Original Article

Inhibitors of adopting stabilised earth construction to address urban low cost housing crisis: An understanding by construction professionals

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ABSTRACT Stabilised earth is an alternative building material which is comparatively cheaper than conventional building material in the construction of urban low cost housing. In addition, stabilised earth construction reduces CO_2 emission and is environmentally sustainable. Despite all the benefits of this building material there are potential inhibitors which make stabilised earth construction unpopular among the construction professionals. This article aims to identify and highlight these inhibitors from the literature in the light of its use on site, performance, image in the societies and cultures and validates through a structured research method. First, a critical literature review method is adopted in this article to investigate and identify the inhibitors influencing the adoption of this building material to address urban low cost housing crisis and second, the identified inhibitors is validated through a Delphi technique.

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INTRODUCTION

Cities in the third world have, since the 1950s, experienced unprecedented growth in terms of spatial development and population increase; the urban population increase has

particularly been high due to rural–urban migration (Dwyer, 1981, p. 33). Unfortunately, the cities of developing countries are not planned for these magnitudes of growth in population influx, nor do they in reality have the required jobs and facilities to support such expansion (Srinivas, 1999). Urban facilities, especially housing, have failed to meet the growing demand of the rural poor (Kamete, 2006). According to UN Habitat (1996), the housing shortage alone in African cities ranges from 33 to 90 per cent. This has led to many people resorting to renting backyard shacks and squatting on illegal land. There are no provisions for social services and utilities in squatter settlements. But, it is evident from the literature review that experimental stabilised earth construction projects are a success in many developing (such as India, Sudan, Zimbabwe, South Africa) and developed (such as Australia, Germany, France) countries to address urban low cost housing crisis (Adam and Agib, 2001; Mubaiwa, 2002; Zami and Lee, 2008). In Devon (England) there are 40 000 cob buildings still in everyday use (Abey and Smallcombe, 2007). Thus the question remains, why is stabilised earth construction not yet widely adopted to address urban low cost housing crisis? To investigate the reason, it is logical to review the literature and find out whether there is any structured research so far carried out to identify the inhibitors influencing the widespread adoption of contemporary earth construction. Lack of standardised earth-based materials, rapid urbanisation, changing lifestyles and increased adoption of energy-intensive modern construction materials have led to a steep decline in adoption of traditional/ vernacular earthen structures (Reddy and Mani, 2007). Therefore, it is pertinent to analyse the inhibitors influencing the adoption of this technology. A critical literature review method was adopted in this article to investigate and identify the inhibitors and validated with the help of Delphi technique. The following section reviews the literature on inhibitors influencing the adoption of earth construction to address urban low cost housing crisis.

STATE-OF-ART REVIEW ON INHIBITORS INFLUENCING THE ADOPTION OF EARTH CONSTRUCTION

It is evident that experimental stabilised earth construction projects in low cost urban housing are a success in many developing countries in Africa (Mubaiwa, 2002; Zami and Lee, 2008). Thus the question remains, why is stabilised earth construction not yet widely adopted to address the urban low cost housing crisis in general?

According to Baiche *et al* (2008), various earth-building awareness initiatives and performance-enhancement studies were undertaken in a number of African countries. In Nigeria, tests to improve the durability and affordability of earth building, which has been promoted as an alternative for low cost housing for the poor, were carried out (Olotuah, 2002). It has also been reported that compressed stabilised earth blocks were 'successfully' used in low income housing in Sudan (Adam and Agib, 2001); users' perceptions were however not recorded. Similarly, the potential of earth building in Botswana has also been studied, with the aim of developing a suitable material mix for a compressed earth block technique and recommendations were put forward on the proportions of the block mix; mixing methods; stabilisation; strengthening and transport. The study concluded that further work was required to establish the wider use of earth blocks and it encouraged earth block use for housing in Botswana, Namibia, and Zimbabwe, given the similarity in their soils (Longfoot, 2003). Under pressure for modernisation, the Zambian government has so far neglected the promotion of vernacular construction methods and materials (Tyrell, 1996). Furthermore, the Zambian Institute of Scientific Research and the Copperbelt University carried out research on traditional construction technologies, but the dissemination of their findings has not been

implemented effectively (Mususa and Wood, 2004). A study identified several barriers to earth building in Uganda, including the need for new legislation, technical training, public awareness of sustainability, and knowledge-sharing (CRATerre, 2005).

Baiche *et al* (2008) carried out a research project that examined the viability of earth construction as a building material and technique for urban housing in Zambia. It was anticipated that this might give indications of the reasons for residents' attitudes. According to Baiche *et al* (2008), a twofold quantitative and qualitative research methodology was used to collect data for assessing attitudes towards earth building among end users, building designers and contractors in the Zambian construction industry.

- First, a case study was carried out to gain insights into users' views on living conditions in earth houses. Qualitative information was collected through surveys and semi-structured interviews with 20 residents in two selected sites: earth homesteads in Chief Nkana's area and Musonda compound; and conventional buildings in the Riverside area of Kitwe. This case study provided the basis for the formulation of a questionnaire.
- Second, a questionnaire was used to collect data for a baseline overview of the Zambian construction industry's attitude to earth construction. It also examined the levels of support and involvement of building designers and contractors in promoting the use of earth for housing.

Sixty questionnaires were randomly distributed to architects, structural engineers and contractors specialising in housing. Out of the 60 questionnaires circulated to design practices and contracting companies, 22 were completed and returned, a response rate of 37 per cent. Responses from the survey were analysed using the Statistical Package for Social Sciences. Analysis of the five-point Likert scale answers was carried out by comparing the means by 'one sampling T test'. Respondents were asked to rate a number of limiting factors that impede the use of earth in the Zambian construction industry. The majority (69 per cent) strongly believed that structural weakness (mean value of 4.50) was the key constraint in specifying earth in their projects, followed closely by lack of interest by clients, with a mean value of 4.31. Additionally, respondents rated equally (3.50) the lack of technical knowledge regarding earth construction and the perception of earth as not suitable in an up-market development as critical barriers. Similarly, poor water resistance and the perception by society of earth as a sign of unattractive old architecture were seen as serious impediments to its wider use. Figure 1 shows the inhibitors that impeded the use of earth in the Zambian construction industry.

However, Baiche *et al*'s (2008) research lacks appropriateness of methodological design. First, no critical literature was reviewed before executing this research. In addition, there was no basis justified for the case study approach and to formulate an interview questionnaire in the first place to get insights into users' views on living conditions in earth houses. Furthermore, the one or other technique was adopted to collect data in Baiche *et al*'s (2008) research, which was not justified and compatible to investigate the user's and professional's perception. The problem under investigation in this research is directly related to people's perception, literacy, educational background, attitude, culture and belief. According to Baiche *et al* (2008, p. 6), 'The case study shows that earth buildings are perceived as not durable and aesthetically unpleasant; and are believed to be a sign of poverty and backwardness. Additionally, designers and

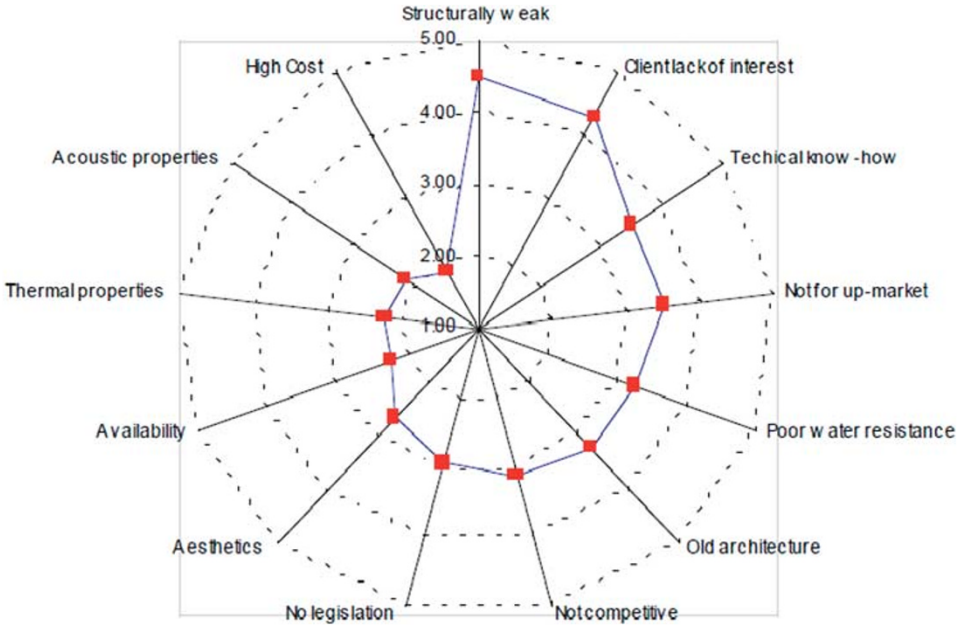

Figure 1: Inhibitors of earth construction in Zambia.
Source: Baiche *et al* (2008).

contractors were reluctant to specify and select earth materials due to their technical and performance limitations'. Therefore, the research methodological design and in particular the research techniques adopted were not appropriate to collect data from construction professionals and users.

Baiche *et al*'s (2008) research shows that there are many inhibitors that influence the widespread adoption of stabilised earth construction and inhibit this technology being universally accepted by the clients (users) and practicing professionals. The experience of the last three decades has thrown up considerable information on the process of dissemination of stabilised earth technologies and it must be admitted that the spread of earth technologies has not been a smooth process (Jagadish, 2007, p. 25). Moreover, earth materials and techniques are perceived as 'substandard' or 'second class', while modern construction methods and materials are seen as 'civilised' or 'symbols of affluence' (Sojkowski, 2002). Table 1 lists the inhibitors from the intensive literature review.

All the inhibitors identified in Table 1 of contemporary earth construction lack empirical evidence and it would seem from a thorough review of the literature that sparse research to date has been undertaken to substantiate whether the inhibitors in Table 1 are real or mere speculation. It is questionable whether they are the author's perception, and thus lack empirical data to substantiate the findings. Therefore, this article aims to develop a holistic understanding of the inhibitors influencing the widespread adoption of contemporary stabilised earth construction by professionals to address the urban low cost housing crisis. It is essential to note that inhibitors identified in Table 1 and drawbacks of earth construction are the same. According to literature drawbacks are considered as inhibitors too.

RESEARCH METHODOLOGY

After a critical review of the existing literatures, it appears that there is a lack of structured research, to date, carried out to identify and understand the potential inhibitors

Table 1: Inhibitors influencing the adoption of contemporary earth construction

Inhibitors (Summarised from the literature review)	*Authors*	
1. *People's mistaken perceptions and cultural problems.* a. Considered as 'Taboo'. b. Image problem. c. There is a social stigma. People think it is a temporary structure and symbol of poverty. d. Lack of acceptability among professionals. e. Owing to ignorance, prejudices against loam (earth building material) are still widespread. f. People are reticent to change the way they build because the communities have an adverse reaction to interference in their traditional way of life.	Morton (2007, p. 377), Norton (1997, p. 8), Chaudhury (2007), Kateregga (1983), Blondet and Aguilar (2007, p. 8), Jagadish (2007, p. 26), Hadjri *et al* (2007), Maini (2005), Adam and Agib (2001, p. 11), Minke (2006, p. 18), Baiche *et al* (2008), Sojkowski (2002), Woolley (2004)	No structured research was carried out to identify these inhibitors. Therefore, these are the author's perception.
2. *Lack of knowledge, skills, and understanding among professionals, government, donors and users.* a. Lack of information regarding availability of earth as a construction product. b. Lack of skilled labour in stabilised earth construction. c. Inadequate understanding of earth construction processes among builders and professionals. d. Untrained teams producing bad quality products. For example: – over or under stabilisation. e. Specialist skills needed for plastering.	Jagadish (2007, pp. 26–27), Houben *et al* (2007), Morton (2007, p. 383), Hadjri *et al* (2007), Maini (2005), Baiche *et al* (2008), Woolley and Caleyron (2003)	
3. *It requires extra money, labour and time.*	Morton (2007, p. 379), Blondet and Aguilar (2007, p. 8), Cassell (1993), Kateregga (1983), Dobson (2000)	
4. *Lack of technologies and resources.* a. Lack of suitable machines to produce good quality CSEB. b. Inadequate delivery systems for CSEB. c. Bad quality or unadapted production equipment.	Jagadish (2007, pp. 26–27), Maini (2005), Dobson (2000)	
5. *Lack of courses and trainings in the universities.* a. Lack of training programmes for construction supervisors. b. Universities, technical and vocational colleges do not teach earth construction.	Jagadish (2007, pp. 26–27), Houben *et al* (2007, p. 39), Castells and Laperal (2007), King (1996, p. 5)	
6. *Lack of care and focus on the environment, aesthetics, and comfort.* a. Lack of awareness about global warming and sustainable built environment among professionals, administrators, builders.	Jagadish (2007, p. 27), Houben *et al* (2007, p. 39), Elizabeth (2005), Adams (2005)	
7. *Lack of building codes, policies to adopt earth construction.* a. Lack of standards and quality control criteria.	Morton (2007, p. 377), Lal (1995, p. 124), Eisenberg (2005), Hadjri *et al* (2007, p. 143), Adam and Agib (2001, p. 11)	
8. *Professionals make less money from their customary percentage on total cost of earth construction projects.*	Robinson (1939)	
9. *Housing credit and insurance are difficult to obtain from financial institutions.*	Norton (1997, p. 8)	
10. *Low technical performance of earth as a construction material.* a. Wide spans, high and long buildings are difficult to do. b. Low resistance to abrasion and impacts. c. Low tensile strength – poor resistance to bending moments, to be used only in compression, for example, bearing walls, domes and vaults.	Maini (2005), Hadjri *et al* (2007), Adam and Agib (2001, p. 11), Dobson (2000)	

Source: Compiled by author (2009).

of contemporary stabilised earth construction in urban low cost housing. In addition, the inhibitors identified by different practitioners and researchers mentioned in the literature are generally written from their perception, and thus there is a lack of empirical data and validation through a research methodological process. The critical review of the literature is intended to permit the researcher to recognise and identify the existing up-to-date inhibitors mentioned by different researcher, in which there are some conflicting information appeared. The inhibitors found in the literature are written in the light of researchers experience and perception. Therefore, the adopted research technique should be appropriate in nature to be able to validate the inhibitors identified from the literature review. A Delphi technique is chosen in this article as an appropriate method to validate the inhibitors which effectively collect data from construction professionals and compare the list of benefits found in the existing literature.

The Delphi research technique is chosen as the mode of data collection because of its ability to explore the inhibitors of adoption of stabilised earth construction in urban low cost housing. This technique can be applied to problems that do not lend themselves to precise analytical techniques but rather could benefit from the subjective judgments of individuals on a collective basis (Adler and Ziglio, 1996) and to focus their collective human intelligence on the problem at hand (Linstone and Turoff, 1975). Therefore, for this research, the Delphi technique is chosen as a suitable research technique because the results will offer an informed look at the current and potential status of the inhibitors of stabilised earth construction to address the urban low cost housing crisis in general. Based on the nature, attitudes and beliefs of a carefully selected group of expert respondents, the inhibitors will be captured. A substantial literature review in the previous section found that the identified inhibitors suffer from lack of empirical data. Considering these glaring discrepancies in the prescriptions made by different researchers in this area, the results of this Delphi technique will be relevant, and provide clarification the inhibitors identified in the literature review.

As there are a limited number of contemporary earth construction experts in the world, the most notable of these were contacted as expert panellists for this Delphi technique. A list of 34 participants (experts) was contacted from both the private and public sector that would appear to have the required knowledge and/or experience of the subject. Thirty-four letters were sent out inviting them to take part in this Delphi technique. A total of 14 individuals responded and agreed to participate, equating to a 41 per cent response rate. Out of the 14 individuals, seven were academician researchers, one was a practitioner, and six were practitioner researchers. During the second round of administering the Delphi technique, three academician researchers and one practitioner experts did not respond, which made a total of 10 participants. Only two rounds of Delphi were needed for the participants to reach a consensus.

ANALYSIS AND DISCUSSION OF FINDINGS FROM ROUND ONE DELPHI TECHNIQUE

The Delphi technique adopted for this research consists of two rounds of questions whereby the second round of questions were constructed from questions and feedback acquired from the previous questions. The aim of the questions in the first round was to elicit the inhibitors of adoption of stabilised earth in the construction of urban low cost housing and to find out whether inhibitors and drawbacks are the same. The second round of the Delphi technique confirms whether inhibitors and drawbacks are the same and summarised the inhibitors in rank order acquired from the first round and were presented to the experts for reconsideration and validation.

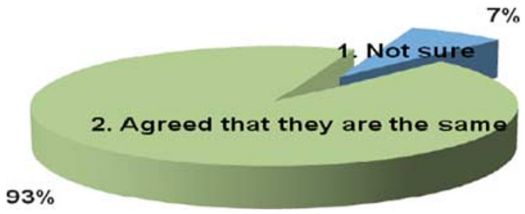

Figure 2: According to most experts' opinion the inhibitors and drawbacks that are the same.

Distinction between a drawback and an inhibitor

All experts (14) responded while they were asked, what is the distinction between a drawback and an inhibitor? One expert (7 per cent) was not sure of the answer to this question. The remaining 13 experts (93 per cent) agreed that the drawbacks of stabilised earth construction and adoption inhibitors are the same. Figure 2 shows the nature and percentages of responses from the experts.

Three of the experts stated, 'Sometimes the inhibitors are listed under the title of drawbacks depending on the author's understanding'. Similarly, experts B and H stated, 'A comprehensive list of inhibitors should contain all the potential disadvantages'. Therefore, the drawbacks and adoption inhibitors of contemporary stabilised earth construction are viewed as the same. In addition, inhibitors could be listed under the title of drawbacks and similarly drawbacks under inhibitors depending on the understanding of authors. A list of inhibitors shows all the drawbacks.

Inhibitors and drawbacks influencing the adoption of stabilised earth construction in urban low cost housing

All 14 experts responded while they were asked to list down the inhibitors and drawbacks. One expert's (7 per cent) response was inconclusive. Thirteen experts listed several inhibitors and drawbacks. Figure 3 shows the nature and percentages of responses from the experts.

Twenty nine inhibitors and drawbacks influencing the adoption of stabilised earth construction in urban low cost housing are identified from the expert's responses and listed according to their importance (rank). They are firstly grouped into the categories identified from the literature review (Section 'State of art review on inhibitors influencing the adoption of earth construction') and then this was check listed against the number of times they were mentioned in this study. Table 2 shows the summarised list of inhibitors and drawbacks influencing the adoption of stabilised earth construction according to their importance (rank). Furthermore, there are three additional inhibitors as well as the 10 inhibitors identified in the literature review that are identified from the Delphi Round One and they are as follows:

1. Regions with inappropriate climatic conditions and unsuitable soil for stabilised earth construction.
2. Lack of good quality exemplar earthen architecture and existing substandard earth structure.
3. Lack of policy to minimise the use of energy intensive materials like burnt clay bricks, concrete and steel for housing projects.

The first 12 (listed in Table 2) inhibitors and drawbacks are ready for inclusion and validation by the experts in the second round of Delphi technique. It is notable that

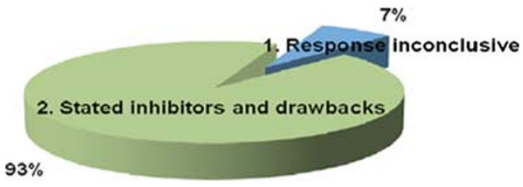

Figure 3: According to most experts' opinion there are potential inhibitors and drawbacks that are influencing the adoption of stabilised earth construction in urban low cost housing.

Table 2: Inhibitors and drawbacks influencing the adoption of stabilised earth construction in urban low cost housing organised according to their importance (rank)

Inhibitors and drawbacks influencing the adoption of stabilised earth construction (summarised from the Delphi Round One)	*Number of experts*
1. *Lack of knowledge, skill and understanding among professionals, government, donors and users.* a. Lack of education for the users and building professionals. b. Lack of confidence in design and in adopting earthen construction among civil contractors, labourers and the professionals in the construction industry. c. Lack of skill and scientific knowledge generation in accommodating the variability in soil characteristics and appropriate methodology in the adoption of earth from various geographic regions. d. Inadequate awareness of its structural performance, earthquake resistance among the professionals and users. e. Most of the first users of stabilised earth have a poor understanding of the process of soil stabilisation. f. Earth construction is, in general, unknown by the local government housing offices, non-government funding and implementing agencies. g. Scope for misuse and unscientific adoption of earth construction.	Nine
2. *People have mistaken perception and cultural problems.* a. There is a cultural factor that inhibits earth construction. As poor people built with earth without technology, many earth houses have low durability. So, the material is associated to the poverty. b. Prejudice that buildings in earth are old-fashioned, primitive, unhygienic and difficult to clean.	Seven
3. *Lack of technologies and resources.* a. Lack of expertise in terms of structural services. b. Block making machines are not readily available and costly. c. Lack of good quality text books on this subject. There are some books but they lack depth of knowledge.	Six
4. *Lack of courses and training in the universities.* a. Engineering and Architecture university courses do not study earth as a construction material. So, engineers and architects do not know anything about this material and do not recommend it. b. Mainstream civil engineering schools do a negligible amount of research in stabilised earth. c. It requires special skills other than the skills used in construction of concrete block buildings and other systems of earth construction. Unfortunately there are not many institutions offering such training for artisans. d. There are inadequate training programmes and a lack of demonstration structures spread across the regions to educate stake holders of earth construction. Many training programmes also lack rigour.	Four
5. *Lack of good quality exemplar earthen architecture/ building and existing substandard earth structure.* a. Most of the first users of stabilised earth had a poor understanding of the process of soil stabilisation. They tended to produce substandard stabilised earth construction and send wrong signals to the community. Early examples of stabilised earth housing in India in 1948, 1949 and 1988 represent such failed attempts at earth construction. b. A poorly constructed stabilised earth building can be worse than using raw earth, and there are many examples of such bad construction, thus discouraging many people.	Four

Table 2 *continued*

Inhibitors and drawbacks influencing the adoption of stabilised earth construction (summarised from the Delphi Round One)	*Number of experts*
6. *Low technical performance of stabilised earth as a construction material.* a. In fully serviced buildings, SSBs cause problems, such as pipe work and conduits embedded in the walls, fixings a fitted kitchen, wall shelves. Over two storeys they need to be structurally sound and so quality control becomes very important, bringing costs up – and in the densely urban scene high rise flats may be wanted. b. The earth materials are fragile hence it requires special maintenance plans. c. No earthquake resistant systems. d. Not very flexible like concrete or adobe when it comes to expansion. Though very durable when it is well constructed, however, repair is also a difficult with stabilised earth because of its rigidity after construction. And one has to bear in mind that no building can last forever without repair and maintenance.	Four
7. *It requires extra money, labour and time.* a. It is too costly when compared to other system of earth construction, for example, adobe. The savings are not much (if any) when compared to concrete building.	Two
8. *Lack of care and focus for the environment, aesthetics, and comfort.* a. The new generation of entrepreneurs do not care enough for environment but would rather make money and building contractors are reluctant to use stabilised earth because there is less opportunity for them to make large profit.	Two
9. *Regions with inappropriate climatic conditions and unsuitable soil for stabilised earth construction.* a. The climate may not be appropriate – remember that SSBs are sun dried. Stabilised earth building might not be suitable for winter weather in Britain?	Two
10. *Lack of building codes and policies to adopt earth construction.*	One
11. *Professionals make less money from their customary percentage on the total cost of earth construction projects.*	One
12. *Lack of policy to minimise the use of energy intensive materials like burnt clay bricks, concrete and steel for housing projects.*	One
13. *Housing credit and insurance are difficult to obtain from financial institutions for earth construction.*	None

inhibitor 13 is not mentioned by any of the experts in this first round though it was found in the literature review (Section 'State of art review on inhibitors influencing the adoption of earth construction'). The results show that inhibitor 1 is selected top of the ranking list although inhibitor 2 was mentioned by the majority of the authors in the literature review.

ANALYSIS AND DISCUSSION OF THE FINDINGS OF THE DELPHI SECOND ROUND

Four experts did not participate in Round Two of the Delphi technique. Therefore only 10 experts participated in this second round and two questions were asked. The following sub-sections summarise and analyse the responses to these two questions of second round.

Distinction between a drawback and an inhibitor

No experts commented on this in the second round. Therefore, the drawbacks and adoption inhibitors of contemporary stabilised earth construction are agreed unanimously as the same. As discussed in Section 'Distinction between a drawback and an inhibitor' sometimes the inhibitors are listed under the title of drawbacks and drawbacks under inhibitors depending on the author's understanding; a comprehensive list of inhibitors should contain and reflect all the potential drawbacks.

Inhibitors and drawbacks influencing the adoption of stabilised earth construction in urban low cost housing

There were 29 inhibitors and drawbacks summarised and identified from the Delphi First Round interviews. These inhibitors and drawbacks influencing the adoption of stabilised earth construction in urban low cost housing were organised in the list according to their importance (rank) and sent to the experts in the second round interviews for validation. One of the experts confirms that earth structures can be earthquake resistant if constructed accordingly. Another expert added more inhibitors influencing the adoption of stabilised earth construction in urban low cost housing and they are as follows:

- The promotion of the technology by foreign agencies to poor communities in developing countries automatically sends a negative signal that the technology is for the poor.
- Lack of legislation to protect earthen buildings from the effects of modernisations most especially the construction of roads and drainage that often endangers the survival of these buildings particularly in urban centres.

After careful consideration of the expert's second round interviews the inhibitors and drawbacks are revised and adopted as shown in Table 3 and Figure 4 shows their importance (rank).

The second round verified and validated the responses given. In response to the question asked whether inhibitors and drawbacks are the same, the experts agreed that the drawbacks and adoption inhibitors of contemporary stabilised earth construction are in fact the same. Feedback on the question on inhibitor, the Delphi Round Two validated the 12 inhibitors and drawbacks influencing the adoption of stabilised earth construction in urban low cost housing. In addition, the experts stated two additional inhibitors and drawbacks in this second round making a total number of 14 inhibitors. It is important to note here that inhibitor number 10 identified in the literature review (Section 'State of art review on inhibitors influencing the adoption of earth construction') is not mentioned by

Table 3: Inhibitors and drawbacks influencing adoption of stabilised earth construction in urban low cost housing summarised and adopted from the Delphi technique

Inhibitors and drawbacks influencing the adoption of stabilised earth construction (summarised from the Delphi Round Two)
1. Lack of knowledge skill and understanding among professionals, government, donors and users.
2. People's mistaken perception and cultural problems.
3. Lack of technologies and resources.
4. Lack of courses and training in the universities.
5. Lack of good quality exemplar earthen architecture and buildings and existing substandard earth structure.
6. Low technical performance of stabilised earth as a construction material.
7. It requires extra money, labour and time.
8. Lack of care and focus for the environment, aesthetics and comfort.
9. Regions with inappropriate climatic condition and unsuitable soil for stabilised earth construction.
10. Lack of building codes and policies to adopt earth construction.
11. Professionals make less money from their customary percentage on the total cost of earth construction projects.
12. Lack of policy to minimise the use of energy intensive materials like burnt clay bricks, concrete and steel for housing projects.
13. The promotion of the technology by foreign agencies to poor communities in developing countries automatically sends a negative signal that the technology is for the poor.
14. Lack of legislation to protect earthen buildings from effects of modernisations most especially construction of roads and drainage that often endangers the survival of these buildings particularly in urban centres.

Source: Author (2010).

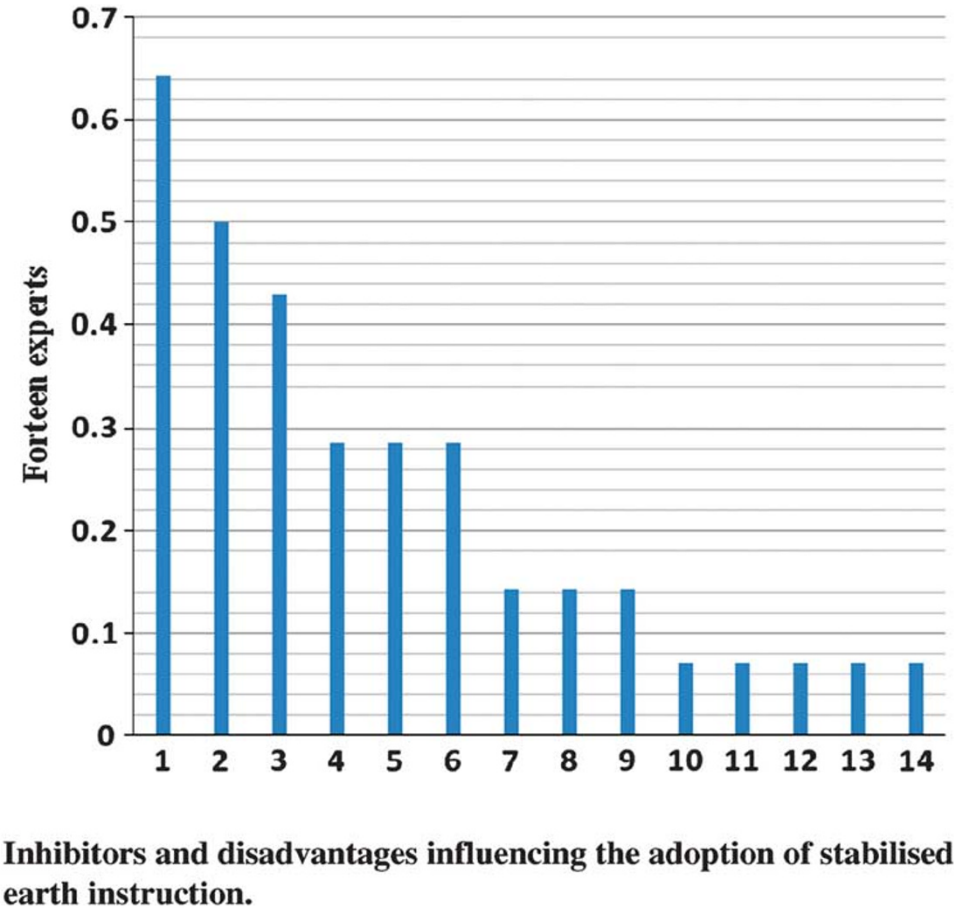

Figure 4: Importance (ranking) of the inhibitors and drawbacks influencing the adoption of stabilised earth construction in urban low cost housing adopted from Delphi technique.
Source: Author, 2010.
Notes:

1. Lack of knowledge among stakeholders.
2. Mistaken perception.
3. Lack of technology.
4. Lack of courses in universities.
5. Lack of good quality exemplar buildings.
6. Low technical performance.
7. Requires extra cost, time and labour.
8. Lack of care on comfort, aesthetics.
9. Inappropriate climatic conditions.
10. Lack of building codes and policies.
11. Professionals make less money.
12. Lack of policy minimising energy-intensive materials.
13. Wrong promoters.
14. Lack of legislation protecting existing structures.

any of the experts. Moreover, five additional inhibitors (5, 9, 12, 13 and 14 in Table 3) are identified in the Delphi technique that was not identified in the literature review.

The panel also expressed concern over the lack of earthen architecture education taught in the universities around the world which is a major inhibitor influencing the adoption of this technology. It is noted that, currently only the School of Architecture in Grenoble, France, offers a specialised masters programme in earthen architecture through

CRATerre. In Nigeria, two universities, ATBU (Abubakar Tafawa Balewa University) and ABU (Ahmadu Bello University), offer earthen architecture as a module at undergraduate architecture level. Similarly, another university, OAU (Obafemi Awolowo University), offers the course at postgraduate diploma on their conservation programme. The situation is the same in United Kingdom. The University of Plymouth, despite the presence of CEA (Centre for Earthen Architecture), offers the course as an elective module at BA architecture level and postgraduate conservation programme. Apart from these few institutions, earthen architecture is often learned through very short workshops and conferences, which are grossly inadequate. Sadly, traditional craftsmen are becoming scarce because of a lack of patronage, a lack of interest and in some cases lack of opportunity in urban centres for younger generations to learn the trade, thus creating a huge vacuum between older and younger generations.

According to expert 'N', 'at the moment we have two sets of groups of professionals in 2 stream ends. The first group are those that believe that the technology is obsolete while the other group believe that the technology is ultimate. In my opinion both groups are wrong, because no material is 100 per cent OK, therefore we earthen architecture practitioners should try as much as possible to identify these weaknesses in order to improve those that can be improved. However we should know the limitation of the material. This can only be achieved through intensive and dedicated training of architects, engineers, masons, carpenters, electricians, plumbers and this training should last a minimum of one year'. This statement argues that the inhibitors originated from the building industry professionals can be avoided by positive thinking about contemporary earth construction, engagement in research and innovation.

CONCLUSIONS

This article has investigated and analysed the state-of-art review of literature of inhibitors influencing the adoption of contemporary earth construction in general and validated through Delphi technique. It was found that there is a lack of structured research, to date carried out to identify the inhibitors. Therefore, it was imperative to empirically substantiate the findings of the literature review and validate them through an appropriate research technique. In the Delphi technique experts agreed that the drawbacks and adoption inhibitors of contemporary stabilised earth construction are in fact the same. Diversified inhibitors and drawbacks were stated by the experts in both rounds of the Delphi technique from which 14 inhibitors and drawbacks were summarised and identified. It is important to note that 5 more inhibitors and drawbacks were identified in the Delphi technique in addition to 10 inhibitors identified in the literature review. In addition, the Delphi panel expressed concern over the following:

- Lack of modules of earthen architecture taught in the universities around the world which is a major inhibitor influencing the adoption of this technology.
- The traditional craftsmen are becoming scarce because of lack of patronage and lack of interest as well as in some cases lack of opportunity in urban centre for younger generations to learn the trade, thus creating a huge vacuum between older and younger generations.
- Earth construction professionals are divided into two groups. One of the groups is those that believe that the technology is obsolete while the other group believe that the technology is ultimate. Experts thought that earthen architecture practitioners should try as much as possible to identify the weaknesses of earth as a material in order to

improve it and the limitations of this material should be known. The inhibitors originating from the building industry professionals can be avoided by positive thinking about contemporary stabilised earth construction, engagement in research and innovation.

- Earth construction is not just for the poor but rich also.

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