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Noor Hanita Abdul Majid, Ibrahim Udale Hussaini
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Housing Design Practice and Energy Efficiency Consideration in Nigeria

Noor Hanita ABDUL MAJID [1], Ibrahim Udale HUSSAINI [2]

[1]Kulliyyah of Architecture, and Environmental Design International Islamic University Malaysia
[2]Architecture Programme, Abubakar Tafawa Balewa University, Bauchi –Nigeria

Abstract
The growing concern on the reduction of energy consumption in the residential sector of national economies rests on some parameters and issues that deserve to be resolved. Fundamental among these issues are the architectural concern, the appliances/services efficiency issue; and most recently the human behavioural dimension. This study focuses on the architectural issue with the objective of determining the level of energy efficiency consideration in housing design practice by the housing stakeholders in Nigeria, with a notion that arousing the professional cultures of the stakeholders, particularly architects and building service engineers in the direction of efficiency can help improve energy efficiency design practice. This is in recognition of the fact that more than one third of the world's energy is used in buildings; and a majority in houses and apartments (Wulfinghoff, 2003) [1]. Therefore, instituting energy efficiency design practice would lead to attainment of significant reduction in household energy consumption. This study employs opinion survey on the stakeholders (architects, building service engineers and builders) as a measure of their perception and practice in our attempt to evolve energy efficiency housing design practice guidelines. The result reveals an obvious gap in housing design practice and energy efficiency consideration in Nigeria.

Keywords

Energy Consumption, Energy Efficiency, Housing, Design Practice, Professional Culture, Nigeria.

Introduction

The issue of energy and its conservation has become one of the most sensitive discussions of our time, arising from the realization of a need for sustainable energy resources development. This concern has prompted the world governments and societies to begin to accept the possibility of a change in the patterns of consumption, leading to energy conservation measures and more rational use of existing resources to ensure sustainability. In the built environment, architecture and buildings tend to offer the greatest potential for this challenge which could be achieved through clever design and planning decisions that can help us to use resources sparingly, improve the durability of buildings and reduce environmental damage [2]. On this account, there is the need to adopt all possible measures to ensure that buildings use of energy is minimal. That is, we should minimize demand for artificial services (lighting, heating and cooling); maximize the efficiency of essential services and condition occupant behaviour [3]. Many research works have been conducted, and are ongoing on the

Corresponding Author: Ibrahim Udale Hussaini, Email: hudalib@yahoo.co.uk
+2348068135766, +60176212707

aspects of appliances efficiency, energy-efficient design guidelines and sparingly on human behaviour, but little have been directed on the social aspect of design practice (i.e. the professional cultures). This is because building designers have either been ignored by the bulk of energy research [4; 5] or considered to be 'intermediaries' in energy efficiency decision making process (Stern and Aronson, eds., 1984) cited in Janda [6]. Notwithstanding, the global interest in energy-efficient dwellings presents a challenge to the stakeholders in the housing industry to develop sustainable management scheme towards enhancing the quality of our environment through environmental and energy-conscious planning, design and construction. In the light of this, Reyner Banham in 1967 proclaims the need for a new attitude in architecture because the conventional approaches were not able to solve the growing environmental problems. Stressing that "architects should no longer regard a building as a structure equipped with technical apparatus, but rather should go on to develop a 'climate device' which, like a sailing boat, reacts dynamically to environmental influences and gains its energy through exploiting the energy available locally" [2]. In addition, Janda [6] has proposed the idea of using 'professional culture' in the perspective of energy analysis; and cited that using culture to explain behaviour is not new to the efficiency literature [7; 8] as in the past, the concept of 'culture' has been used to describe the behaviour of many kinds of groups from tribes to pinmakers [9; 10]. In fact, the 'professional culture' focuses on the goals, values, beliefs, and practices that affect the behaviour of a certain class of occupational groups: the professions. To further elaborate on this, Janda [6] presented the result of his 'Energy Edge' research demonstration project in which the greatest proportion of architects sampled (interviewed) had mixed reaction to the project while the smallest number of engineers felt this way. He attributed this result to the differences in professional cultures as architects and engineers are not simply intermediaries in the design process. They both have their interests which influence both work practice and design decisions; and in the current balance of power and responsibility, neither architects nor engineers have an incentive to adopt the tenets of energy efficiency as an integral part of their work practice [6]. Nonetheless, the challenges remain basically that of stakeholders in the housing industry; and this study is essentially to verify the current level of energy efficiency design practice in Nigeria due to the prevailing problem of energy-inefficient households. It is actually, our presumption that one of the causes of this problem is poor energy efficiency consideration in design practice which can be ameliorated by evolving a framework of obligations that can arouse the professional culture towards an ensuring energy efficiency design practice.

Location of Study

Nigeria is the most populous black nation of the world with a current population of over 150 million people and an annual growth rate of 3 per cent. It is a country in the West Africa sub-region which lies between latitudes 4^0N and 14^0N of the equator, and between longitudes 3^0E and 15^0E of the Greenwich meridian. It is one of the largest oil producing countries in the world; yet, the energy sector is undergoing power deficit as it lacks enough and adequate power and energy to sustain her growing economy [11]. As a developing country, the energy demand is growing fast and the trend is likely to persist with negative impact on the living standards of the people if there is no substantial increase in power generation and/or energy efficiency practice is not adequately instituted. In fact, there is a specific problem of higher energy use demand in the building sector, particularly in the urban areas arising from the rapid growing population, increase in living standards and rising number of apartments. One of such areas is Bauchi- a typical urban town (the specific study area) located in the north eastern region between latitudes 9^0 30'N and 12^0 30'N; and longitudes 8^0 45'E and 11^0 0'E. It is the capital of Bauchi State; and a onetime administrative centre of the region. It has a population of about 493,730 (2006 census) people and having four established tertiary

institutions; one university, two polytechnics and a school of nursing and midwifery. Due to the relatively high concentration of educational facilities and commercial activities coupled with the population growth in Bauchi town, the energy demand/consumption level has surpassed many of the towns within the region, thereby making it a high potential for energy efficiency. Above all, the climate of Bauchi may be considered intermediate between the extremes of the swamp forests with very high rainfall/humidity (above 3500mm/88%) in the south; and the near desert, Sahel savannah with very low rainfall/humidity (less than 600mm/10%) in the very far north. It experiences both wet and dry seasons of the year, and annual rainfall between May and September. Bauchi has mean maximum range of about 29.2^0C in July/August to 37.6^0C in March/April. The mean minimum range is about 11.7^0C in December/January to 24.7^0C in April/May. The humidity ranges from about 12% in February to about 68% in August [12].

Approaches and Methods

This study is an opinion survey on the stakeholders in the housing industry undertaken as a preparatory measure to instituting efficient household energy use in Nigeria. A structured questionnaire applying close-ended questions was administered on the architects, building service engineers and builders in Bauchi town. This took place during the periods of monthly association meetings (a gathering of all members) for the months of October- December, 2010 to determine their levels of energy efficiency consideration in housing design practice. It was self-administered and a cross-sectional design. The questionnaire was designed to provide information on two major data levels on the professional practice respondents. The first section is on personal information, giving information on age, gender and marital status of respondents, while the second section provides information on the professional practice. Here, information was sought on the individual and his/her professional body or association with respect to energy efficiency practice on design scheme and appliances specification using judgmental sampling.
'Judgmental sampling' which is a kind of 'purposive sampling' was adopted because we are seeking a more predefined group; and particularly judgmental as it involves the choice of subjects who are the most advantageously placed or in the best position (as experts in the field) to provide the required information [13; 14; 15; 16].

The target population was the housing design practice professionals in Bauchi town as determined by the register of professional associations of respective disciplines (architects, building service engineers and builders) as at the time of study. A sampling factor of 30% was initially hypothesized, but due to the meagre population of some practitioners, the entire population of architects (81), building service engineers (32) and builders (43) on the respective associational registers was sampled. Eventually, responses of 59 architects (73%), 27 engineers (84%) and 32 builders (74%) were recorded due to unavoidable factors of availability and continuous professional practice engagement on the part of some professionals. Therefore, in a total population of 156 housing design practice professionals currently in Bauchi town, only 118 of them responded to the questionnaire survey, constituting a cumulative sample factor of 76%.
Some of the questions provided with a range of answers in the second section are as follows;

- What is the level of your awareness on energy efficiency in general?
- What is your concern for conservation in the built environment?
- How do you rate Energy Efficiency consideration in your housing design practice?

- What is your utmost consideration in terms of appliances selection or building materials/components specification?
- How do you rate your awareness/knowledge on energy efficient appliances in the building/construction market in Nigeria today?
- In which aspect of your practice do you consider energy efficiency most?
- Are your clients conversant with or demanding energy efficiency in your practice?
- What is the most specific limitation to energy efficiency in your profession by your understanding etc?
- Are you professionally registered?
- Do you attend seminars/workshops etc on energy efficiency? Etc.

Results and discussions

The result from the first section of the questionnaire reveals that most of the professionals in practice are males (90.7%); with the majority of respondents in the age range of '38-47yrs' (38.1%) and others; '28-37yrs' (34.7%), '48yrs and above' (16.1%) and '18-27yrs' (11%).

It has also revealed that only 44.9% (i.e. 53 out of 118 professionals) are professionally registered, and among them, 30.2% (i.e. 16 out of 53) are architects; 35.8% (19 out of 53) are engineers; and 34% (18 out of 53) are builders. This account shows the serious need to advocate for professional registration of practitioners particularly architects where continuous professional development can be enforced.

The result on the *level of awareness* in the second section of the questionnaire has indicated 'Little' rating with the highest score of 39% (i.e. 46 out of 118 professionals); among which are 28 architects, 5 engineers and 4 builders. Other ratings are 'Good' (36.4%), 'Very good' and 'Very little' (10.2% each), 'I don't know' (2.5%) and a missing value of 1.7%. This is an indication that the architects have the least of awareness among the entire group of professionals.

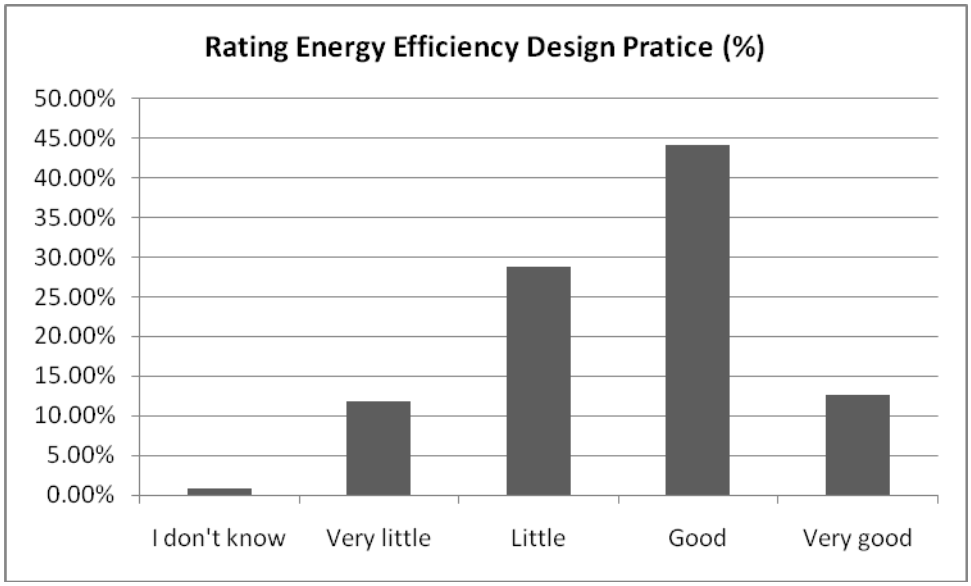

Figure 1: % Energy Efficiency Design Practice Level

The rating on *energy efficiency consideration in design practice* as shown in figure 1 has indicated 'Good' as the cumulative highest score of 44.1% (i.e. 52 out of 118 professionals). But the breakdown of the percentage within is 44.1% (i.e. 26⁄59) architects; 44.4% (i.e. 12⁄27) building service engineers and 43.8% (i.e. 14⁄32) builders. This scenario calls for concern as a majority of the professionals are yet to be informed and to fully imbibe the concept of energy efficiency into their professional practice/culture. A typical case is the architects group whose major factors of consideration remain aesthetics and functionality in design. This therefore means that the housing design practice in Nigeria lacks the requisite consideration for energy efficiency, which conforms with Janda [6] result in which majority of the architects had mixed reaction to the 'Energy Edge' project on energy efficiency practice. Although, the engineers and builders have shown better awareness in this case, they have not superseded the architects in energy efficiency design practice.

It is surprising that a majority of the professionals have indicated 'Little' to 'I don't know' on the scale of *'knowledge of energy efficient appliances in the building market'*. The highest score is 'Little' (45.8%), then 'Good' (34.7%), 'Very little' (12.7%), 'Very good' (4.2%) and 'I don't know' (1.7%). It is also amazing that 56.8% of respondents indicated that they are 'Not at all' aware of any *professional guidelines/regulations* that stipulate or advocate energy efficiency design practice. Among these are 39 architects (i.e. 66.1% within), 13 engineers (i.e. 48.1% within) and 15 builders (i.e. 46.9% within). Nonetheless, a majority of respondents have suggested the promulgation and implementation of sustainable policies to embody public education/sensitization programmes by the government; and proper coordination of design practices through seminars, conferences and workshops by professional bodies to keep members abreast of development trends in energy efficiency design practice.

The result on *clients' demand of energy efficiency service* from the stakeholders as shown in figure 2 indicates 'Little' (33.1%) as the highest score. The reason for this could be due to lack of awareness/information on energy efficiency and the benefits arising thereto. On this note, it therefore becomes necessary for the government and other stakeholders to institute energy efficiency education and awareness programmes for the public. It is equally appropriate to establish channels for effective dissemination of information to the public in this respect.

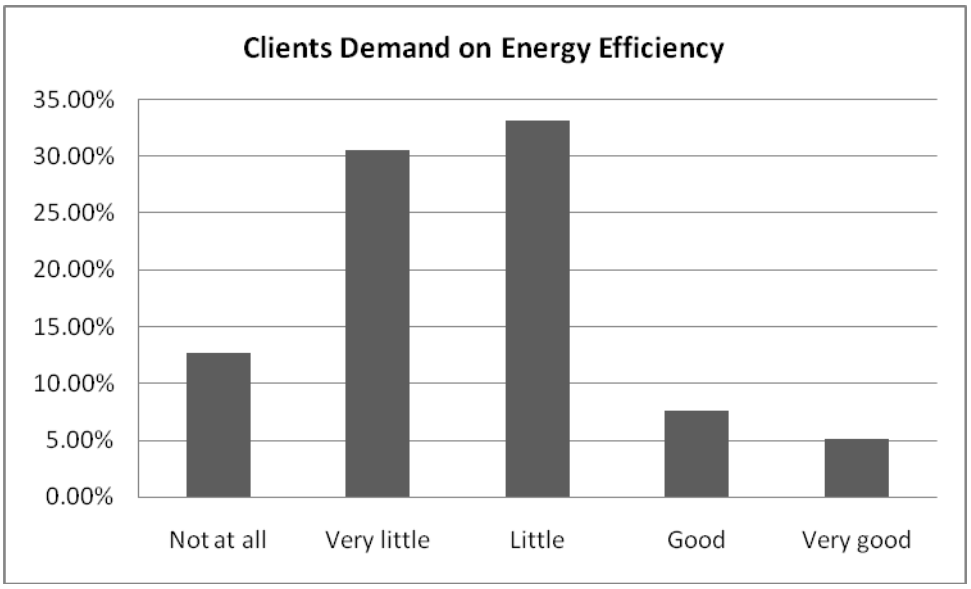

Figure 2: Clients' Demand on Energy Efficiency Service (%)

The result of responses on *seminar attendance* in areas related to energy efficiency reveals that 48.3% of respondents have not attended any at all, while the rest have indicated 'Quarterly' attendance (5.9%), Half-yearly (0%), Annually (18.6%), 'Others' (16.1%) and a missing value of 10.2%. This result is not encouraging for a sustainable development when practitioners seem not to be abreast with the current global interest on energy efficiency. This problem in addition to all others identified with the stakeholders of the housing industry in this study, arises from the lack of appropriate policy and practice regulations in place by the government and the housing agencies/stakeholders. This must be addressed; and incentives should be provided for good practice.
In contrast to past studies where most of the attention or research work is concentrated on appliances efficiency, design guidelines, and sparingly on consumer behaviour, this particular study focuses on the social aspect of housing design practice by the stakeholders of the building industry; and as such has little comparison to make.

Findings and conclusion

It is to be acknowledged that there was the problem of access to respondents as many were not willing to give some time for interaction before attempting to answer the questions common with most research undertaking. There was also a clear manifestation of un-coordinated activities within the building industry in terms of the 'rules of obligation' with reference to energy efficiency practice. This may be due to the lack of adequate policies in place, and also the fact that a majority of practitioners are not professionally registered. As a result, it was difficult for the stakeholders to give adequate and appropriate responses that were devoid of discrepancies.
On the whole, it can be inferred that the Nigerian building industry is yet to be ardently familiar with the principles of energy-efficient designs and the ongoing global concern for energy efficiency practice. This is evident in the responses of a majority of architects and some engineers and builders who declared a 'no-consideration' of efficiency in their practice; and a 'no-provision' of formal policies/strategies for implementation by the government or respective professional associations. In fact, the result of the study has revealed an obvious gap in energy efficiency consideration and architectural practice in Nigeria. This is principally due to the low level of awareness on the part of the public including the stakeholders in the building industry. Although, there is a general apathy in energy efficiency consideration in design practice, the building service engineers and builders have demonstrated as in the survey result, a better level of awareness and knowledge of energy efficient appliances/systems in the building industry than the architects.
In summary, there is the lack of adequate information and appropriate policy to institute building energy efficiency on the part of government; the lack of energy efficiency service demand from the clients due to ignorance; and the lack of necessary input from the professional bodies/associations in establishing concrete guidelines on energy efficiency practice for their members to implement. Thus, our presupposition on the architectural issue, that one of the problems of energy inefficiency of households (residential buildings in Nigeria as in most developing countries) is poor efficiency design practice has been justified by the findings of this survey. It becomes valid and necessary therefore, to recommend further studies aimed at providing framework of energy efficiency design practice for the housing stakeholders with the cardinal objective of proffering ways of improving the professional cultures towards energy efficiency practice. In addition, the following recommendations would help in improving housing design practice towards energy efficiency;

- Professional bodies and government housing agencies should ensure that all practitioners are professionally registered for proper coordination of design practice towards energy efficiency.
- The professional bodies in conjunction with the 'Energy Commission of Nigeria' should evolve energy efficiency design practice guidelines to be complied by all practitioners.
- There should be 'Continuous Practice Development' programmes in the form of seminars, conferences, workshops and design competitions on this subject to rejuvenate a practice culture; and also to keep practitioners abreast.
- The housing authorities/agencies should embody a monitoring scheme at the design approval stage to ensure design compliance with energy efficiency guidelines.
- The government agencies in collaboration with professional bodies should workout incentive programmes for good practitioners.
- The professional bodies should establish continuous collaboration with the universities and foreign institutions on energy efficiency and energy conservation programmes.
- Energy efficiency and energy conservation should be taught as courses at all levels of education.

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Table 1: PROFESSIONAL HOUSING STAKEHOLDER RESPONDENTS QUESTIONNAIRE RESULT

A. PERSONAL INFORMATION DATA									
Parameters	Responses	Total Frequency	Percentage (%) Total	Architects		Bldg Service Engineers		Builders	
				Frq.	%	Frq.	%	Frq.	%
1. Age Range	18-27yrs	13	11.0	11	9.3	0	0	2	1.7
	28-37yrs	41	34.7	22	18.6	7	5.9	12	10.2
	38-47yrs	45	38.1	20	16.9	13	11.0	12	10.2
	48yrs and above	19	16.1	6	5.1	7	5.9	6	5.1
2. Gender	Male	107	90.7	50	42.4	27	22.9	30	25.4
	Female	11	9.3	9	7.6	0	0	2	1.7
3. Status in the Housing Industry	Architect	59	50.0						
	Building Service Engineer	27	22.9						
	Builder	32	27.1						
4. Years in Practice	5yrs and below	32	27.1	18	15.3	6	5.1	8	6.8
	6-10yrs	36	30.5	21	17.8	5	4.2	10	8.5
	11-15yrs	18	15.3	5	4.2	7	5.9	6	5.1
	16-20yrs	17	14.4	8	6.8	5	4.2	4	3.4
	21yrs and above	14	11.9	6	5.1	4	3.4	4	3.4
	Missing value	1	0.8	1	0.8	0	0	0	0
5. Professional Registration	Yes	53	44.9	16	13.6	19	16.1	18	15.3
	No	51	43.2	38	32.2	7	5.9	6	5.1
	Missing value	14	11.9	5	4.2	1	0.8	8	6.8

B. PROFESSIONAL PRACTICE INFORMATION									
Parameters	**Responses**	**Total Frequency**	**Percentage (%) Total**	**Architects**		**Bldg Service Engrs**		**Builders**	
				Frq.	**%**	**Frq.**	**%**	**Frq.**	**%**
1. Level of Awareness on Energy Efficiency	I don't know	3	2.5	1	0.8	1	0.8	1	0.8
	Very little	12	10.2	6	5.1	2	1.7	4	3.4
	Little	46	39.0	28	23.7	5	4.2	13	11.0
	Good	43	36.4	16	13.6	15	12.7	12	10.2
	Very good	12	10.2	7	5.9	4	3.4	1	0.8
	Missing value	2	1.7	1	0.8	0	0	1	0.8
2. Concern for Energy Conservation	Not at all	2	1.7	1	0.8	0	0	1	0.8
	Very little	5	4.2	2	1.7	1	0.8	2	1.7
	Little	26	22.0	15	12.7	4	3.4	7	5.9
	Good	59	50.0	26	22.0	16	13.6	17	14.4
	Very good	24	20.3	13	11.0	6	5.1	0	0
	Missing value	2	1.7	2	1.7	0	0		
3. Rating of Energy Efficiency Consideration in Housing Design Practice	I don't know	1	0.8	1	0.8	0	0	0	0
	Very little	14	11.9	5	4.2	1	0.8	8	6.8
	Little	34	28.8	18	15.3	8	6.8	8	6.8
	Good	52	44.1	26	22.0	12	10.2	14	11.9
	Very good	15	12.7	7	5.9	6	5.1	2	1.7
	Missing value	2	1.7	2	1.7	0	0	0	0
4. Utmost Consideration in Appliances/Services Specification	Purchase price	12	10.2	5	4.2	5	4.2	2	1.7
	Aesthetics	6	5.1	5	4.2	0	0	1	0.8
	Social acceptability	5	4.2	2	1.7	1	0.8	2	1.7
	Energy efficiency	58	49.2	28	23.7	16	13.6	14	11.9
	Accessibility	10	8.5	6	5.1	1	0.8	3	2.5
	Convenience	23	19.5	9	7.6	4	3.4	10	8.5
	Missing value	4	3.4	4	3.4	0	0	0	0

Parameters (Continued)	Responses	Total Frequency	Percentage (%) Total	Architects		Bldg Service Engineers		Builders	
				Frq.	%	Frq.	%	Frq.	%
5. Knowledge of Energy Efficient Appliances	I don't know	2	1.7	1	0.8	0	0	1	0.8
	Very little	15	12.7	7	5.9	1	0.8	7	5.9
	Little	54	45.8	31	26.3	10	8.5	13	11.0
	Good	41	34.7	19	16.1	12	10.2	10	8.5
	Very good	5	4.2	6	5.1	4	3.4	1	0.8
	Missing value	1	0.8	1	0.8	0	0	0	0
6. Efficiency Rating of Appliances in the Building Market	I don't know	5	4.2	2	1.7	0	0	3	2.5
	Very low	29	24.6	16	13.6	5	4.2	8	6.8
	Low	70	59.3	36	30.5	18	15.3	16	13.6
	High	13	11.0	5	4.2	3	2.5	5	4.2
	Very high	1	0.8	0	0	1	0.8	0	0
7. Vision of Establishment on Energy Efficiency Practice	Not satisfactory	93	78.8	48	40.7	22	18.6	23	19.5
	Satisfactory	21	17.8	11	9.3	3	2.5	7	5.9
	Missing value	4	3.4	0	0	2	1.7	2	1.7
8. Professional Guidelines/Regulations on Energy Efficiency Practice	Yes	46	39.0	18	15.3	14	11.9	14	11.9
	No	67	56.8	39	33.1	13	11.0	15	12.7
	Missing value	5	4.2	2	1.7	0	0	3	2.5
9. Utmost Stage of Energy Efficiency Consideration in Housing Design Practice	Not at all	3	2.5	2	1.7	0	0	1	0.8
	At the design stage	35	29.7	20	16.9	10	8.5	5	4.2
	Specification/service	48	40.7	25	21.2	12	10.2	11	9.3
	design stage	14	11.9	5	4.2	2	1.7	2	1.7
	Construction stage	16	13.6	5	4.2	3	2.5	8	6.8
	Occupancy stage	2	1.7	2	1.7	0	0	0	0
	Missing value								
10. Clients Demand on Energy Efficiency	Not at all	15	12.7	9	7.6	4	3.4	2	1.7
	Very little	36	30.5	22	18.6	7	5.9	7	5.9
	Little	39	33.1	18	15.3	10	8.5	11	9.3
	Good	9	7.6	4	3.4	2	1.7	3	2.5
	Very good	6	5.1	3	2.5	1	0.8	2	1.7
	Missing value	13	11.0	3	2.5	3	2.5	7	5.9

Parameters (Continued)	Responses	Total Frequency	Percentage (%) Total	Architects		Bldg Service Engineers		Builders	
				Frq.	%	Frq.	%	Frq.	%
11. Most Specific Limitation to Energy Efficiency Practice	Low level of awareness	22	18.6	14	11.9	4	3.4	4	3.4
	Educational gap among profs	5	4.2	3	2.5	0	0	2	1.7
	Lack of concern among profs	7	5.9	5	4.2	1	0.8	1	0.8
	Lack of policy/implementation	37	31.4	14	11.9	13	11.0	10	8.5
	All of the above	33	28.0	19	16.1	6	5.1	8	6.8
	Others	1	0.8	0	0	1	0.8	0	0
	Missing value	13	11.0	4	3.4	2	1.7	7	5.9
12. Opportunities to Improving Energy Efficiency Practice	Yes	83	70.3	42	35.6	23	19.5	18	15.3
	No	19	16.1	12	10.2	2	1.7	5	4.2
	Missing value	16	13.6	5	4.2	2	1.7	9	7.6
13. Seminars/Workshops Attendance on Energy Efficiency	Not at all	57	48.3	31	26.3	11	9.3	15	12.7
	Quarterly	7	5.9	4	3.4	3	2.5	0	0
	Half-yearly	0	0	0	0	0	0	0	0
	Annually	22	18.6	7	5.9	6	5.1	8	6.8
	Others	19	16.1	10	8.5	6	5.1	2	1.7
	Missing value	12	10.2	5	4.2	1	0.8	7	5.9