

Investigation of Traditional Bamboo House Construction Practice and the Need for Bamboo Construction Technology in Awi Zone

Asimie Agegnehu Gatie, Kassahun Admassu Abegaze, Wallie Tilahun Bitew



Abstract: Bamboo for housing construction is a paramount material due to its adaptability characteristics, cost advantage, wider accessibility and environmental friendliness. This study focused on bamboo technology for bamboo housing construction in Awi Zone of Ethiopia and it has also identified the current use of bamboo for construction, challenges facing bamboo improvement, factors influencing bamboo application and to propose the mechanism of technology transfer in bamboo house construction technology transfer in the bamboo house construction future. The main tools for the collection of data were questionnaires, interviews and case studies which were used to identify the various challenges and factors influencing bamboo construction technology. The data were analyzed using a Statistical Package for Social Sciences software within its mean value. The findings of this study indicate that lack of research funds for bamboo building materials with a mean of 4.22; inadequate technologies and weak technology transfer in bamboo construction with a mean of 4.13 and lack of finance to facilitate bamboo construction technology with a mean of 4.11 are the major problems of bamboo construction technology development.

Keywords: Appropriate, Technology, Awi, Bamboo, Construction, Housing, Product, Traditional, Technology, transfer

I. INTRODUCTION

Bamboo is one of the oldest and most flexible building materials with many uses in the field of construction, particularly in developing countries. It is strong and lightweight and can often use without processing or finishing. Bamboo constructions are easy to build, resilient to wind and even earthquake forces, and readily repairable in the event of damage Jayanetti et al, (2008) [3] [11] [12] [13]. It is a current construction material among rural societies in Ethiopia, especially in regions of Awi; where it grows naturally. The country is rich in traditional bamboo housing designs, practices and skills.

However, the sustainability of the traditional and modern architecture used by the poor communities in Ethiopia is under threat due to reducing resource availability, increasing rural populations, and a shortage of contemporary processing technologies. The government is also willing to develop bamboo as another construction material using laminated bamboo and is planning to establish a manufacturing industry. This will provide a possible road for incorporating bamboo into the formal housing industry (Paudel, 2011) [7].

1.2. Statement of the Problem: In Ethiopia, bamboo as a construction material was not completely utilized in the construction industry and this shows that the bamboo housing construction technology still remains at its infant stage. Since bamboo is readily available and less costly unlike cement, sand and steel. The people in focus do need an alternative material and technology. Bamboo is highly renewable and the fastest growing material and has properties that make it suitable for construction as happened to be elsewhere. The challenges existing for technology transfer in bamboo construction like; unwillingness of the transfer of the real technology and technical know-how, has led to unproductive technology ownership, incorrect technology selection, unmatched with the current practice elsewhere, shortage of practical training and too much rush in the adoption process. Therefore, this research attempts to fill these gaps by investigate traditional bamboo house construction practice and bamboo house construction technology in Awi Zone.

1.3. Specific Objectives were: to identify the challenges of bamboo improvement in housing construction sector, to investigate the major factors affecting bamboo application for construction and to identify the governing factors of technology transfer in bamboo house construction.

II. MATERIALS AND METHODS

A. Study Area Selection:

The rural area was selected due to various reasons. Awi has managed the bamboo production system due to the accessibility of bamboo forest. The area is selected based on the major users of commercial bamboo resources and the main traditional bamboo handcraft processing centers. The selected area is more or less illustrative for the Ethiopian bamboo growing and processing places and later provides useful reasonable insight in to bamboo products and technologies.

Manuscript received on 27 May 2024 | Revised Manuscript received on 08 June 2024 | Manuscript Accepted on 15 June 2024 | Manuscript published on 30 June 2024.

*Correspondence Author(s)

Asimie Agegnehu Gatie*, Lecturer at Debre Markos University, Debre Markos Institute of Technology, Debre Markos, Ethiopia. E-mail: asimieage@gmail.com, ORCID ID: [0009-0001-3056-1074](https://orcid.org/0009-0001-3056-1074)

Wallie Tilahun Bitew, Lecturer at Debre Markos University, Debre Markos Institute of Technology, Debre Markos, Ethiopia.

Dr. Kassahun Admassu Abegaze, Managing Director of Ethiopian Institute of Architecture, Building construction and City Development Addis Ababa University, Ethiopia.

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an open access article under the CC-BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

Investigation of Traditional Bamboo House Construction Practice and the Need for Bamboo Construction Technology in Awi Zone



Figure 2. 1 Location of the study area (Williams, 2007) [10].

B. Source of Data:

Primary Source of Data were conducted through questionnaire, interview (In nondirective type of interview the interviewer asks questions as they come to mind) Taber, K et al.. (2016). Case study (multiple data collection techniques will be preferred to understand the context and make the participant s' response with practically high validity) (Jones, 2001) [4]. Secondary sources of data were obtained from relevant books, journals and research papers .The population was used from stakeholders (owner, professional and regulatory bodies) who work in awi zone bamboo house construction. After the baseline survey was complete, semi-structured questioners, interviews and case studies were conducted on bamboo houses, bamboo craft enterprises, bamboo enterprises and other consumers and bamboo experts Aibinu et al.. (2002) [1].

C. Sample Size Determination:

Sampling is the process of selecting representative units of construction parties for the study. The advantage of using a

sample is that it is more practical and less costly than collecting data from all the construction parties (Njogu, 2015) [6].

$$no = (p*q)/ V^2 \dots\dots\dots(3.1)$$

$$n=no/[1+(no/N)] \dots\dots\dots(3.2)$$

Where: no: First estimate of sample size, p: The proportion of the characteristic being measured in the target population with value of 0.5, q: Complement of p or 1-p, V: The maximum standard error allowed, N: The population size and n: The sample size.

D. Methods, Tools and Instruments Used for the Research:

The qualitative data was collected through interviews and case studies which were analyzed based on the specific objectives of the study. Quantitative data was collected through questionnaires and the analysis uses for order of mathematical operations to evaluate the properties of data Khawaja K.et al.. (2012) [5]. Quantitative data obtained from the respondents were fed into the SPSS sheet to calculate and process the data. Later it was analyzed using the Statistical Package for Social Sciences (SPSS) and mean score to obtain ranks of the results (Greasley., 2007) [2]. The reliability of the result has been checked by Cronbach's alpha to know the measure of internal consistency ("reliability") (Taber, 2016) [8] [9].

III. RESULTS AND DISCUSSION

A. Challenges of Bamboo Improvement in Housing Construction

The challenges bamboo improvement in housing construction sector respondents was asked about all the seven challenges bamboo improvement in construction.

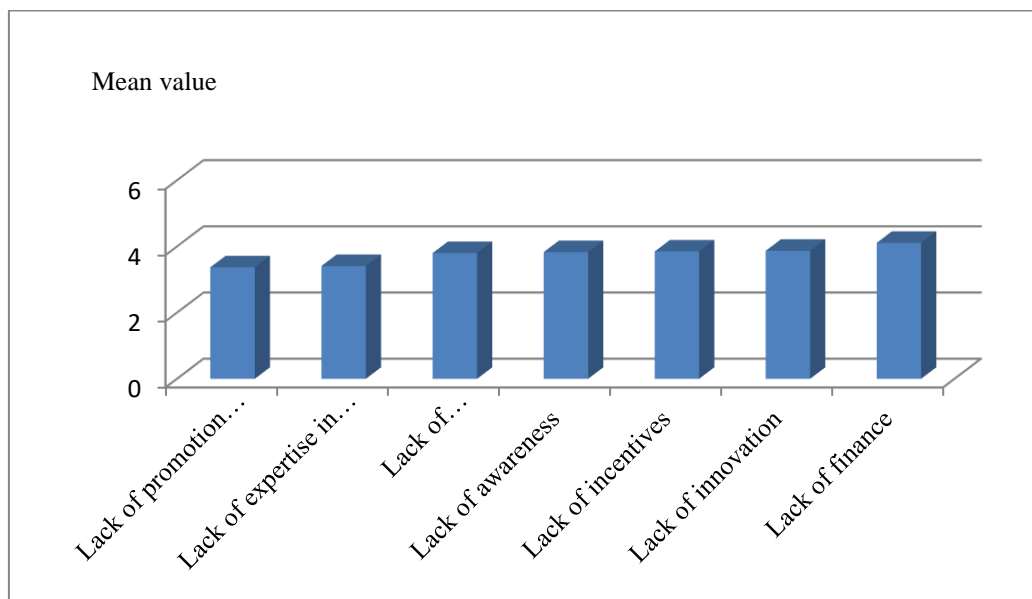


Figure 3. 1 Challenges Bamboo Improvement in Housing Construction

As the response obtained from the respondents on the challenges bamboo improvement the reliability statistics Cronbach's Alpha value (0.550) is acceptable with the largest mean score value of 4.11. As per the result that is presented above the top five challenges bamboo improvement based on their mean values are lack of finance with 4.11, lack of innovation with 3.87, lack of incentives with 3.85, lack of awareness with 3.83 and lack of commitment of stakeholder

institutions with 3.80. The rest are of minor challenges bamboo improvement in housing construction.

B. Major Factors Affecting Bamboo Application

The major factors affecting bamboo application is categorized in to two major groups like, application- related factors and policy - related factors.

a. Application related factors in bamboo use

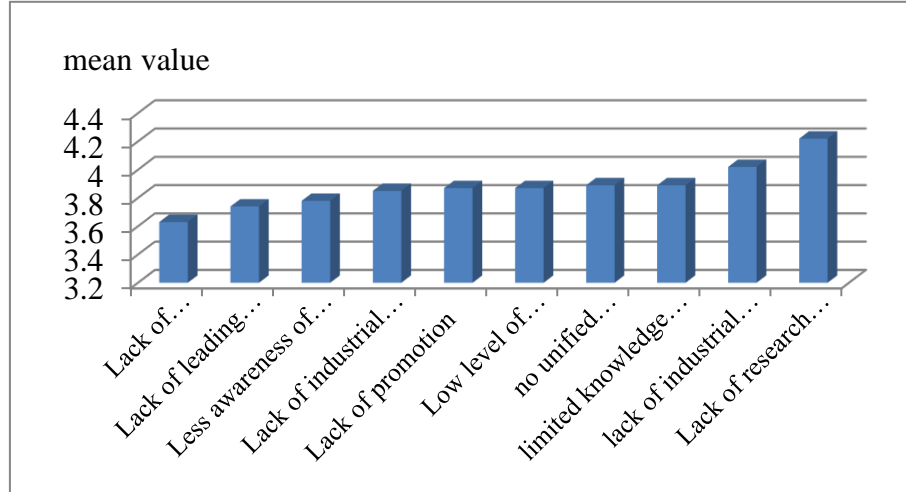


Figure 3. 2: Application Related Factors in Bamboo Use

The above table shows that lack of research funds for bamboo building materials with a mean of 4.22, lack of industrial associations and construction certification bodies with a mean of 4.02, limited knowledge on cultivation of good bamboo with a mean of 3.89, no unified education system of bamboo and wood structure with a mean of 3.89,

low level of industrialization for production with a mean of 3.87, lack of promotion with a mean of 3.87, lack of industrial planning and marketing planning for bamboo with a mean of 3.85 are the top seven major factors in bamboo application.

b. Policy related factors in bamboo application

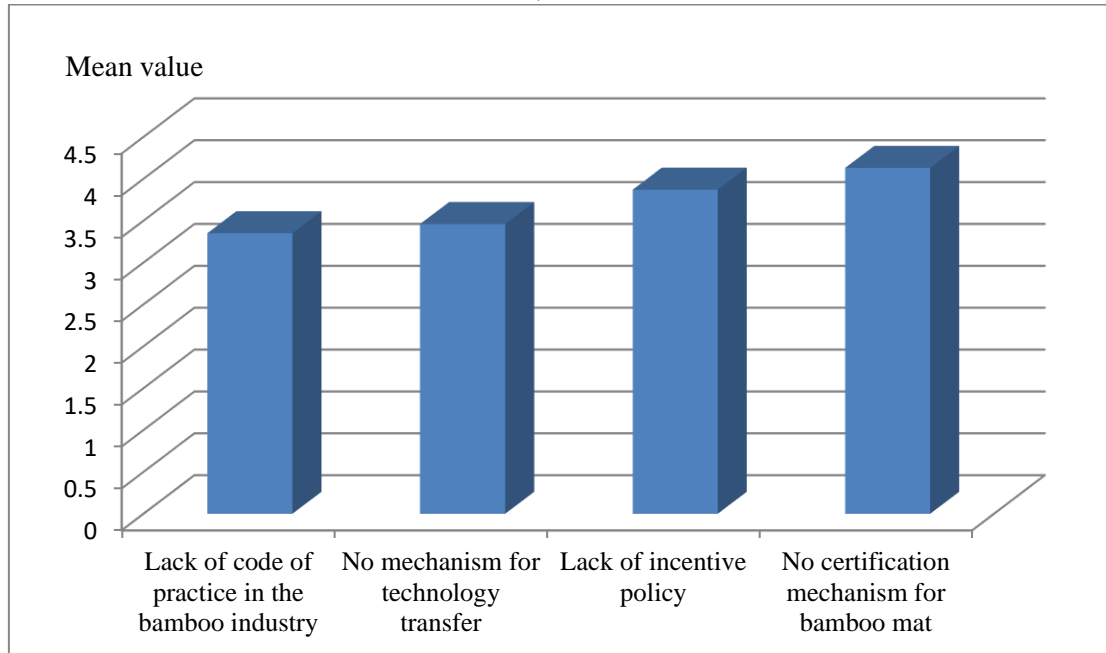


Figure 3. 3: Policy Related Factors in Bamboo Application

As the response obtained from the respondents on policy related factors in bamboo application has low reliability (0.126) with the highest mean score value of 4.13. The above table shows that no certification mechanism for bamboo mat with a mean of 4.13, lack of incentive policy with a mean of

3.87, no mechanism for technology transfer with a mean of 3.46 and lack of code of practice in the bamboo industry with a mean of 3.35 are the top four major factors in bamboo application under policy related factors.

Investigation of Traditional Bamboo House Construction Practice and the Need for Bamboo Construction Technology in Awi Zone

C. Factors of Technology Transfer in Bamboo Construction

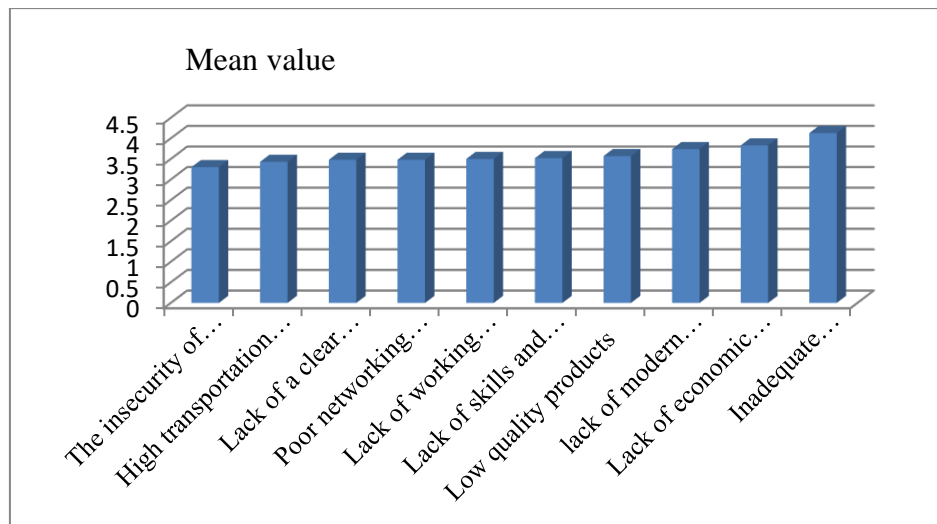


Figure 3. 4: Factors of Technology Transfer in Bamboo Construction

The above table shows that, inadequate technologies and weak technology transfer with 4.13, lack of economic incentives to promote rural communities with 3.83, lack of modern processing technologies with 3.74, low quality

products with 3.52 and lack of skills and tools for processing bamboo with 3.50 are top five factors of technology transfer in bamboo construction. While the rest of all other are minor factors of bamboo construction technology transfer.

D. Current Use of Bamboo in Housing Construction

a. Traditional use of bamboo in Awi Zone

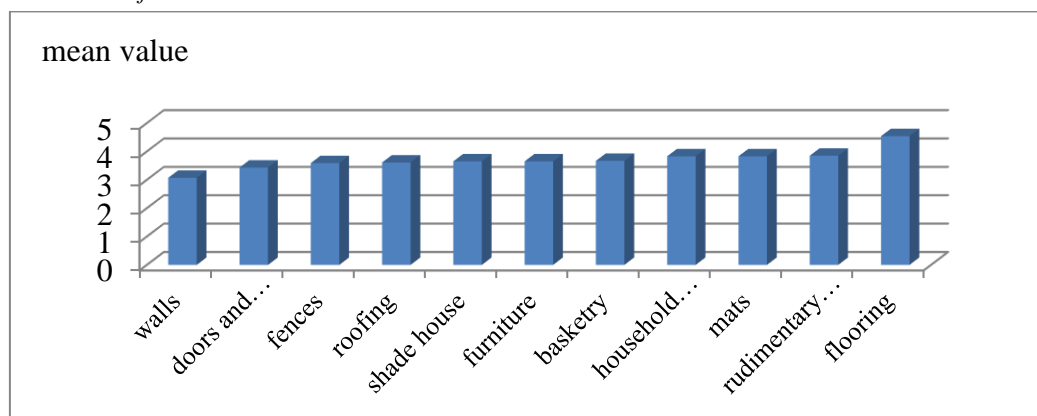


Figure 3. 5: Traditional use of bamboo in Awi Zone

As a result shown above, has sufficient reliability of 0.442 with a peak mean of 4.54. The most products of bamboo used for flooring, rudimentary furniture, mats, basketry and household utensils in a traditional manner.

b. Contemporary use of bamboo in Awi Zone

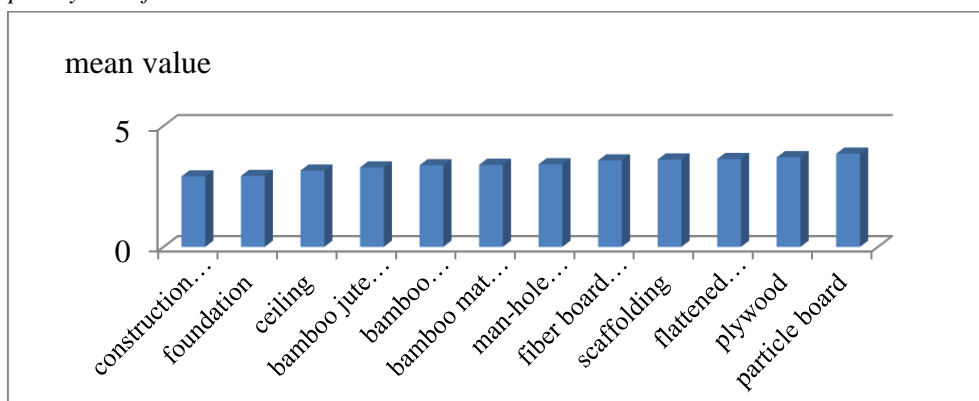


Figure 3. 6: Contemporary use of Bamboo in Awi Zone

As the results in the above show, reliability (0.487) is acceptable with 3.85 higher mean score value. Most products of bamboo are used for particle board, plywood, flattened bamboo boards, scaffolding and fiber board prefabricated houses contemporarily.

Table 3. 1: Challenges of Bamboo Innovation in House Construction

Challenges of Bamboo Innovation in House Construction	Yes (%)	No (%)	Rank
Lack of bamboo house promotion	49	51	5
Lack of government support to develop bamboo house technology	52	48	3
Low interest in bamboo house construction	61	31	2
Lack of working capital	48	52	6
Inadequate machines and tools to work bamboo house	72	28	1
Lack of adequate education and skills	51	49	4

Based on the results of interview questions, inadequate machines and tools to work bamboo house (72%), low interest in bamboo house construction (61%), Lack of government support to develop bamboo house technology (52%) and lack of adequate education and skills are the main factors of technology in bamboo house construction.

Table 3. 2: Site Practice Problem of Bamboo House Construction

Case study I: Site Practice Problem of Bamboo House Construction	Yes (%)	No (%)	Rank
Have you used harvested bamboo in dry season to avoid fungus attack and excess moisture?	55	45	4
Have you used chemical treatments in raw materials of bamboo?	17	83	1
Have you protect bamboo materials from direct sun, moisture and rain?	44	56	3
Did you encourage peoples to use bamboo for house construction?	72	28	5
Did you get training on the ways of bamboo house construction?	23	77	2
Case study II: Factors of Bamboo Enhancement in Housing Construction			
Lack of strategy, implementation and integration on bamboo materials	59	41	2
weak linkage between different institutions	45	55	6
Limited management system of bamboo resource	42	58	8
Improper use of bamboo materials for house building	48	52	5
Lack of systematic experimental research	62	38	1
Inadequate bamboo processing techniques	49	51	4
Difficulty in forming storing joints	52	48	3
Difficulty in quality control	44	56	7

From case study I, chemical treatment of bamboo materials were not used (83%), lack of training on the ways of bamboo house construction(77%), protect bamboo materials from direct sun, moisture and rain were not adopt(56%) are the main problems of house construction technology implementation based on the ranks of respondents saying no. whereas, From case study II, Lack of systematic experimental research (62%), lack of strategy, implementation and integration on bamboo materials (59%), difficulty in forming storing joints (52%) and inadequate bamboo processing techniques (51%) are the main factors of bamboo enhancement in housing construction based on the ranks of respondents saying yes.

IV. CONCLUSION

Conclusions are drawn from the study by combining the results and discussions leading to solving the problems. It was meant to answer the questions raised and the specific objectives stated in section 1.3.2 of the introduction chapter. Based on the finding, most products of bamboo are used for flooring, rudimentary furniture, mats, and basketry and household utensils in a traditional manner. The results indicated that, lack of financial support, lack of innovation and lack of incentives are the main challenges bamboo improvement in housing construction industry. This research revealed that the major factors affecting bamboo application

E. The Results of Interview Questions

The main challenges of bamboo innovation in house construction obtained from the interviews are stated below.

F. Case Study

The case study were conducted to the site practice problem of bamboo house construction and Factors of bamboo enhancement in housing construction on selected stakeholders as presented below. The methods of analysis were based on the percentage of the respondents.

are: lack of industrial associations and construction certification bodies, limited knowledge on cultivation of good bamboo, lack of unified education system of bamboo and wood structure and no certification mechanism for bamboo. The findings showed that, limited technologies and weak technology transfer, lack of economic incentives to promote rural communities and lack of modern processing technologies are the major obstacles of technology transfer in the bamboo house construction.

DECLARATION STATEMENT

Funding	No, I did not receive it.
Conflicts of Interest	No conflicts of interest to the best of our knowledge.
Ethical Approval and Consent to Participate	No, the article does not require ethical approval and consent to participate with evidence.
Availability of Data and Material	Not relevant.
Authors Contributions	All authors have equal participation in this article.

REFERENCES

1. Aibinu, A. and G. Jagboro . (2002). The effects of construction delays on . 593-599.

Investigation of Traditional Bamboo House Construction Practice and the Need for Bamboo Construction Technology in Awi Zone

2. Greasley., P. (2007). Quantitative Data Analysis Using SPSS.
3. Jayanetti, D. and P. Follett. (2008). Bamboo in construction, in Modern.
4. Jones, R. (2001). The psychological effects of Hurricane Andrew on ethnic minority . 103.
5. Khawaja Khalid , Haim Hilman and Dileep Kumar. (2012). Get along with.
6. Njogu, J. (2015). Influence of .
7. Paudel, S. (2011). Development and .
8. Taber, K. S. (2016). The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education.
9. Taber, K. S. (2016). The Use of Cronbach's Alpha, When Developing and Reporting .
10. Williams, C. (2007). Williams, C.(2007), Research methods. Journal of Business & Economics Research (JBER), 5(3).
11. Singh, K., Garg, H., & Pabla, B. S. (2019). Evaluation of Mechanical Properties of Different Bamboo Species for Structural Applications. In International Journal of Innovative Technology and Exploring Engineering (Vol. 8, Issue 11, pp. 2927–2935). <https://doi.org/10.35940/ijitee.k2218.0981119>
12. Inamdar, S. J., Patil, U., & Lodam, H. (2019). Thermal Energy Storage System using Bamboo in Combination with PCM. In International Journal of Engineering and Advanced Technology (Vol. 8, Issue 6s, pp. 865–869). <https://doi.org/10.35940/ijeat.f1163.0886s19>
13. Medrano, M. T. S., & Domínguez, E. J. S. (2019). Microscopic Analysis of Bamboo Pieces and Its Relation to Compression Resistance. In International Journal of Recent Technology and Engineering (IJRTE) (Vol. 8, Issue 3, pp. 3809–3812). <https://doi.org/10.35940/ijrte.c5448.098319>

AUTHORS PROFILE



Mr. Asimie Agegnehu Gatie Profile is Lecturer at Debre Markos University Debre Markos, Ethiopia; I did Bachelor's degree in construction technology and management engineering from Debre Markos University and Master's Degree from Bahir Dar in Civil Engineering. I am a member of various professional bodies. I was provided community service like shed construction, teaching, students during summer season and providing trainings for freshman students. I was worked in different construction industries, such as road construction building construction as site and office engineer. I have a good expert in statistical packaging in social science (SPSS), AutoCAD, primavera and I was participated in different academically conferences and research programs. I have 8 years experience in teaching and research work.



Mr. Wallie Tilahun Bitew profile is Lecturer at Debre Markos University, , Debre Markos, Ethiopia he did his Bachelors in construction technology and management engineering from Debre Markos University and Master's Degree from Bahir Dar in Civil Engineering. He chair holder of Construction Material and Technology for leading material laboratory work in Debre Markos University. He has a good expert in statistical packaging in social science (SPSS), AutoCAD, primavera also. He has a good expert in providing higher diploma program (HDP) tanning, for fresh man teachers/ assistance lecturer and also fresh graduate candidate in civil engineering. Also he was lead managing various construction projects like the construction of public and buildings. He has 9 year work experience in teaching and research.



Dr. Kassahun Admassu Abegaze: he is Managing Director of Ethiopian Institute of Architecture, Building construction and City Development Addis Ababa University, Ethiopia and he is PHD in Civil Engineering. Currently working as phd holder at Addis Ababa university college of Ethiopian institute of architecture building construction department of architecture having 37 experience in teaching and research. His strength is honest, committed, rational thinking, problem solver, disciplined and work as friendly in every working activity. He is a good leader for administering and managing institute of architecture and building construction in addis ababa city development. He teaches masters students in different universities like Bahir Dar, Gonder, Adama and Hawassa. He is one of the successful professional in construction industry and teaching activities.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)/ journal and/or the editor(s). The Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP) and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.