by the emerging theory whether substantive

or formal. Here an emerging substantive theory on "what issues are faced by architects while incorporating EE principles and technologies in practice" the data collection. The researcher begins by identifying EE housing development constrains as key concepts of the research. After formulation of research questions, theoretical sampling through in-depth semi-structured interviews of five key field professionals was conducted. Open coding was done to each interview to identify new and recalled concepts on research question. Conceptualization of substantive theories on the questions and selection of next informant was done as the theory emerged from the collected data. List of interviewees is as follows:

- Interviewee 1: Architect, 4 years of practice with nearly 40 residence projects completed in Kathmandu
- Interviewee 2: Designer with more than 5 years of experience, worked with alternative materials in mass housing
- Interviewee 3: Chief architect of a firm with nearly 10 years of experiences, worked as contractor and investor in residential projects
- Interviewee 4: High official (architect) at KMC Building Permit division
- Interviewee 5: Senior architect based in Kathmandu with more than 45 years of experience

At the end of open coding, axial coding was conducted by comparing concepts with each other to identify five categories their degree centrality was calculated by using social network visualization tool [17]. Based on theoretical saturation of theoretical sampling ten substantive theoretical statements were formulated.

3.2 Opinion Survey

Likert scale was used to rate agreement on substantive theories from theoretical sampling. Questionnaire contained three sections. 1. background information (age, role, experience, knowledge on EEB), 2. Statements on EE housing, and 3. cross comparison table on residential project goals. The form was disseminated online to field professionals majorly architects through internet and request was made to share with their contacts i.e. recent residential clients, contractors and material suppliers. Response receiving was stopped at 120 responses due to limitation of time. At first screening of the responses was done and 106 responses were found to be valid. Out of 106, 10 respondents knew about energy efficient residence although they had never been directly involved in any residential project while 4 of those involved didn't know about EE housing. 71 % of the respondents were Architects and 14 %, 5 % were clients and contractors respectively. The Cronbach's coefficient was used to determine the internal consistency of the Likert scale used. The responses were grouped based on the role of the respondents on residential development to compare and analyse the perspectives of different groups. Then responses from Architects were separately analysed to establish arguments on substantive theories.

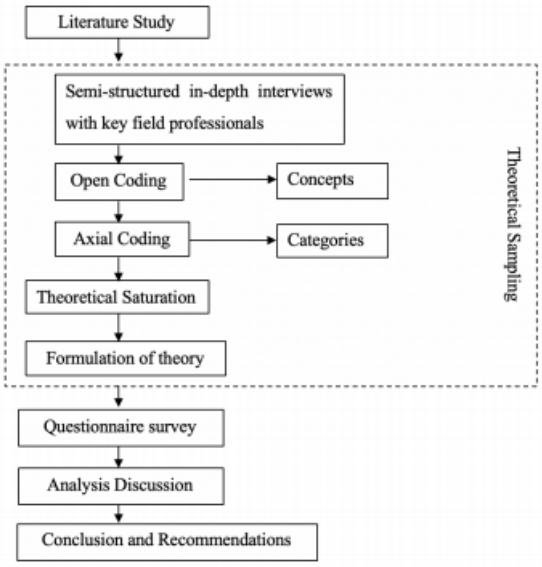

Figure 1: Methodology

4. Results and Discussion

Open Coding

Interviewee 1,

New Concepts:
1. Budget,
2. Municipal requirement only,
3. Site constrains,
4. Rental use,
5. Land price,
6. Voluntary,
7. Collaboration of industry and government,
8. Lack of example,
9. Expensive technology,

10. Sophistication,
11. Going back in technology,
12. Return driven attitude

Interviewee 2

Recalled Concepts: 2, 3, 7, 8, 10

New Concepts:
13. Passive government,
14. Existing potential,
15. Mandatory,
16. Client response,
17. Low additional cost,
18. Regulation as awareness tool

Interviewee 3

Recalled concepts: 1, 2, 6, 10, 12, 13, 18

New concepts:
19. Value of space,
20. Profit driven housing industry,
21. Technical human resource,
22. Incentive on EE technology

Interviewee 4

Recalled Concepts: 1, 2, 4, 6, 9, 12

New concepts:
23. Financial loss of Alternate energy,
24. Social deprivation,
25. Failure of prescriptive effort,
26. Market readiness,
27. Public approval,
28. Industry driven trend,
29. Unregulated contractor,
30. Public housing

Interviewee 5

Recalled concepts: 2, 7, 8, 11, 12, 13, 15, 17, 18, 21, 25

New concepts:
31. Cultural positiveness,
32. Additional burden,
33. For the public good

Axial Coding

Finance

Cost crucially influences decision making in residential projects. It determines the scope of product. The financial state of a society determines the quality of living condition. The requirements of a family in their residence is determined by financial state. At present the residential construction process in Kathmandu identifies EE technologies as additional cost. The return driven mind set of those involved in residential development is due to financial system. Unbalanced and unchecked land market deter the quality of houses built on them.

Category concepts: Budget, Land price, Expensive technologies, Financial loss of AE, Social deprivation

Overlapping Categories: Social Construct, Industry

Awareness

Awareness on EE technologies determines the potential of achieving energy efficient housing condition. Aware general public has higher chance of incorporating EE technology in their residence. Misconception and not knowing the positives of EE technologies hinder the progress. At present there are no example buildings in Kathmandu to encourage residential projects to incorporate EE technologies. Public approval on new technologies are glass ceiling for EE technologies.

Category concepts: Lack of examples, Sophisticated technologies, Public approval, For the public good

Overlapping Categories: Social construct, Regulation

Regulation

Regulation plays vital role in achieving desired social state. It assures the overriding principles are followed. In an unaware society, regulation can also become medium of raising awareness about the positives of following EE principles. The residence development practices in Kathmandu has greater tendency to neglect ideas other than forced by regulations. In other words, clients are more likely to support EE principles if it is mentioned in regulations. Prescriptive measures are likely to fail but still making EE specifications mandatory is a debatable idea.

Category concepts: Voluntary, Collaboration between industry and government, Passive government, Regulation as awareness strategy, Incentives on EE

Overlapping Categories: Social Constructs, Awareness, Technologies

Social Construct

Attitude of society towards new ideas determine their development. Residential design and construction in Kathmandu are restrained in scope due to return driven attitude of middleclass majority. Most of the

residential design projects include consultants just to meet the municipal requirements and has certain set of requirements such as rental floors and maximum space coverage. Though existing positives such as culturally embedded energy efficient practices of traditional buildings and attraction towards new technologies, energy efficient materials are sometimes taken as unsafe and rudimentary.

Category concepts: Municipal requirement only, Rental use, going back, Return driven attitude, existing social potential, culturally embedded good practices, additional burden, value of space

Overlapping Categories: Finance, Awareness, Regulation, Industry

Industry

Potential of building industry largely affects the potential of EE development. Established practices in the industry are profit driven and take huge effort to change to new principles. The unregulated local contractor driven residential constructions pose challenge to effective implementation of building regulations. The housing industry have limited their objectives to financial achievements and the opportunities of EE communities have gone to waste. Potential regulatory interventions on improving EE of housing stock is limited by market unreadiness. Yet potential of collaborative effort from the industry and government is deemed as way forward.

Category concepts: Market readiness, Industry driven housing typologies, Unregulated local contractor system, profit driven housing industry, technical HR

Overlapping categories: Finance, Social construct

Leadership

Lack of interest and leadership from the stakeholders nip the bud of potential EE integration in residential project. Diminishing effort and interest as the project move forward, change the route of designed EE residences to be satisfied without effective implementation. Most of the mass housing industry Architects are held off from incorporating EE technologies by the disinterest of the investors. And the leadership of public administration is a must.

The axial coding was done by inputting category concepts and overlapping categories in SocNetV tool [17] to analyse their degree centrality. Social construct category had highest centrality degree followed by Regulation, Industry, Awareness, and Finance accordingly. Substantive theory statements were produced based on the comparison analysis. Social construct on how residential construction is approached by the society of Kathmandu was kept central. Ten general statements were then formulated as the issues faced by design professionals on implementing EE technologies in residential projects.

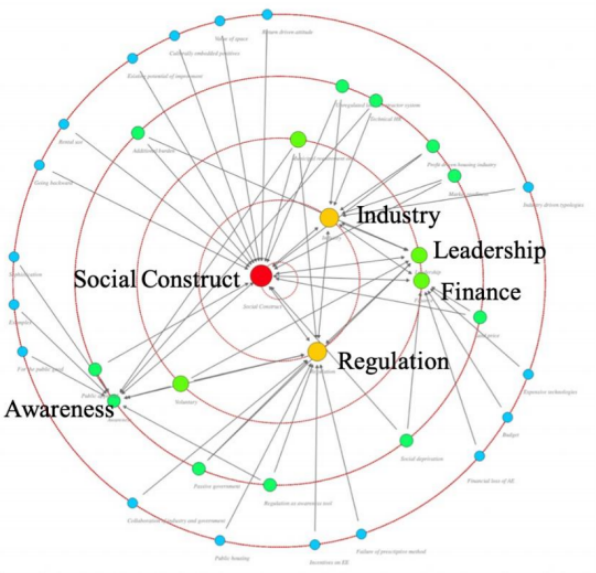

Figure 2: Radial Diagram of categories based on degree centrality

S1	Constructing an energy efficient residence is very costly.
S2	Energy efficient residences take longer construction time.
S3	Information about energy efficient residence construction are not adequately available.
S4	Energy efficient materials and technologies are not available in Kathmandu.
S5	Energy efficient materials and technologies are not selected because they are unreliable in their performance.
S6	Building code should include energy efficiency specification.
S7	Adopting energy efficiency in residence should be voluntary.
S8	Present construction industry doesn't promote energy efficient residence construction.
S9	Promotion of energy efficient residence construction is mainly governments responsibility.
S10	Energy efficiency is not discussed during residence design phase.

Figure 3: Substantive theory statements

Survey Findings

Total 106 valid responses were from 75 Architects, 15 clients, 5 contractors, 1 researcher and 10 not involved in residential project but having knowledge about EEB. Cronbach's alpha was calculated to be less than 0.7. The total responses were divided by role of respondent in residential project and further analysed.

Most of the respondents knew partially about energy efficient technologies including 53% of the Architects while 40% of the Architects had adequate knowledge on energy efficient construction of residence. The importance level given by the valid respondents on the

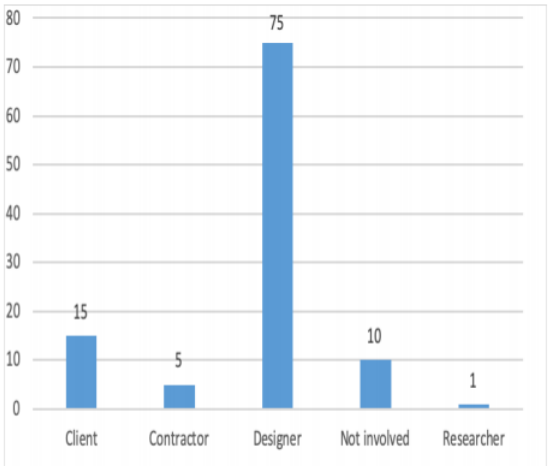

Figure 4: Respondents distribution according to role on residential project

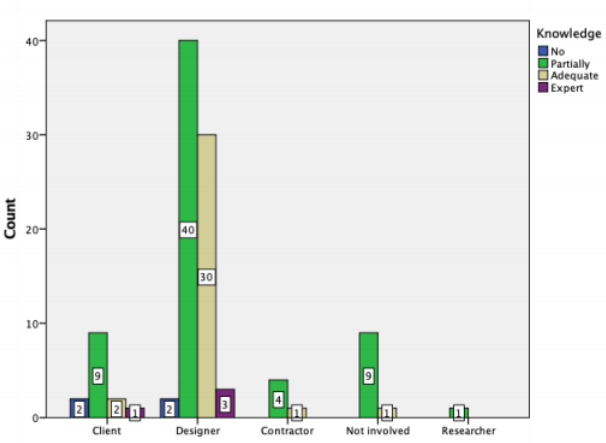

Figure 5: Level of knowledge on EE technologies in different respondent groups

cross comparison table was analyzed separately. Clients valued affordability the most followed by environmental impact and aesthetics while Architects valued environmental impact. Surprisingly contractors valued affordability the most with nearly 29% of the project goal. Energy efficiency remained the second least valued project goal only ahead of water efficiency.

The Likert scale score on statements were analyzed based on different groups. As shown in figure 7 clients believed EE residences are costly contrasting with the views of Architects that they'd disagreed that constructing energy efficient residence is very costly and lengthy endeavor. Though it was commonly agreed that EE material, technology and information are not available easily and adequately. The respondents were highly in favor of inclusion of EE specifications in building code though in prescriptive

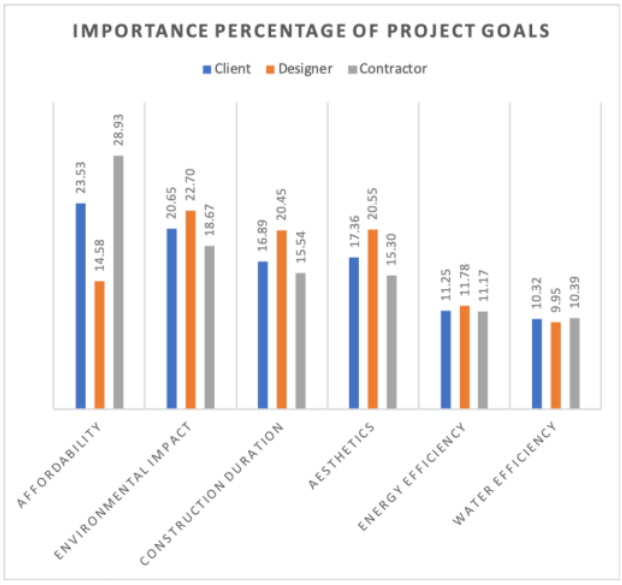

Figure 6: Comparison of project goals by different groups

manner only. Clients had rather neutral views on responsibility of government in promotion of EE technology in contrast to contractors who are more likely to depend on governments efforts to improve energy efficiency of housing stock.

Statement	Total		Client		Architects		Contractors	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
S1	2.70	1.024	3.08	1.118	2.63	0.965	3	1.095
S2	2.63	1.024	2.69	1.251	2.64	0.963	2.6	1.200
S3	3.49	1.000	3.23	0.927	3.51	0.974	3.6	1.356
S4	2.35	0.804	2.39	0.650	2.34	0.837	2.4	0.800
S5	2.75	1.065	2.62	1.261	2.77	1.034	3	1.095
S6	4.30	0.935	4.31	0.751	4.32	0.984	4	0.632
S7	3.59	1.091	3.31	1.316	3.62	1.062	3.8	0.980
S8	3.53	1.010	3.46	0.877	3.52	1.056	4	0.632
S9	3.26	1.128	3.00	1.354	3.27	1.096	3.6	1.020
S10	3.39	1.138	3.15	1.281	3.44	1.118	3.2	1.166

Figure 7: Table of mean and standard deviation of Likert scale scores on general statements

Analysis of Architects Prespectives

Most of the Architects don't think that information about energy efficient residential construction are adequately available strengthening the lack of examples concept from theoretical sampling phase. Traditionally and locally availability of energy efficient material and technology is indicated by most of the Architects as the disagreed-on absence of energy efficient material and technology in Kathmandu. The reliability of energy efficient material and technology is debatable as more than half of the respondents either stayed neutral or disagreed

that they are not selected for their unreliability. There was general agreement that energy efficiency is not a topic of discussion in residential design process.

Further analysis of the main respondent group of Architects was conducted separately. Architects with more than ten years of experience mostly disagreed that energy efficient construction takes longer time. There was general disagreement on the availability of energy efficient materials and technologies. Architects with 5 to 10 years of experience don't think that energy efficient materials and technologies are rejected due to their unreliability. The more experienced Architects don't think that the current building industry promotes energy efficient construction. Architects with 5-10 years of experience feel it's not just governments responsibility to promote energy efficiency in construction while the other groups think otherwise.

Statement	less than 5 years		5-10 years		more than 10 years	
	Mean	SD	Mean	SD	Mean	SD
S1	2.61	1.00	2.72	0.96	2.50	0.84
S2	2.82	0.97	2.39	0.85	2.00	0.89
S3	3.45	1.02	3.56	0.92	3.83	0.75
S4	2.37	0.78	2.28	0.96	2.33	1.03
S5	2.90	1.01	2.39	1.04	2.83	1.17
S6	4.31	0.92	4.17	1.25	4.83	0.41
S7	3.76	0.92	3.22	1.22	3.67	1.51
S8	3.31	1.00	3.94	1.06	4.00	1.10
S9	3.47	1.00	2.72	1.02	3.33	1.63
S10	3.39	1.11	3.56	1.10	3.50	1.38

Figure 8: Table of mean and standard deviation on statements by experience groups of Architects

5. Conclusion and Recommendations

Generally, clients are inclined to value financial performance during design phase. Although accepted to cause little additional cost by EE incorporation, it affects the market competitiveness of the investors in housing development. Dissemination of information on advantages of EE incorporation alone might not be able to overcome the issue. Innovative energy standards that encourage incorporation of EE strategies at lower costs, incentivization in certain areas, and provision of technical support might be necessary to overcome financial barriers of EE development.

There is a general understanding among Architects that incorporation of energy efficient materials and technologies does not incur high extra cost and construction time. Rather they have pointed out at social constructs such as attitude of general public to look at design envisage as meeting municipal requirements only and return driven attitude as major setback limiting EE potentials of residential projects. The lack of example prototypes has made it difficult for the Architects to approach clients from energy efficiency perspective and also has raised questions on the reliability of them. EE is not discussed during design phase of residential projects and many Architects feel that it's government's responsibility to improve EE in buildings.

The information available are not at adequate level hence EE technologies are considered sophisticated and inaccessible. This has also generated reluctance in incorporating EE among stakeholders. Although debatably favoured to remain a voluntary act, inclusion of EE specifications in building codes is a well-received idea. And it is also seen as a tool to raise awareness among general public. The example of successful transition in residential construction practice of Kathmandu from under reinforced RCC construction to appropriately reinforced in recent time after enforcing mandatory requirements can be taken as example. A simple replacement of conventional high embodied energy materials to EE materials and technologies, that Architects accept to be available, could be impactful if done so in large scale. In general, a strong leadership from the public sector is sought out by all stakeholders of residential development. Incorporation of mandatory energy standards in public buildings, public housing schemes or even in privately undertaken multi housing projects could be the way forward.

6. Further Study

This research adopts qualitative analysis of the residential construction practices through interviews and questionnaire survey approach. There are some limitations such as concerning only on construction of single-family residences, major portion of respondents were Architects, limited number of interviews and research area limited within Kathmandu. To outline clearer picture of energy efficient construction issues, study of perspectives from general public, public institutions and construction enterprises is necessary. Furthermore, study expanding to commercial buildings and multi-family residences can also be conducted. Study of these areas could be would further the understanding of the existing issues in incorporating energy efficient construction practices.

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