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EVALUATION OF NATURAL BUILDING STONES FOR SUSTAINABLE HOUSING IN JUJA, KENYA

BY

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Declaration

This research project is my own original work and has not been submitted for another examination, for any another degree or any other award.

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Dedication

To the restoration of God's will on earth and to all men and women that will dare obey and trust Jesus Christ without wavering in their faith, with the assurance that the gods that never created the heaven and the earth shall perish from the earth and under heavens. (Jeremiah 10:11)

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May the almighty God bless you all abundantly!

Abstract

Construction materials constitute 60% to 70% of the total cost of building a house. Out of this percentage, about 60% is taken up by the walling materials for low cost housing. Kenya currently, is exhibiting a predominant use of quarried stones for all buildings; this has increased the cost of housing production beyond the reach of many Kenyans. Yet other alternative materials that are both environmentally friendly and economical exists but are not being used sufficiently to provide housing. On this understanding, the research project attempted to answer questions regarding, why the predominant use of natural stones, against other selected alternatives and proposed a framework for utilizing locally available building materials for sustainable housing. Factors that contributed to the over-reliance on natural stones were evaluated, along with some environmental and socio-economic issues. Policies and institutional framework that contribute to the observed practices of housing construction were also evaluated. To achieve the objectives of the study, Juja location in Thika district in Kenya was the target area, where housing developers and providers, materials producers, the local government, and central government respondents, provided primary data through questionnaires, interviews, observation guides, and photography were utilized to collect primary data. Both systematic random and purposive sampling techniques were used to gather the sample from the target population. Data was analysed with the aid of computer packages: SPSS and Microsoft Word Excel. The generated output was illustrated in form of pie charts and histograms. The main limitation to this study besides insufficient time and money was that, the respondents were not willing to give information as they felt that the information being sort was personal and sensitive; this was true especially for material producers/suppliers. The data derived from the research showed that the policies, laws and by-laws that govern extraction and utilization of building stones, encourage over-reliance on natural stones, environmental degradation and unsustainable housing production. These policies, laws and regulations also facilitate little social economic benefit to the communities living within the area. Information obtained from developers showed that the people, lacked sufficient information in choosing materials for house building. They choose to use natural stones, because they perceive them to be durable and of favourable maintenance quality, and as much as many respondents wished to use alternative materials, they lacked information on other viable products, especially the researched options. This has encouraged un-sustainability in housing production and use of materials of construction. A framework for encouraging production and use of other viable alternatives has been proposed. This product will involve planning and management of the potentially locally, available building materials in Juja; a framework that has the potential for being adapted country wide

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Abbreviations

EA	Environmental audit
EIA	Environmental impact assessment
EMCA	Environmental management coordination act
ITDG	Intermediate technology development group (currently Practical Action International)
Ems	Environmental management system
NEMA	National Environmental Coordination Act
HABRI	Housing and building research institute of the University of Nairobi
HRDU	Housing research development unit, now currently HABRI
JKUAT	Jomo Kenyatta University of Agriculture and Technology
UN	united nations

Chapter 1

Introduction to the Problem

Materials are essential in provision of housing, which is a basic need along with food, medical care and clothing. Provision of adequate housing is crucial in human development process. Housing is not just a consumptive good but also an economic good, raising the level of productivity in terms of goods and services, such as providing a base from where other activities of production can take place, thus creating livelihoods that are so essential in development and well being of the people (World Bank 1993). As a physical structure, it provides shelter from environmental elements (UN HABITAT 1996). However, housing is not possible without immense input of material resources. In fact, it has been shown that housing is an activity that consumes both the highest human and material inputs within any given economy (Chet, 2005). Therefore according to Geiger (2005) houses are not afford to those they are intended to serve due to costly materials, excessive building code, complex designs, and sustainability issues.

Internationally, housing is recognized as a human right. This is stated clearly in article 25 of the universal declaration of human rights. This has been re-emphasized further by UN Habitat and reaffirmed in subsequent resolutions as a human right just like any other human right, (UN HABITAT, 2002). According to Khalili (2000), there are approximately 1.2 billion people in the world who are

either inadequately housed or not housed at all. Out of this 1.2 billion people, 300 million are homeless. Housing development is an ongoing process and unfortunately there is no country in the world that can boast of fully realizing this human right (UN HABITAT 2003, OHCHR undated). Demand for housing increases with increasing population, changing lifestyles and changing economic status. As an example housing that was adequate for a family forty (40) years ago cannot be adequate today. Therefore, new houses need to be constructed for newly formed households, to replace those that are obsolete due to old age and to provide additional housing for those that are homeless and those that are inadequately housed.

It is estimated that the global urban need for new housing units for the years 2000-2010 was 35million units and the bulk of these are in the developing nations (UN HABITAT 2003). An estimate of only 2 to 4 houses per 1000 inhabitants are conventionally constructed yet the population that needs new housing units is about 20 to 35 per 1000 inhabitants per year (Hardly & Satterthwaite 1997). The current demand for housing in Kenya stands at 150,000 units in the urban areas and 560,000 in the rural areas. The supply of housing is estimated to be about 30,000-50,000 units per year ((Republic of Kenya, 2004), this is way below the expected output.

Kenya cited the following factors for inadequate housing as: rapid urbanization, lack of sufficient land and housing finance, stringent planning regulations, high cost of infrastructure, poor economic performance and poverty (Republic of Kenya, 2004). Another factor cited for this is inequitable distribution of resources where the poor are not able to access the resources to obtain adequate shelter (Kothari, 2005). Shelter delivery demands the following input or elements:

- Land
- Materials
- Appropriate technologies.
- The policies, regulations laws, and by-laws that govern the production of housing

This means that to construct a house one basically needs, approved materials, legally owned land, manpower, rules and regulations that govern how the housing buildings are to be constructed.

In Kenya the current practices of supplying housing are based on market forces of demand and supply. An enabling environment for the private sector to supply housing, coupled with the government failure to supply public housing, have not address the housing problems of the poor. Where high rates of unemployment, engagement in causal labour that pays very low wages, translating to inability to pay rent, purchase or build adequate shelter is evident. Prevailing conditions are: the houses available for sale, rental or self build options are beyond the reach of

the poor, as a result of high cost of materials. This has resulted in the majority of Kenyans living in illegal structures and slums outside of the local government mandated form of housing (Kamau, 2004), and this was likely to continue.

Materials of construction usually take about 50% to 70% of the total cost of building a house. Walling materials again take about 60% of the total materials used in housing (GTZ 1996, Gichunge, 2001). The entire cost of the housing structure depends on the materials and the technologies that are used. Therefore the selections of these are crucial in determining whether housing will be affordable to all the citizens or not.

The government of Kenya for a long time has encouraged the use of other materials that are locally available and appropriate so as to make housing affordable to many. It is this in respect that the government instituted HABRI formerly HRDU in 1971 for the purpose of research, developing innovations in materials of construction and technologies, and creating public awareness toward new research and technologies that are appropriate in order to increase affordable housing, especially to the poor. HABRI has done numerous researches on earth construction, alternatives to Portland cements, organic binding materials, and other innovative technologies. Yet, the public have not taken up the technologies, despite all these efforts. Hence the impact of government efforts in HABRI are yet to be felt (International Handbook of housing policies 1990).

For a long period of time building regulations and laws were blamed for slow adaptation of viable alternative materials. Yet, by 1995, stakeholders, well-wishers that included both local and international organizations, NGOs etc had a breakthrough in removing restrictive regulations that dictated the use of only "permanent" materials in formal housing. This led to the passing of Building by-laws of 1995 that allows materials such as rammed earth to be used in urban areas. Yet according to www.citialliance.org adaptation of these technologies are not automatic, hence more than ten year down the line the impact of that by law was yet to be seen. This poses many questions and challenges to key players in the government and other stakeholders in housing provision.

However, one thing is clear, that whatever the answers to the questions regarding why people were over relying on stones for house building, solutions to housing problems will involve large volumes of environmental resources and the selection of the materials of construction to be used, will determine the sustainability of the shelter delivery for all.

In the study Area currently dimensional stones are the predominant material used for construction not just the acceptable houses but most buildings. There exist other materials of construction that have been shown through research and use by traditional communities to be more appropriate and sustainable in providing

adequate housing for all (World Bank, 1975). Yet they have not been adopted as expected, despite the persistent lack of adequate housing for all.

1.1 Problem statement

Provision of adequate housing is a dynamic process that involves utilization of both material and human resources. It is one activity that consumes the highest of both of these resources, thus affecting the environment significantly (Chet, 2005). Thus how materials are managed is a key determinant on shelter delivery for all. There is no housing without materials.

Majority of Kenyan are without adequate shelter, due to high cost of building materials. Stone houses are an expensive option thought out the world (Prentice, 1990). Yet there seems to be an over-reliance on natural stones especially the dimension stones or cut stone in construction of all types of buildings in Juja, Kenya. First, this raises the cost of housing to limits beyond the majority of Kenyan citizen. Secondly, natural stones are not a renewable resource; the supply is being depleted with time. Thirdly, quarrying activities among other mining activities have generated a lot of controversies due to the environmental degradation (Yager, 2001) which contradicts the global principles of sustainable development yet these activities have persisted. Fourthly, according to Oyawa, (2005) other materials of construction that have been shown to be more economical and environmentally viable for housing exist, but they do not seem to

get adopted adequately to provide housing (Chege, 2005). This has led to the need to do more research, to assess the factors that enhance the observed material usage, if any progress has to be made towards shelter provision for all.

1.2 Research questions

- What are the policies, laws and by-laws that govern the mining of natural stones and how do these policies and laws affect the production and use of natural stones for construction?
- Why are natural stones predominately used for housing construction?
- What are the environmental and social-economic implications of quarrying natural stones?
- What can be done to enhance shelter provision for all, by utilizing available materials?

1.3 Objectives

1. To evaluate the policies and institutional framework governing extraction, acquisition and utilization of dimensional stones.
2. To assess factors that determine the use of dimension stone against other alternatives: fired clay products, concrete blocks , earth, and timber
3. To assess the environmental and socio-economic implications of quarrying natural building stones.

4. To propose a framework for sustainable material utilization for adequate housing.

1.5 Assumptions

1. The current policies, laws and by-laws governing extraction, acquisition and utilization of natural stones do not enhance sustainability in housing.
2. There exists viable alternatives to dimensional stones that can be used in the housing industry to provide adequate housing that are not being utilized.
3. The environmental and social-economic cost of the present use of dimensional stone far out- weighs the benefits.

1.6 Justification

In the past, the nation of Kenya has made attempts to encourage use of alternative materials, with research findings showing that, the use of various alternative materials is more appropriate and sustainable in solving the prevailing housing problems. However this does not apparently reflect much on the current housing production. This leads to the questions why and what can be done to enhance utilization of such alternatives. This lacuna in the body of knowledge needs to be filled through this kind of research project, so that the underlying reasons for this can be found and hence forge the way forward.

There is a need to take a pragmatic stand on the issue of material utilization for shelter delivery, considering that the majority of Kenyans are inadequately housed or not housed and the current housing policy is encouraging all stakeholders to produce and utilize all kinds of building materials towards adequate shelter for all (Republic of Kenya, Sessional paper No 3 of 2004). On the other hand housing problems are critical with immense social and environmental implications that need to be addressed with urgency (Oliver, Vellinga, undated). This calls for holistic approach, involving all sectors and individuals that contributes and affect shelter delivery.

With the global trends and demand for sustainable development, it is important to determine whether and where principles of sustainable development are being applied or not applied for action to be taken. It has been found that concrete information about social and environmental impacts due to use of various alternative materials is lacking (Milani, 2001). Provision of housing involves utilization of materials and possible depletion of non renewable resources, resource use conflicts and possible unsustainable development. Information on why people choose the materials they utilize is needful, if strategic measures are not taken. This kind of research project contributes to such a venture.

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1.7 Significance

It is probably not the lack of resources in terms of materials and human resource in Kenya, the restrictive regulations, peoples aspirations (Gichunge, 2001), but there may be other factors that contribute to inadequate housing, that necessitate research into the underlying issues. This research identified the factors that led people to predominately use of quarried stones for housing. These factors included human values, the environmental and social-economic issues. Issues regarding, why the existing alternatives have not been used and whether the developers are aware of their existences or not, were answered. This provided insight into what changes needed to be made in current practices and policies to attain adequate sustainable housing for all. This was in line with the government commitment to intensify efforts in improving sustainable planning and management practices in shelter delivery (Republic of Kenya, 2002) and the current housing policy that targets encouraging the use of affordable materials (Republic of Kenya, 2004) Through this, some of the goals of sustainable development, human rights to adequate housing and some of the UN millennium development goals have been addressed by this research project. For example, provision of adequate shelter improves people health and decrease poverty since shelter protect people from environmental element and also provides a base from which economic development activities can take place.

Globally governments are being encouraged to create an enabling environment that include policy reforms, elimination of regulations and practices that constrain shelter delivery and any hindrances to housing access by all. The developing countries' governments, where shelter problem are more prevalent are advised to encourage private sector involvement by UN habitat (habitat 1995). It is in this spirit that this project focused on identifying bottlenecks to the use of other materials of construction that are available or could be made available and consequently proposing the way forward. This will in the long run contribute to an enabling environment that enhances viable shelter provision for all, especially the poor; an issue which is currently not being effectively addressed.

1.8 Scope of the Study

The research project focused on Juja location in Thika district. The following issues were addressed: National policies that have a bearing on quarrying activities, and hence affect the supply of dimension stone, the building regulations, and the local government building by-laws that touch on materials of construction. The reasons why the housing developers choose to use dimensional stones and not other materials were evaluated; the public knowledge on alternative materials and research awareness on building materials was also assessed. An evaluation of the environmental and socio-economic cost of quarrying dimensional stones was done so as to highlight the relative benefits to the people. From the information gathered a framework for managing building materials was proposed.

1.9 Limitation of the Study

The main limitation of the study was that not all walling materials, but a portion of the main materials were evaluated. On the other hand a list of all the population of housing developments in the study area was not available and hence all effort to reach as many housing developers was made. However not all the targeted respondents were available to give information, while others were not willing to respond to the questionnaire at all.

Chapter 2

Literature Review

2.1 Introduction

In the traditional communities housing was provided through utilization of the locally available resources; both material and human resources (Taylor, 2002). With the emerging western influence on colonized nations, building standards that dictated the materials, skills, construction technologies and techniques required for housing were institutionalized. This has led to major constraints on shelter delivery; shelter being unattainable to many due to the restrictive nature of the building laws and regulations that do not allow indigenous or appropriate materials to be utilized in formal housing (Gichunge, 2001). Yet for the last more than ten years the By-laws of 1995, that allows the public to use other alternative materials were passed by parliament. However these are not mandatory but adoptive (Nzioka, et al 2005) and their effectiveness has not been seen within the general public housing construction practices. The following is apparent despite policy statements regarding promotion of other alternative materials since 1970s (Republic of Kenya, 2004) and research on cheaper materials and technologies by various organizations where materials more appropriate have been developed and recommended:

- People are suffering from inadequate housing.

- Quarrying of stones to produce dimensional stones has continuing albeit accompanied environmental degradation.
- Alternatives shown to be more appropriate are not be effectively utilized with the study area.
- People have continued to use dimensional stones for housing construction despite the fact that they are not a cheap option.
- Blame was put on unfair legal requirements and people's aspirations.

Information gotten by Practical Action through, their experience in Nakuru, Kenya indicated that the following were some of the reasons that lead to continued use of dimensional stones rather than the more appropriate building materials: First and foremost the alternative in case of Nakuru, was stabilized earth. This was labeled "material for housing the poor", yet no one aspires to be poor. Secondly, near by quarries were producing stones at very low prices. Thirdly the technology was introduced to existing local youth and women groups that did not have a capacity to sustain the technology (Chege, 2005). However, there may be other reasons for apparent rejection of alternatives over natural stones, which lead to the need for an integrated approach to solving the problem.

2.2 Sustainable use of Materials of Housing

2.2.1 What is Sustainability?

Sustainable development is a concept now established as an international legal concept involving environmental resources utilization that meets the needs of today without compromising the future generations' ability to meet their needs (Bruntland, 1987). This call to utilize the resources available wisely to benefit mankind; calling for conservation from wanton destruction of both the resources and the environment (Sands 2003). Already in the developed countries excessive consumption of natural, non renewable resources has impacted negatively on the environment, in fact, the developed countries already have a problem of dematerialization, and the global village can only practice sustainable use of materials in the developing world (Wallace 1996). The developing countries must not make the same mistakes made by the developed countries (Maydl 1999). In order to achieve this, international environmental laws have been domesticated in many developing countries to sustainably manage the environment. Consequently, Kenya has ratified and domesticated these international agreements on environmental issues translating to a national environmental coordination act that dictates that; every project to be implemented in Kenya requires environmental impact assessment (EIA), and environmental audits (EA) where the anticipated impacts are evaluated and mitigation measures put in place before the project can

be implemented or continued so as to confirm with sustainable development principles (Republic of Kenya 1999).

Sustainability relates to three main areas:, ecological, economic, and social. It involves a holistic approach rather than piece meal approach to environmental issues (http://www.astm/snews.html). Sustainable use of materials not only translates to sustainable housing but also to sustainable development. According to internet resource (http://www.archive2.official_document.co.uk/document/deps/cs/shdg/sh02/index.html) sustainability in housing may involves the following factors:

- Design for minimum waste,
- Respect people and the local environment,
- Minimise environmental degradation
- Reuse of buildings and lands

In the areas of housing, which revolves around major natural resource utilization, planners, designers and engineers have be criticized for planning and designing buildings, as through the materials resources were inexhaustible (Chet 2005), Yet on the contrary most building materials are not renewable and are exhaustible.

On the other hand the issues of accountable stewardship and equity in distribution of the natural resources that involve wise utilization, social welfare issues and conservation for future generation well being are some of the principles of

sustainable development; focus being on adaptation of standards that govern the rate and use of specific natural resource, equity in distribution of these natural resources and the call to integrate environmental and development (Weiss 2003). In the world today there is abundant of resources that can be utilized by all, for social and economic development, if sustainable development principles are utilized in resource management; ways and means to enhance the right choices of materials of construction and technology (Chet, 2005). Therefore there is a global concern for materials. How does this reflect material exploitation on the local scene? So far, there is no evidence that this has been done in this area of materials extraction and utilization for housing in the study area. There is need to incorporate sustainability into housing industry.

2.3 Materials in Housing Construction

To highlight the importance of materials in housing: it can be said that housing is about materials consumption, for there is no building without materials. The choice of materials to use, contributes directly to the cost of construction and it is a major determinant to whether a house will be produced or not. Building materials constitute 40% of all the materials in a countries economy (Chet, 2005). Materials of construction take about 50%, at times even 70% of the total cost of building a house. Walling materials take about 60% of the total materials used in housing (GTZ, 1996). The choice of materials of construction is a major constraint in development of infrastructure and it impacts directly on the natural environment

and livelihoods of the people (Lowe & Schilderman, 2001). Therefore, in a nation the choices have to be made wisely so that the basic needs of the people are meet as well as sustainable development objectives.

Materials are classified as conventional, traditional, appropriate, eco-materials, high-tech materials etc. Currently eco materials are being encouraged globally after Kyoto protocol; these are materials that are economical, ecologically feasible, hence in line with sustainable development principles (Oyawa & Watanabe, 2003). These eco materials that include earth and timber are believed to be the only viable solution to providing adequate shelter.

2.3.1 Natural Stone for Construction

Stones for building have occupied a very important position in the construction industry since 600 BC (Taylor, 2002). Cement that was discovered in 1824 and its' prominent product: concrete have changed the history of construction but have also contributed to huge demands on the natural stone with subsequent associated environmental degradation. This produces conflict between conservation of resources and meeting the demand for these valuable natural products.

In the developed nations, there exists an elaborate system of planned control of stone quarrying that strikes an acceptable balance between conflicting demands

(Prentice 1990). On the contrary, in the developing nations the resources are left to private enterprises and ordinary citizens to manage the resource (UNCHR1995).

2.3.2 Stone Quarrying and its Effect on the Environment

The process of getting materials of construction from the ground for use is referred to as quarrying. There are several methods of achieving this which have their disadvantages and advantages as far as the resource exploitation is concerned. The materials can be hand quarried after being detonated by explosives. Alternatively, most modern methods utilize machinery to dig and cut dimensional stones to required size.

Generally, most environmental degradation of land is associated with poverty: in that the immediate survival needs of the people conflict with the need to preserve and maintain the viability and the integrity of the environment (Republic of Kenya, 2000). However, the relationship between environmental degradation due to stone quarrying activities and poverty issues is not apparent. But one issue that is certain is that most of the quarrying activities in our Nation are said to have some controversies. These controversies evolve around short-term quarrying impacts which include, dust production, noise pollution, creation of open pit that collect storm water that is a source of distress to the communities living near such places etc (Njuki, 2006). Controversies hardly involve anything associated with the

overall predominately use of the natural stone and possible long term effects of quarrying on the overall environment

2.3.3 Alternative Building Materials

Alternative building materials are those materials that can be used in place of the conventional ones. They include the following:

- Earth products that include, wattle and daub, cob, adobe, rammed earth, stabilized earth etc.
- Timber products
- Fired clay products
- Composites: from waste products, concrete blocks, etc

Elsewhere these products are regarded with high esteem and widely used in developed countries where housing problem are not as severe as in the developing nations. The question to be asked is why these products are not being used in the nation as much as they should.

2.4 Policies, Laws, By-laws, and Regulations governing extraction of Natural Stones for Construction

In order to provide adequate housing, it is important to plan for it. Planning involves setting goals and means of achieving the set goals (Fuladi A 1973). This on the ground translates to setting goals in housing that are realistic in reference to

the resources available. Perhaps also it may involve adopting those goals that have already been set by international community; yet home grown solutions are the best. As an example the UN by consensus has declared adequate housing a human right. This has been ratified in many nations and in policy; these nations have agreed to remove all obstacle to attainment of this universal right (Habitat, 2002). Therefore assessing what resources one has at hand and using it sustainably is paramount in achieving the planned, desired ends. This must be done with a certain framework of broad goals that are translated in to policies, laws, regulations, local government by-laws and standards, within which the nation can operate to develop solutions.

Kenya current laws, local government by-laws, regulations and policies have a colonial legacy. This has been blamed for current housing crisis due to their restrictiveness nature. For example, for a building to be approved for construction by the local government, it must be designed to be constructed with permanent materials i.e. stones, concrete etc. Otherwise if the buildings are designed to use other materials locally available eg timber or earth it will not be approved by local authority for construction. Well-wishers, NGOs, private and public sector individual have taken steps to remove this restrictive legal requirement (Chege, 2004), but more than ten years down the road that is after the 1995 Building By-laws were approved by the parliament, there does not seem to be much change or a shift towards more usage of the other alternatives.

2.4.1 Policies governing the Exploitation of Building Materials

Policies set by the government that deal with issues of housing provision, national resource management are bound to affect building material usage and consequently housing provision. Resource exploitation in Africa has been left to the control of market forces. It is documented that ordinary people are the principle agents in management of natural resources (Habitat 1995). In the developing countries elaborate systems of control of mining are designed to strike a balance between conflicting demands on the same resource (Prentice 1990). In a developing country like Kenya, policy targets creation of an enabling environment to provide adequate housing, away from the earlier policies of government being the provider of housing, The current policy on housing encourages the private sector, the individual citizen and the other bodies to produce and utilize materials to provide housing for general public (Republic of Kenya sessional paper No 3 of 2004). This may conflict with principles of sustainable development that emphasizes conservation and on minimizing negative environmental impacts in all economic activities.

2.4.2 The Housing Policy

The housing policy sets the goals of the nation to house it population and the guidelines on how to achieve the desired end. The current sessional paper No 3 on housing policy has highlighted very important policies issues that the government intends to encourage, research and use of locally available materials to improve

shelter delivery among other issues. However, how this will be achieved is not clear, since this has been in the housing policies made in 1970s (Republic of Kenya, 2004). If there is no adequate institutional framework to guide changes, then the policy document will achieve very little in providing adequate housing for all.

Past government attempts to provide housing within the existing institutional framework has not been successful (UN HABITAT 2002b). This has lead to the current enabling environment policy which so far has not been able to deliver adequate shelter to the majority of Kenyan in both the rural and urban areas. The current enabled environment targets the middle and upper income people who have access to mortgages and a capacity to pay for rental housing and mortgages. This is due to the fact that enabling environment attempts to allow market forces to operate in providing housing (habitat ud). Consequently there is need to formulate another way forward.

2.4.3 The Local Authority Building By-laws

The local authority has the power to delineate areas for materials extraction for construction of infrastructure which includes housing. Each local authority is also mandated to enforce the building by-laws within it locality (Republic of Kenya, 1972). The local government exercises it authority over housing by enacting building by-laws that determine what material is or not approved for building. The

local government can also exercise its control through regulating and influencing the exploitation of building materials through designation of specific areas of housing and material exploitation. This has not been done effectively enough to discourage wanton destruction of material resources.

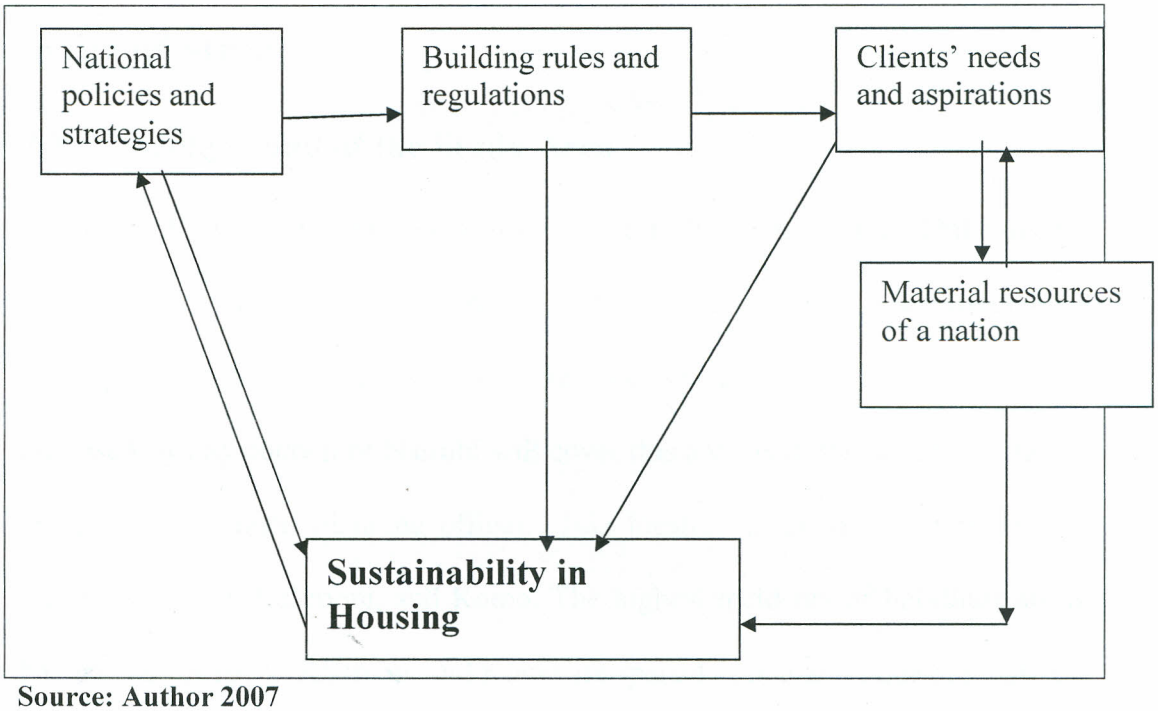
National building laws and regulations are enforced by the local authorities. These laws, by-laws and regulations affect the choices of materials of construction that the citizens can make. The building by-laws of 1966 that are currently in force have been blamed for enhancing lack of housing especially for the poor by demanding standards that are too high to be achieved by majority of Kenyans and are not relevant to our national needs, climatic conditions etc (Nzioka *et al* 2005). These have demanded expensive materials to be used such has reinforced concrete and dimensional stones. However, in the recent past Kenya's situation has changed with ITDG, currently Practical Action International, other leading organizations, NGOs and other stakeholders joined hands in a campaign that lead to a new building code being approved by the parliament (UN HABITAT); the building code of 1995 also referred as to as the second grade by-laws. With this recent development, more appropriate, affordable, locally available and sustainable materials can in utilized in urban and rural housing. But the question that one should ask is, since 1995 how much has been realized through this historical victory for the urban majority in Kenya? And how effective are these by-laws and

regulations in bringing about sustainable resource utilization and how far do they affect the demand and supply patterns of building materials?

2.5 Conceptual Framework

The issue of integrating sustainable development principles into all development activities and having a more broader perspective towards solving problems rather than a sector by sector traditional approach has been recommended in tackling social problems. Therefore, in due respect, this approach was adopted in dealing with the issue at hand. An integrated approach to management of resources has also been done in water resources and in localizing agenda 21 in cities programme by UN Habitat. Therefore it is important to have an integrated approach towards finding a solution to this issue. Figure 2.1 illustrates a construct of the conceptual framework.

Conceptual Model



Source: Author 2007

Chapter 3

Area of Study

3.1 Background of the Study Area

Juja was selected as the study area. It is located in Ruiru division of Thika district in central province in Kenya (figure 3.1). Juja is situated about 40km away from the capital city of Nairobi, Kenya. The proposed greater Nairobi plans being proposed by city council of Nairobi will cover this area as it lies in the peripheries (Nairobi city council planning office). Juja location is divided into three sub-locations Kiaora, Kalimoni, and Komo. The highest incidents of buildings are in Kiaora sub-location. Kalimoni and Komo are sparsely population due to most land being utilized for large scale farms and agricultural estates. Kalimoni is home to most of the hand operated quarries. While most of the Machine operated quarries are along Ndarugu River. Sub-division and sale of land for housing were on going in both Kiaora and Kalimoni sub-locations. Kiaora sub- location had the highest housing construction going on and hence was targeted for data collection.

The uniqueness of Juja as a study area was that most of all the buildings in Juja were housing units. There were no housing cooperatives to dictate what materials should be used unlike other housing estates elsewhere. Developers were making decisions on their own according as to what materials they wished to use for

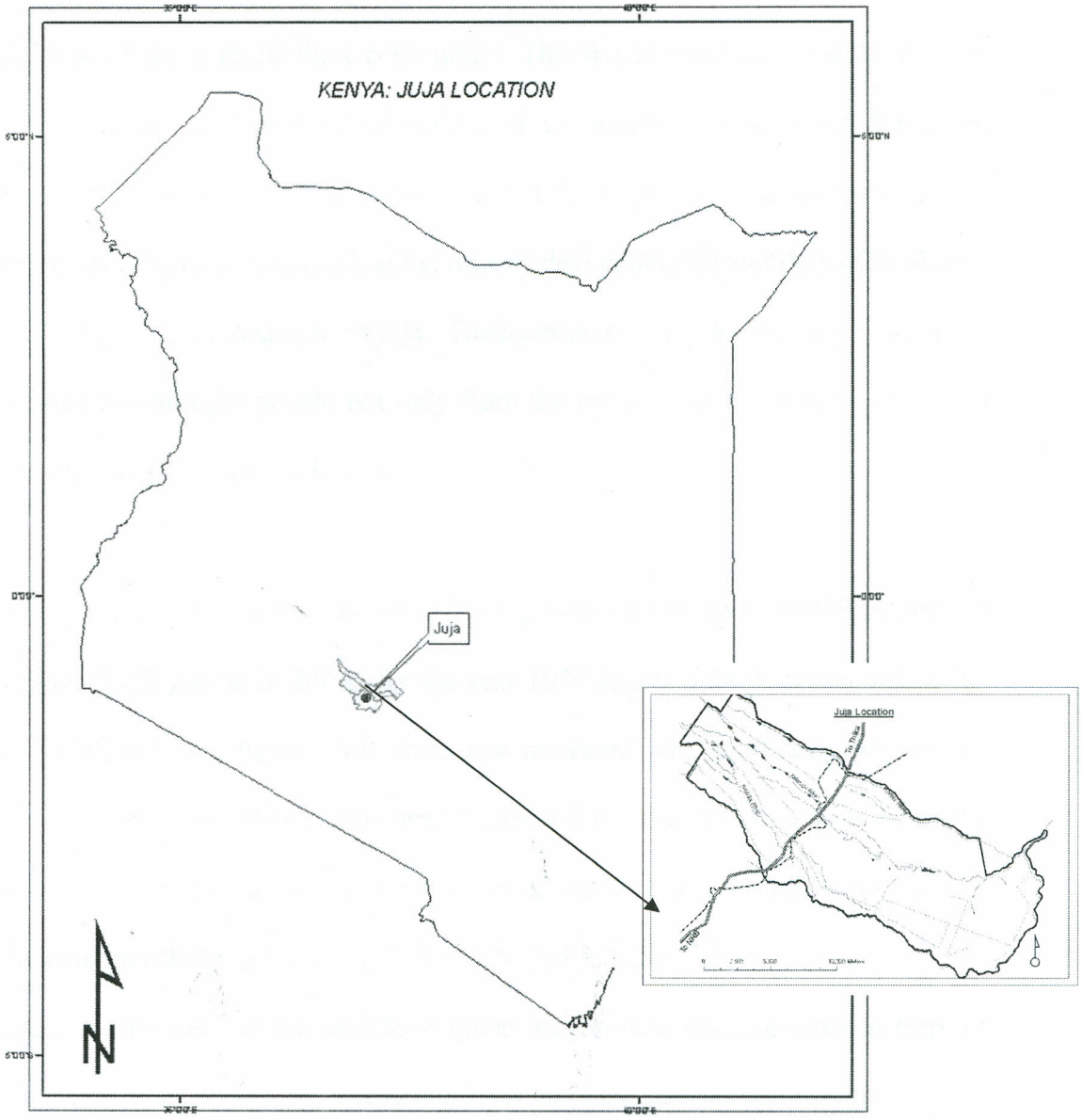
constructing their houses. According to Thika planning office, some of those housing areas are informal in that the sub-divisions of the land were outside the planning mandate and hence could have been illegal. The other reason that gives weight to selection of this was that the community and the central government was in the process of preparing the physical plans for Juja and the author hoped to contribute to this process.

Most of the land in Juja was originally owned by private citizens, under freehold land tenure system. The late American millionaire Macmillan, who had brought in stolen west African gods "ju" and "ja", from which the area derives it name from, owned 19,000 acres(Thika district physical planning 2006) was one such private land lord. But in the recent past, land owners in Juja have sold big portions of land to land buying companies that have subdivided them further and sold them out to individuals in small portion of less than ¼ acres (100x100feet). Most of these plots are of less than 1/8 acre. Most of these portions of land were being utilized for housing. All types of housing typologies existed, ranging from flats, to low, high and rise hostels, to single family dwelling units with a single to two floors, etc. But one common issue was that, there was high prevalence of dimensional stones usage.

3.2 Physical Set Up

Juja is located in Thika district in central province of Kenya at about 37^0.5" East and 1^0 10" south. The area has an altitude of about 1416 metres above sea level. This area lies along the Thika- Nairobi highway, located between Ruiru and Thika town. Two small rivers: Thiririka and Ndarugu, that join the Nairobi river at the lower boundary of the location supply water to this area, for both domestic and other activities.(figure 3.1)

Location of the study Area



Source: (GEGIS Department, JKUAT)

Figure: 3.1 Location: Map study area

3.3 Socio – Economic set up

Juja location has a multiethnic community. This has resulted from the location of sisal plantations and process industries, which attracted labour from the entire country: the East African Bag company currently the premier bag company. Large flower farms were in operation, at the time of data collection and they offered a lot of casual jobs to the residents of juja. The location of Jomo Kenyatta University in this area has brought people not only from the entire country of Kenya but also from other regions outside Kenya.

The population of Juja was shown to have grown steadily from 19438 persons in 1979 to 43150 person in 2005. By the year 1979 Juja had 5471 households. (Juja chief's office) This figure must have also increased with increasing population. This population of 1979 mainly was composed of squatters that worked in the coffee and sisal farms and the workers from the sisal processing factory (Chief Juja location office).

Squatter settlements in the area have given way to new housing units in form of rental and owner occupied, incremental housing. One such squatter settlement was Muchatha that was located near Juja police station is currently occupied by a modern hotel, flats, a bank, post office high-rise hostel and shops, with a trace of former slum settlement.

Initially, the land-use of this area prior to 1980 was large scale farming of coffee in the upper region and sisal in the lower region. Juja grew due to location of sisal, coffee, plantations and the East African bag company. From 1981 the area has grown both in population density and housing development due to the development of Jomo Kenyatta University from a small college of agriculture and technology to a national university. Many flowers growing farms are also located within this area and they offer employment to many. The university and the flower growing farms have attracted many people to this area. Construction and quarrying activities have consequently increased due to demand for buildings and infrastructure, hence attracting many more people into the areas due to increased labour demand in the area.

There is increasing demand for housing, for workers within and outside the areas. There is also a growing population of students that demand accommodation; therefore there is likelihood of continued growth in housing and demand for more building materials. Land subdivision and new building are coming up at a very high rate and this trend is set to continue as more land sub-division and housing units continue to be constructed.

Quarrying activities are on the increase, as dimensional stones have a market in Juja, and the surrounding areas. The closure of quarries in Nairobi is likely to increase the demand for stones from juja quarries. Most of the quarrying activities are taking place along Ndarugu River.

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3.4 Geological Set Up

The general rock formation in Juja is tertiary basic igneous rock; olivine basalts, phenelites, and older basic turf. This kind of general rock formation provides abundance of building materials. The igneous rocks are used mainly in production of coarse aggregates that are used mainly in making concrete for building construction and in road construction. The other rocks which are relatively soft compared with the igneous rock are quarries for building stones using both hand and machine methods. The soils are moderately well drained, shallow, friable gravely clay or petrophithente with pockets of murram with lithesol. Murram soils are also very good in earth construction for the coarse particles of murram provide the mechanical strength of the walling structure. There are also pockets of poor drained deep to very deep petrophithite, vestrsols, undifferentiated and vertic gleyosols. This geological formation provides the abundance materials of construction, a potential for growing timber for construction and a firm foundations for building structures.

Chapter 4

Research Methodology

4.1 Type and Sources of Data

Secondary Data

This consisted of information collected from existing data, literature from the library, internet resources, etc. This is important in order to know what already exist in the body of knowledge and to identify gaps in the issues that are important in this study.

Primary Data

Primary data involved getting information from quarries, other material suppliers, local authorities, and central government departments, namely the ministry of environment and natural resources, Ministry of housing development and housing developers.

4.2 Sampling Frame

Sampling frame included:

- All housing developers in Juja. Most of these have constructed their own houses and hence are owner occupiers. A section of Juja, with the highest self housing was selected. This was in Kiaora sub-location.
- The Local Authority, i.e. the county council of Thika.

- The government department: Ministry of housing, Ministry of environment and natural resources where relevant resource persons in the two departments were targeted, that is NEMA and the department of natural resources development.
- All material producers and suppliers to the area: these included:
    - Quarries; both hand cut and machine cutting quarries were included in the sampling frame there are over 20 quarries that use machine and many that are hand quarried. Timber suppliers; these were timber yards within the area.
    - Clay products manufacturers; there are two clay product manufacturers that are within reach of the area..
    - Concrete products manufacturers;
    - And the "jua kali" sector concrete products producers

4.3 Sampling Procedure

Systematic Random Sampling

This was done for the building developers, in the selected area, after dividing it into three strata. Where the strata were Ithuri, Gachororo, and the newer housing estates: Greenfield, Oasis, Joyland and Mililani which were grouped into one stratum. Housing buildings were selected through systematic random sampling in each stratum. Every fifth housing building was selected to target the developers in the area of study. Since most of the houses in the study area were owner occupied,

the developers were more often than not owners. The selected developers were visited to get their responses. A total of 36 developers were sampled

Quarries were stratified into two strata; quarries that are hand operated and those that are machine operated. Samples were taken from each of these strata through simple random sampling. Juja has over 20 twenty Machine operated quarries and effort to sample as many as possible was put but out of these 10 of them were accessed to get information. Hand operated quarries are located in Kalimoni areas and the area is under private ownership of one individual that rents them to out to interested people. One such group of hand quarries was also visited to gather data.

Purposive Sampling

Purposive sampling was done, for: The alternative material producers; all who were within reach of the study area and all were visited. These included: four out of the five the about five timber yards. Information derived from the four timber yards was similar so there was no need to visit the other one. As for the clay product manufacturers that are within reach of the area, there were only two and both were visited and data collected.

One Concrete products manufacturer; manufacturing walling materials within reach of the study area was visited and information obtained from them. And one jua kali sector concrete products producer was also sampled.

Purposive sampling was also done for the Local Authority and the central government departments. In these departments, the planning offices of the local government and the ministry of housing were visited and information obtained from them through interviews. At NEMA offices the deputy director NEMA was interviewed. The department of mining and natural resources, resource mapping was also visited.

4.4 Method of Data Collection

Data was gathered from building owners and other stakeholders through a semi-structured and open-ended questionnaire. For quarrying and other housing activities and observation guides were used. For observations and photographs were taken and kept as record of events on the ground. In evaluating the reasons why quarrying still continues despite evident environmental degradation, the following were considered though observations and questionnaire with the stone producers: the production of wastes and their utilization or disposal, economical benefits to the area in terms of numbers of employees and their enumerations, volume of stones produce and sold, and the Prices of stones at the quarries and at other outlets.

Where possible triangulation was done, where by; secondary data from literature review was be confirmed by interviews with the relevant persons, and the actual situation on the ground was observed and recorded. The local authorities were

visited to gather information regarding the issuing of licenses, planning regulations, charges that the government receives from quarrying activities and any by-laws that govern stone quarrying.

4.5 Data Analysis and Presentation

Gathered data was coded and computer applications SPSS and Microsoft excel were used to assist in analyzing the results. Qualitative data analytical techni1ues were used in the study.

Chapter 5

Results and Discussion

5.1 Introduction

This chapter gives the analysis and discussions of the research findings. It consists of the following three sections:

1) Evaluation of the policies, laws, and building code and local government by-laws; how they had impacted on the mining and use of natural stones, that lead to the practice of prominent use of dimensional stones despite environmental degradation and their high cost. Policies and laws are governance statements that direct the activities of people within a society. The policies and laws that have been evaluated within this section included the following: Kenya's National housing policy strategy Sessional paper No 3 of

2004, Building code, Environmental Management and Coordination Act of 1999 (EMCA) and the Mining Act cap 306.

2) Evaluation of the factors that contribute to prominent use of quarried stones; the factors that determine why people use stones rather than the other alternatives such as timber, fired clay bricks, concrete blocks and earth. This was to give an in-depth understanding of why dimensional stones were preferred over the other

materials of construction as far as the criteria that influence people choices of building materials were concerned.

3) The environmental and social economic consideration were analyzed and discussed in relation to use of stones and other alternatives: timber, fired clay bricks, concrete blocks and earth.

5.2 Policies, and the Institutional Framework Governing Extraction, Acquisition and Utilization of Natural Stones

5.2.1 Housing Policy

The current housing policy Sessional paper No 3 of 2004 has an overall goal of facilitating adequate shelter for all social economic groups. Considering that the demand for housing in Kenya by then stood at about 150,000 units in the urban areas and 560,000 in the rural areas and the supply was estimated to be about 30,000-50,000 units per year, this was far below the expected output. To increase the production of housing, the housing policy gives basic objectives that included the following:

- To protect the human settlements environment and ecosystems from pollution, degradation and destruction in order to attain sustainable development,

- To encourage research and popularize the use of appropriate, locally available building materials.
- To streamline the legal and institutional framework to promote increased housing development.
- To promote participatory planning in development and management of housing programs.

From the above basic objectives in the housing policy, it can be deduced that, some of these are likely to conflict, as an example the statement on encouraging use of appropriate materials and technologies for housing against the one on the environmental protection are likely to conflict. This was due to the fact that the quest for meeting the basic needs of people usually utilize natural resources that tend to conflict with the need to take care of the environment, which involves wise utilization and conservation principles (Sands 2003). On the other hand according to the Kenya national Development Plan for 2002-2008, full integration of environmental concerns into social economic development is a big challenge, in that there is lack of environmental awareness.

Section 3.3.3 of the national housing policy document deals with building material and research, the issues raised in the section among others is the fact that Kenya is endowed with abundance of all forms of material resources and labour. These can be utilized to increase available housing. But the question is, these resources have been there, what is curtailing their usage to meet the escalating needs for housing?

Why are the people not taking up the opportunities available to them to bring a positive change or is it the government that is required to do something?

In section 48 there are thirteen policy statements that have touched on every aspect of housing production, from increasing research allocation in material research, to promotion of indigenous architecture. This is positive in that the policy statements are not restrictive. They allow anything be done to remedy the situation of inadequate housing, giving a broad base for private and public institutions to be innovative in material production and usage. However, the policy seems to give no specific direction to be taken in achieving the goal of adequate provision of housing for all. These policy statements may in the long run effect no changes in the sustainable production of building materials in housing industry. One would be correct to believe that, there was no clarity of vision on what the housing sector was targeting in terms planning and management of materials resources for housing provision. This may led to private sector exploitation of the abundant material resources the nation is boasting to have.

5.2.2 Natural Resource Exploitation Policies Governing Material Exploitation

National resource issues fall under the Ministry of Environment and Natural Resources Development. There are two Acts that mainly deal with mining and

quarrying of building materials, in relation to environmental sustainability. These are:

- The Environmental Management and Coordination Act of 1999 (EMCA)
- The Mining Act Cap 306

Environmental Management and Coordination Act (EMCA)

EMCA states the requirement for Environmental Impact Assessment (EIA) and environmental Audit (EA) for most of economic development activities. This is meant to facilitate sustainable development through mitigation of negative social and environmental effects or restrict development that has negative effects on the environment. Talking to the officials of NEMA the following became very clear :

- The Authority is committed to sustainable development that does not degrade the environment.
- The Authority has the mandate to direct closure of facilities that have negative effects on the environment and in regards this they had issued a statement to facilitate closure of all quarries in Nairobi.

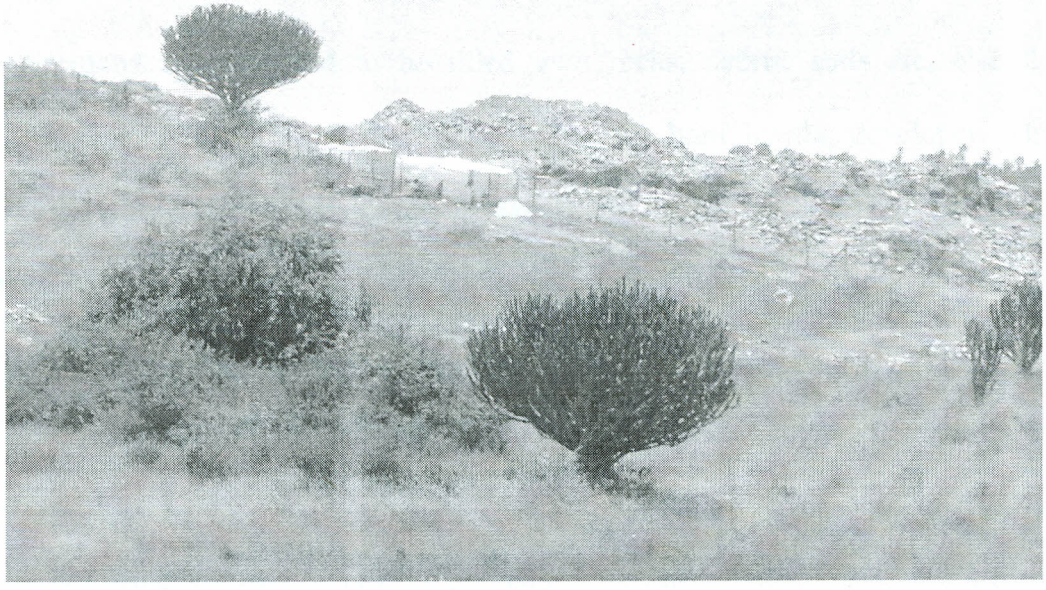
However, from observations it also became evident that the Environmental Authority had no way of enforcing the rules they made and hence quarrying activities were still going on in Nairobi even after the deadline to cease quarrying

had passed. Initially, the deadline was December 31 2006, and then an extension of six months was done which also expired yet quarrying activities continued.

To operate a quarry, EIA is compulsory for a new venture and audit reports for on going ventures. These EIAs and EAs are usually done by persons under the employment of the developer. NEMA accepts all documents that are presented to them as true account on the ground and the only time attention is dawns against these documents is when the communities living around the quarry areas complain about the environmental impacts. There is a likelihood of the developer putting undue influence on the reports and also the public not complaining even when there are problems due to the prevailing lack of environmental awareness (Republic of Kenya, 2002).

The authority does not seem have adequate capacity to supervise or confirm that the EIA and EA carried are correctly done or not, hence they only rely on the communities and stakeholders to complain so that action can be taken against the offenders. For example plate 5.1, is a picture showing degraded land due to quarrying activities but since the activities are taking place in private land no one is likely to complain. Yet whether environmental degradation is taking place in a private land or in a secret place it will in the long run impact negatively on everyone. In many places within the study area quarries are on private land. So the communities are unlikely to have collective communities' complaint against the

private land owners. According to one environmental officer, complains are many but no complainant is ready to make his /her complaint formal. NEMA takes action when complaints are formal or collective action is present.



Source: Field survey, 2007

Plate 5.1: Degraded land, pilling of waste materials from a quarry in Juja

Mining Act Cap 306

The Mining Act Cap 306, revised edition of 1972 define a mine as any place, excavation, or working, where prospecting for mining is carried out. To mine has been defined in this Act as to intentionally win minerals. This Act also defines what minerals are and has specified that Clay, sandstone, sand, murram and building stones etc are not minerals. Hence building stones are not covered by this

act save for part IV of this act that deals with safety of excavation and rehabilitation of the mined areas. In this part IV: section V the Act states that, the excavation must be protected so that there is no danger to the public traffic. This is found in subsection 7 of this part. In subsection 8 of the same section, all excavations are supposed to be filled with rocks, debris, soils etc, else the government will fill them and the cost will be born by the developer. This requirement to refill the holes left by excavation has never been fulfilled neither has the government filled any of them to recover cost from the developer.

Observation made at the stone quarries in Juja showed that, the requirement of the law, that the holes or excavations left after mining or quarrying were to be filled was not being fulfilled. Very deep and large excavated areas have been left open. It seems almost impractical to fulfill such legal obligations, due to the magnitude and extent of the quarrying. Very large volume of materials would be needed and the question is where they would be gotten from. Therefore the requirement of filling the holes should be removed and other mitigation measures derived that are appropriate and achievable. If no appropriate mitigation measures can be instituted, then a decision to continue or not to allow quarrying under such condition should be made as a matter of urgency, and communicated to all stakeholders.

Information obtained from the officials of the mining department indicated, that the current Act being drafted will include the issues of stone quarries (Ministry of Environment and Natural Resources). Yet since private property is protected by the constitution of Kenya, it is yet to be seen how this new Law being drafted will bring changes in the stone quarrying industry.

Internet information retrieved from: http://www.tradeandindustry.go.ke indicated that existing geological maps are made in large scales of: 1:50.000, 1:125,000 and 1:250,000 at reconnaissance and regional level. For a specific quarrying location there exists no detailed maps or data on geological condition that are key in determining the extent of the particular rock formation and the possible impacts of mining the rock it's area of influence. If a prospective miner or quarrying enterprise needed more detailed geological formation; more than the 1:50,000 maps could offer, he/she has to pay for ground exploration. The information derived from this exploration is more detailed than the existing information. It would be more crucial to the government rather than to stone merchants, to have this detailed information since most quarries were rented for short durations, meaning that if a quarry does not yield good product, the developers can always relocate to another section of the land. Some of the stone quarrying enterprises are working on agreements with the land owners that may not be benefited by detailed ground exploration. Yet, this detailed information is crucial to the government, in predicting possible serious implication on the current and the future land use of the

spatial expanse within the quarry influence. This should be a major concern of the government, in that quarrying may have serious impacts on the ground conditions within the immediate surroundings and probably further away than expected. Therefore this is the only way the government can decide that the mitigation measures proposed in the EIA and EA are appropriate or not. Otherwise for now one would be correct stating that quarrying was done in a black box; this should not be the case since the possible impacts could not be predicted, neither any effective mitigation measures proposed is detailed geological information was available. The mining department should have details of every area or a prospective miner should pay for this ground exploration to determine the rock extent and the possible impacts on land use in the area. This information must be available to NEMA before they approve of the EIA or EA reports.

5.2.3 Local Government.

The only control the Local government has on quarrying of stones is through licensing. Information obtained from Thika county council showed that any person wishing to engage in quarrying activities, who could show that they have the right of use of the land for quarrying and have the money to pay for a license, could operate or engage in a quarrying venture. The large companies that quarry stone are supposed to be charged about twenty thousand Kenya shillings (20,000 Ksh) only per year. While the small quarrying individual ventures hardly pay anything, since most of them are quarrying on land that does not belong to them or on public

land illegally. However, information gotten from the Environmental Officer of the law enforcement department of Thika country council showed that none of the quarrying companies had paid for the said license in Thika county council offices. The only levy the local government collected from quarrying ventures was about Ksh 150 to 200 per lorry load of stones from any quarry. Yet the local government needs to benefit more from all economic activities within it locality hence more stringent control should be enforced.

The other reason why the Local Government does not have much control over mining of stones is that most quarrying is done on private land. Considering that private land is protected by the constitution and most of these land owners are not "men of straw", the local council seems to have decided it none of their business. NEMA also relies on public complaints regarding negative impact on the surrounding areas for them to act and usually they do not receive any formal complaints from the public regarding quarrying on private land.

Building Laws and By-laws

The building By-laws of 1966 are still in force in the area. These By-laws are not mandatory but adoptive meaning that every local council can or may not adopt them. On building materials the code; part III of it deals with them. By-law 32 of part III refers to walls of stone bricks and blocks; that no person shall use or cause

to be used in erection of a building, materials of which are unsuitable nature. Section 2 and 3 of this law state that any one doing this is guilty of an offence that is punishable by law and will be required to remove this structure or pay for it's removal.

In subsection 4, the materials conforming to the latest edition of British Standards are deemed of suitable nature. In the third schedule of this by-laws strength and other specific parameters for walling materials are given in detail. The compressive strength required for materials are given in imperial system. It should be noted here that Kenya currently uses metric system and SI units; therefore this is not an appropriate system of units to the people of this nation. The use of imperial units in the compressive strength requirements, while the country uses metric system and SI unit, indicates a colonial legacy that is still in force.

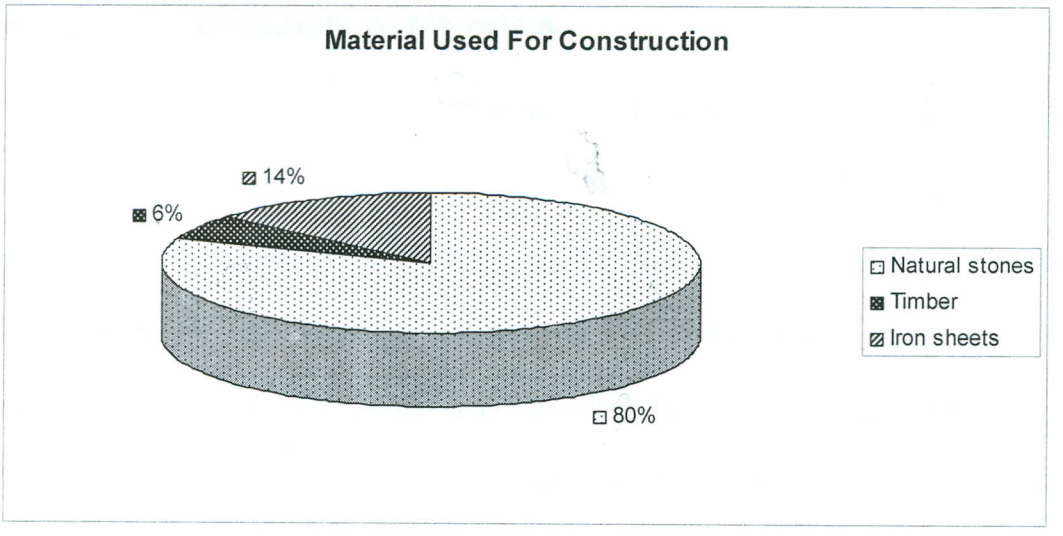
Information derived from interviews held with officials of Thika county council, where Juja location falls indicated that plans can only be approved by this local authority if permanent materials are used. These permanent materials are stone, fired clay bricks or concrete for walling. Other alternatives such as timber and earth are referred to as temporally materials and are used for temporary structures, informal housing, and in the rural areas. The interpretation of the By-laws is in the hands of the local government and they have the mandate to adopt what they wish. This leaves the housing developers with no choice but to use materials approved

by the Local government for housing. For those that cannot afford the "permanent materials" they are given no other option but to build illegal structures in informal settlement away from formal planning.

The grade 2 building by-laws of 1995 that allows materials such as stabilized earth are only being allowed for slum upgrading and have not been adopted for other areas. For this very reason, the over reliance on natural stones, has been reinforced by the current building by-laws. Thika county council has not adopted the 1995 by- laws that allow other locally available materials to be used.

5.3.1 To Assess why People use Dimension Stones more Predominately than other Materials

This section confirms that the people had used dimensional stones, more predominately than the other materials. Followed by how the various factors were ranked as considerations in the choices the developers made. These factors indicated the preferences, values and criteria for the choices that developers made. Figure 5.1 shows that about 80%, 14% and 6% of the respondents had used stones, iron sheets, and timber respectively. This clearly shows that most housing buildings in the study area were constructed using dimensional stones. The respondents had not used other alternatives that have been advocated for as viable alternatives through research.



Source: Field survey 2007

Figure 5.1: Construction materials used in the study area

5.3.2. Reasons for choosing Stones against other Materials

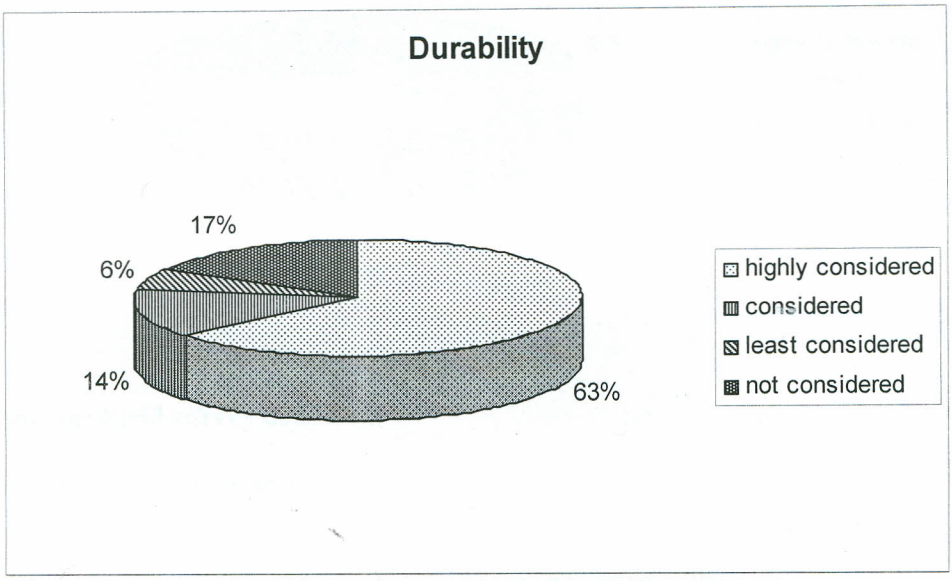
Reason for using stones were more due to aspirations of the people and not due to the hindrance of the building code and by-laws only as it had been said earlier. Many people did not even consider the requirements of the law. The main reasons given by the developers regarding why they had used stones in construction of their houses, were durability, maintenance, aesthetics legal requirements etc.

In order of what was highly considered, considered, least considered and not considered, the following data was derived from the respondents' responses. Figures 5.2 up to 5.8 indicate the weight attached to each factor that people considered in selecting the materials for construction of their dwelling units.

5.3.2.1 Durability of Materials

Durability was highly considered as major criteria by the respondents in selection of building materials for their houses. 63% of all respondents indicated that durability was a major considered in selecting the materials of constructions as shown in figure 5.2. Durability is a relative term in that when you compare for example timber and rock, timber may be vulnerable to insect attack while stone can also weather due to environmental condition. All materials will wear out with time. Most materials with the right treatment will last for a reasonable period of time. In most cases building stones are known to be relatively more durable than

most alternative, but since the consideration of durability is in this environment of lack of adequate housing, it should not be given such weight as the respondents have.

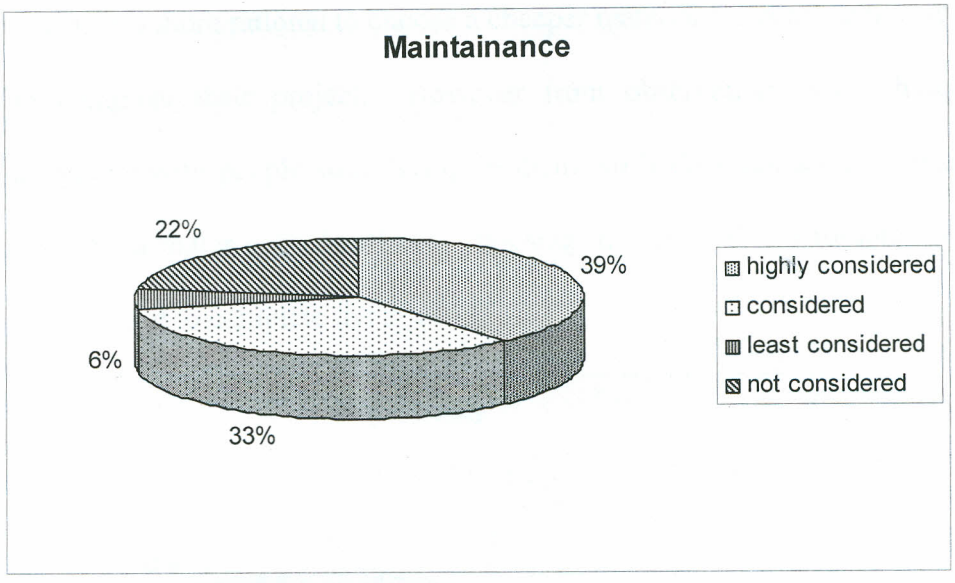


Source: Field survey 2007

Figure 5.2: Durability of Building Materials

5.3.2.2 Maintenance of Houses

Maintenance was also another consideration with over 70% of the respondents considering it in making choices on which materials to use, as shown in figure 5.3. Yet the fact is that all materials need some form of maintenance, with varying degree of cost and frequency. The overall cost of a building is in terms of materials of construction, construction cost, and Maintenance cost. Maintenance need to be considered in relation to the initial cost of the building.



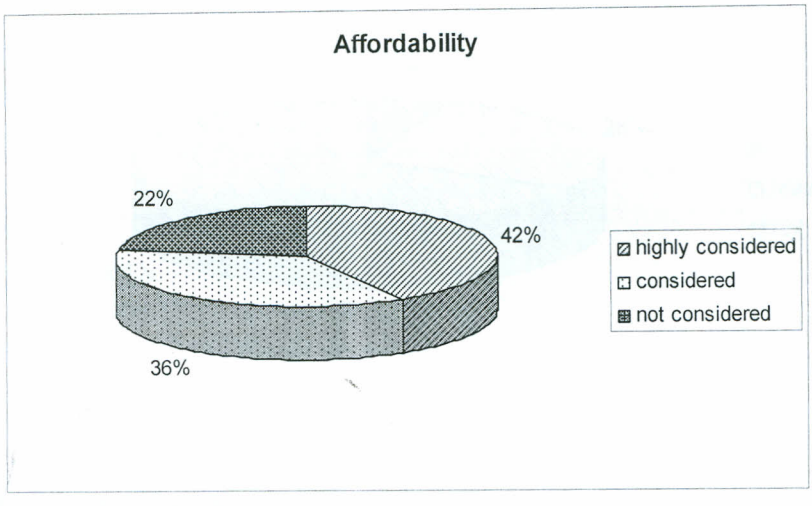
Source: Field survey 2007

Figure 5.3: Maintenance

5.3.2.3 Affordability of Housing Materials

It was interesting to find out that about 80% (figure 5.4) of the respondent considered affordability of the material they used. However it was expected that only small percentage of respondents that had used other options such as timber, and iron sheet should have considered affordability. Existing knowledge indicated that, people were inadequately housed because housing materials were expensive. The materials of construction in question being mainly stone, concrete and fired clay. Since these are the only ones that were approved by the building By-laws in using then. On the other hand if affordability was a major consideration and at the end one makes a decision to use a certain material on this ground, it would indicate that the respondents that could afford to build with what ever material they had

chosen. It is more rational to choose a cheaper material for construction so that one can complete their project. However from observations some houses were incomplete with people were living in them; so it does not seem to make much sense that a major consideration is choosing the material is affordability yet they cannot afford to complete the houses.



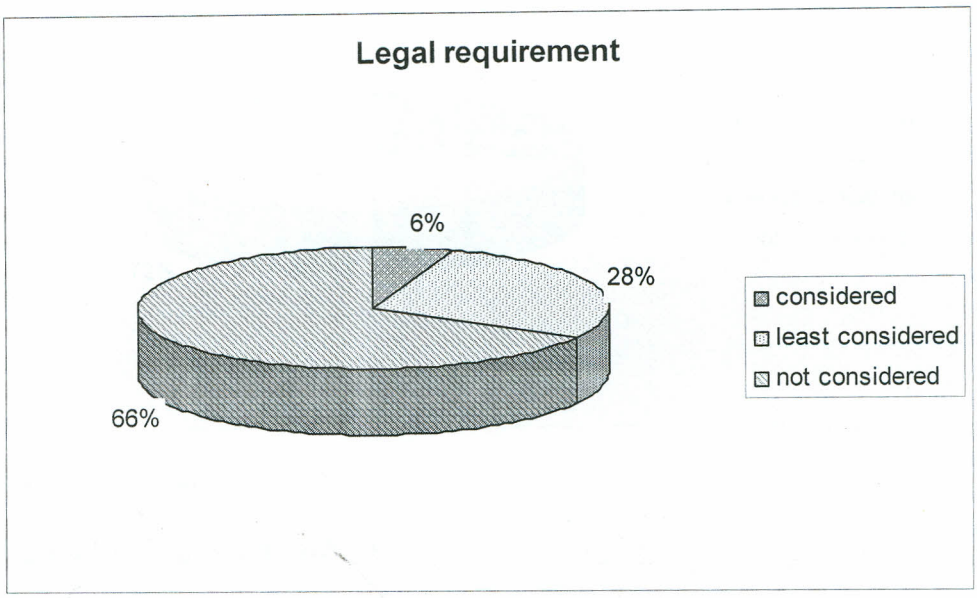
Source: Field survey 2007

Figure 5.4: Affordability of the building materials

5.3.2.4 Legal Requirements for Building materials

Legal requirements; the building code, by-laws have been blamed for being a constraint to adequate housing due it restrictive nature on what materials to be used. This has been said to have put adequate housing beyond the reach of many Kenyans. Yet in the study area the respondent did not to rank legal requirements as a major factor in considering what material is to be used for construction. Figure

5.5 illustrates People's consideration of legal requirement in making their choices. 66% percent of those that filled the questionnaire did not consider legal requirement

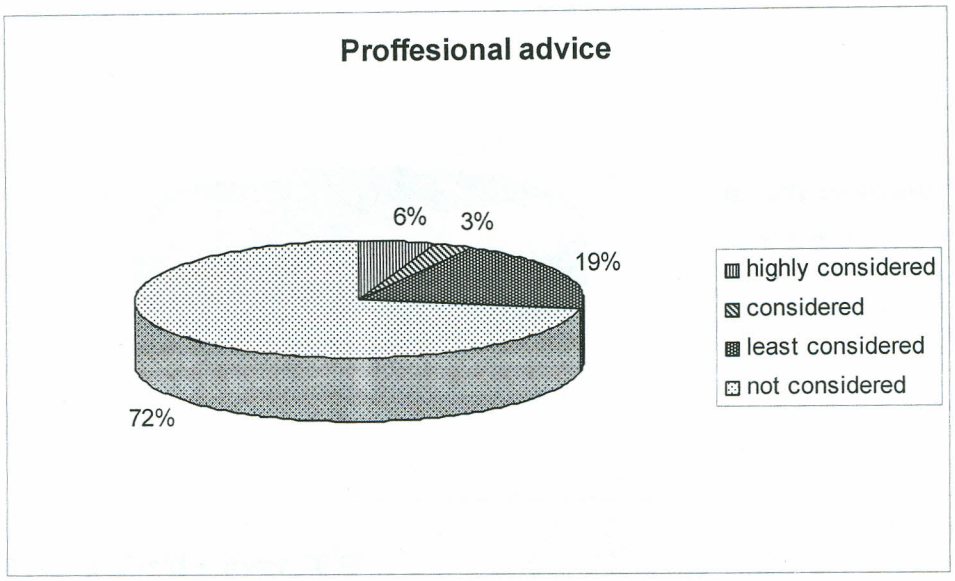


Source: Field survey 2007

Figure 5.5: Legal requirements

5.3.2.5 Professional Advice on Materials of Construction

It is expected that permanent buildings should be constructed with professional input; that is the architect, the structural engineer etc. Yet as much these buildings could be classified as permanent, about 72% percent of the developers did not seek professional advice on the materials they used. The figure 5.6 illustrates the ranking in professional advice as a factor of consideration in selection of the materials for construction.

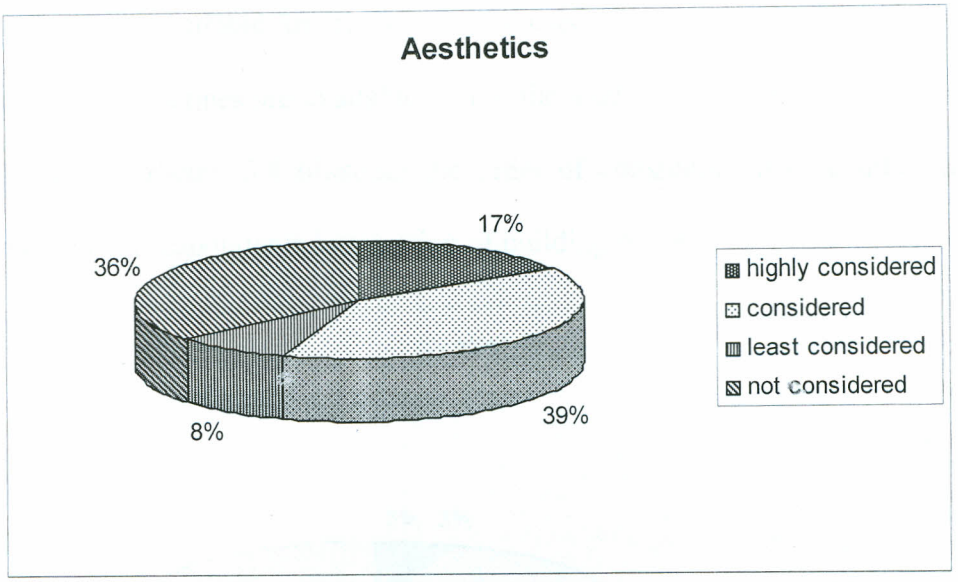


Source: Field survey 2007

Figure 5.6: Professional advice

5.3.2.6 Aesthetic as a Factor of consideration in Choosing Materials of Construction.

Aesthetic, which is the way building appeals to the eye, this was found not to be a determining factor in the selection of materials. It was possible that a person that needs shelter will considered aesthetic least. The figure 5.7 shows how the respondents considered aesthetics in selection of materials of consideration.



Source: Field survey 2007

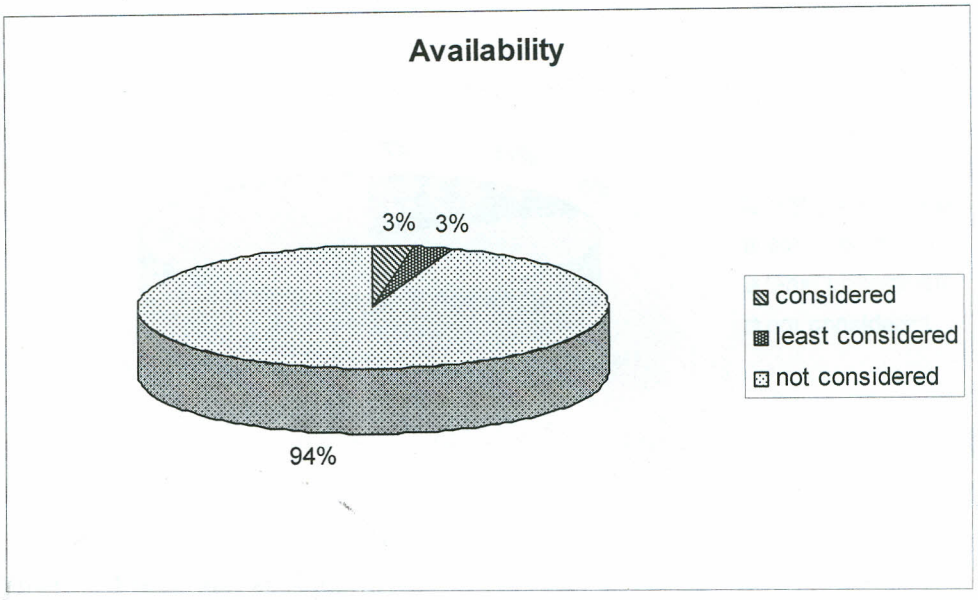
Figure 5.7: *Aesthetic*

Data obtained give 17%, 39%, 8% and 36% in order of highly, considered, least considered and not considered aesthetics in selection of the materials. Aesthetics are a matter of personal taste.

5.3.2.7 Availability of Building Materials as a consideration

In the study area, dimensional stones were available at prices that are less than any other products except earth. Information gotten from the public indicated that availability of stones was not a major consideration. No one considered availability highly as they selected which material to use. Yet it is assumed that availability is a main consideration in choosing any material of construction; in other parts of the country where quarried stones are not readily available those that

are readily available are predominately used. One of the reasons for this is that dimensional stones are available within the study area and hence their availability assumed. Figure 5.8 illustrate the order of consideration of availability of the material by respondents in selection of building materials.



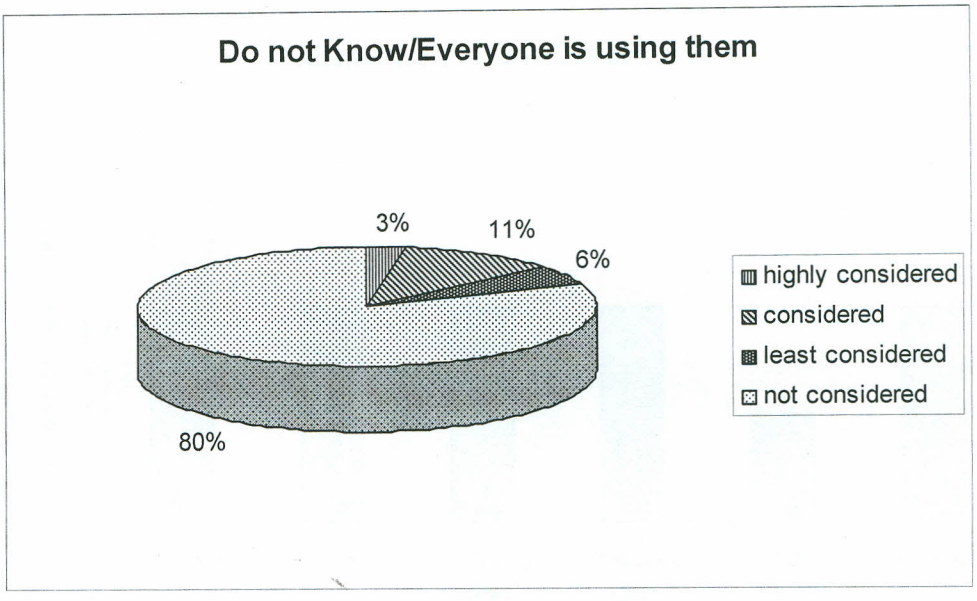
Source: Field survey 2007

Figure 5.8: Availability

5.3.2.8 Those not sure why they choose the material they used

More often than not people are likely to do what others are doing. But from the results only a small percentage 3% indicated that they considered what others are doing in choosing the material options they did. Majority of respondents as shown in (figure5.9) responded that they did not consider what others had used as they

choose the materials of construction. This is a mature approach to decision making .



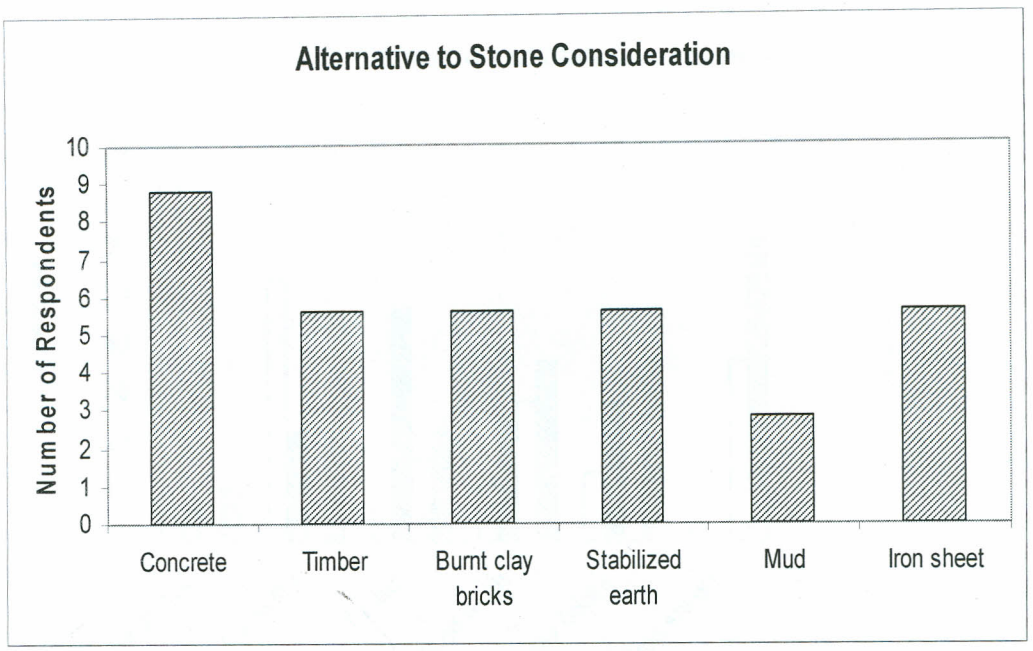
Source: Field survey 2007

Figure 5.9: **Not sure why they choose the material**

5.3.3 Alternative Consideration

Half of the respondents indicated that they had used/would prefer to use natural stones in the construction of their houses indicated that they had not considered any other material as an alternative. The numbers out all respondents that would consider other materials as viable alternatives are as shown in the figure 5.10 below. The numbers are small but they cannot be ignored. Only 8/36 considered concrete 2/36 would/had considered using iron sheets, the other alternative had

about 5/36 considering them as options. The reasons for this are yet to be determined.



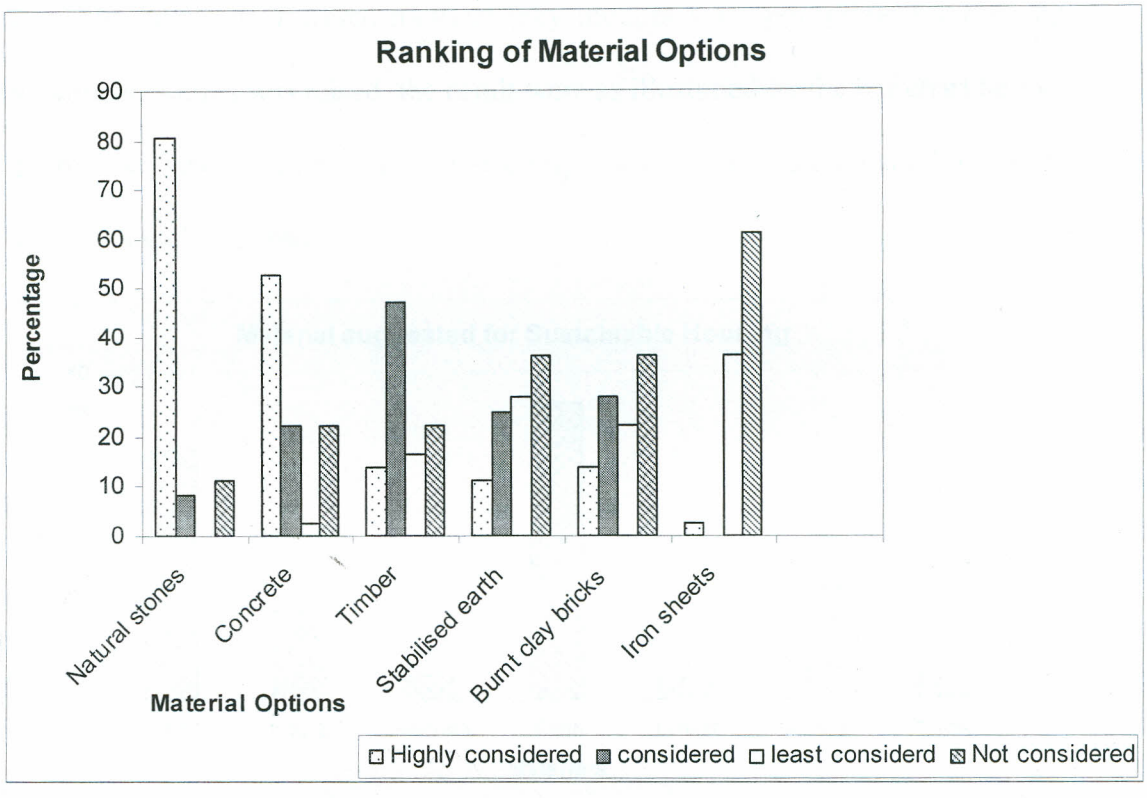
Source: Field survey 2007

Figure 5.10 Alternative considerations.

5.3.4 Alternative Ranking

When the respondents were presented with various options and given a chance to consider the other options that were available and rank them in order of preference, the following results were observed. The figure 5.11 shows the ranking in considering the alternatives in percentages. This information shows that people used what they preferred most and that through some had considered other options

like timber, fired clay and stabilized earth they had not used them. The reasons for this are yet to come out more clearly.



Source: Field survey 2007

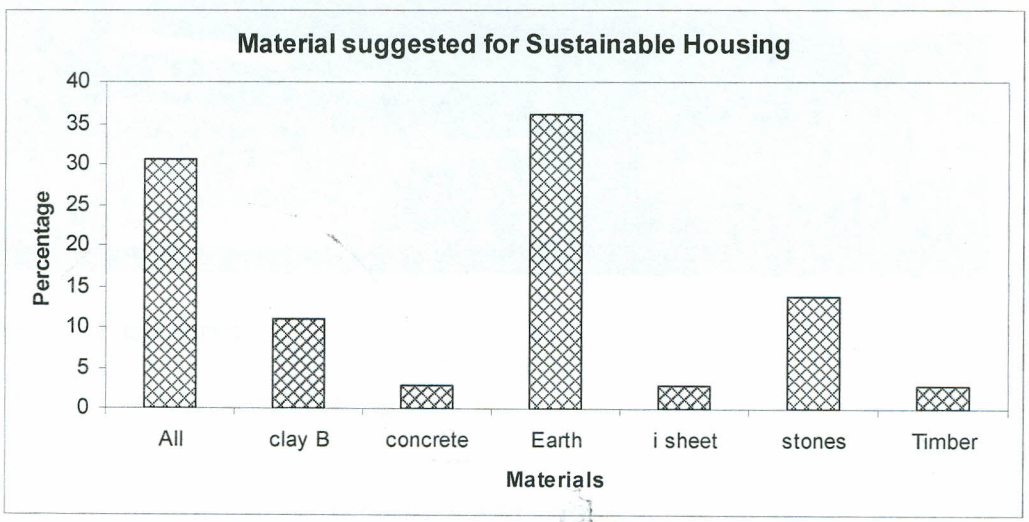
Figure 5.11 Alternative ranking

5.3.5 Adequacy of Natural Stones

The percentage of the respondents that considered stone to be adequate for housing everyone was 19.4%, the other percentage which is 80.6% indicated that natural stones cannot be used to house everyone adequately. This shows that as much as

most people are using dimensional stones for housing they are aware of the fact that, this material is not able to offer adequate housing for everyone in the country.

When the question of which material they thought was appropriate for housing everyone in Kenya was raised, the result were as illustrated by the bar chart below. The first bar labeled all, represents those responses that suggested that all materials available should be used.



Source: Field survey 2007

Figure 5.12: Material for adequate housing

The figure 5.12 indicates what material people perceived could be used for adequate housing in Kenya if every was to be housed adequately. From the figure there is indication that the majority thought that earth was a viable solution. Yet from observations, none seemed to have used earth for housing only dimensional stones were observed to be utilized. Plate 5.2 illustrate typical housing

developments in Juja. Where most of the developments have utilized dimensional stones.



Source: Field survey.

Plate 5.2: A section of housing in Juja

5.3.6 Research Information Awareness

Research on building materials has been carried out in this nation for a long time, HABRI of Nairobi University and other organizations have done extensive works on appropriate materials for housing yet, from the people responses they are not aware of this research information. 77.8% of all the respondents are not aware of any research on materials for construction. Yet even the ones that affirmed that they are aware of existing research information, indicated that they were yet to see these products in the market.

5.4 Environmental and Socio- Economic Considerations in using Dimension Stones against other Alternatives; Fired Clay Products, Concrete Blocks, Earth, and Timber

In this section information derived from the material producers/suppliers was analyzed in comparison to one another so that the factors contributing to over-reliance on dimensional stones can be portrayed. These other factors are inclusive of prices, the environmental cost and the socio-economic implications of using natural stones.

5.4.1 The Market Price of the Material per meter square

Information obtained from the material producers/suppliers showed that the cost of purchasing raw materials to construct a metre square of wall was as indicated in table 1. This was not inclusive of the cost of labour, neither that of binding materials to put up the wall. These figures were derived from calculations based on the average unit price of the raw material at the study areas outlets. These figures give a comparison of the cost of each material at a glance, which is what an inexperienced developer is likely to look for, but they do not give the true cost during actual construction. The average current cost of 200mmx200x400mm block of dimension stone was Ksh 25 at the time of the study, at the hardware outlets but

it's price varied from 25 to 35 Shillings depending on it's quality. Concrete blocks of similar size costed an average of Ksh50. Clay bricks costed Ksh 28 though to make a wall stand one needs two bricks to make the required width for a load bearing wall.

Table 5.1: comparing unit price of various material options

Material	Size in (mm)	Unit price (Ksh)	Cost per metre sq
Dimensional stones	200x200 x400	25	350
Fired clay products	230x115x75	28x2=56	450
Concrete blocks	240x190x390	80	900
Timber	200x25	30	400
Earth	-	-	-

Source: Field survey 2007

The prices given above do not give the true representation of the cost , since the labour charges , the cost of binding materials, the finishing and the time spent in construction by each material options have not been factored in. But more often than not people consider only the main material cost. This does not give the true picture. Professional input and advice is truly required.

5.4.2 The Environmental Implications of Using Dimensional Stones

The dimensional stones have some of the following costs to the environment: Most quarrying activities were located in the river valley or very close to the river. The waste materials generated by quarrying tended to swept toward the river, this had the potential of submerging the river, threatening biodiversity along the riparian lands and downstream of the quarries. The effect of quarrying on the geo-formation and its effects on the foundation of nearby structures seems threatening and is yet to be determined in quantitative terms.

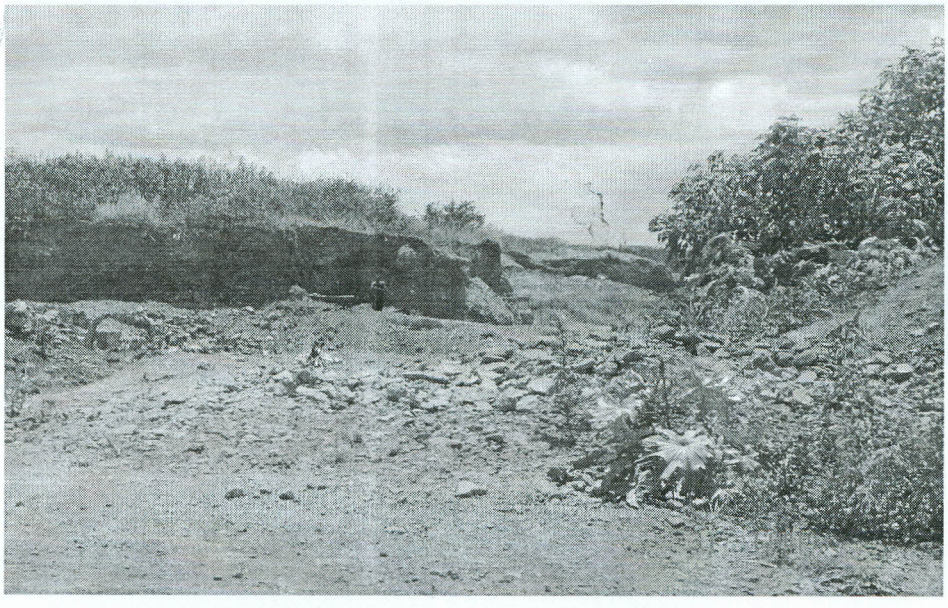
Waste Dimensional Stones at Quarries in Juja

The production of stones at any quarry seemed to produce high quantities of waste materials. Ways of utilizing this waste should be found to maximize on resource uses. Plate 5.3 below illustrates wastes generated by machine production of dimensional stones. These stone are weak in strength and are not strong enough for load bearing walls; they are usually sold as "rejects". This waste shown in the plates 5.4 was generated by hand or manual operated quarrying system, such waste can is used in housing construction through innovative technologies.



Source: Field survey 2006

Plates 5.3: Waste materials from a quarry using machines for cutting stones.



Source: Field survey 2006

Plates 5.4: Waste materials from a hand operated quarry.

Pollution Generation through Transportation

Transportation of building material was mainly by Lorries. Observations revealed that old, smoky trucks were used in transporting these dimensional stones to various destinations. This was contributing to environmental pollution through smoke emitted by the trucks. Such trucks had the potential of damaging the road surfaces adding to more cost on the government expenditure on road rehabilitations.

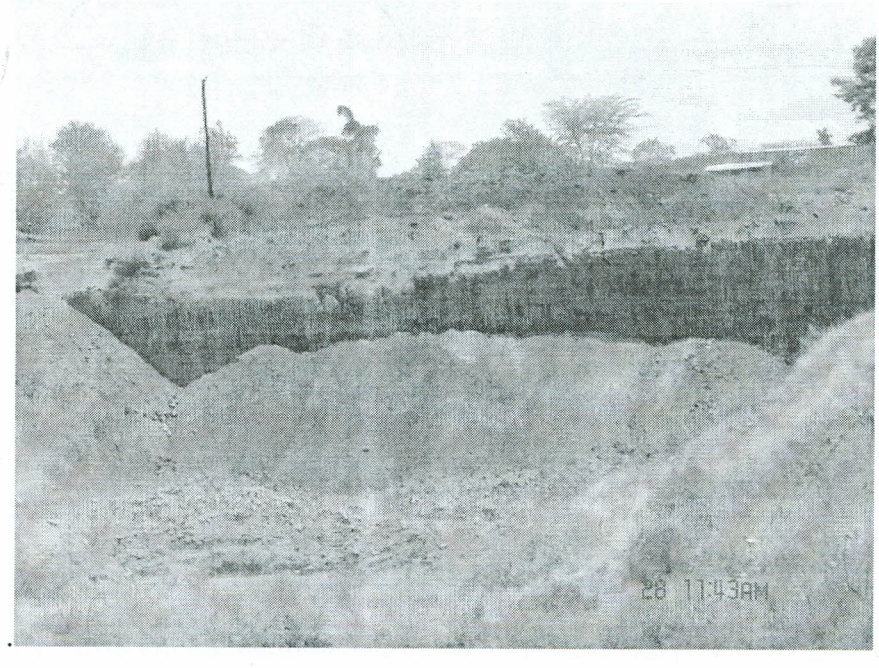


Source: field survey 2007

Plates 5.5: A truck transporting stone products

Possible Effect of Geological Formation on nearby structures

It was observed that quarrying in some areas was very close to residential dwelling areas; this may undermine the foundation of near- by buildings. This can be illustrated by plate 5.6: Some buildings were located relatively close to the quarrying sites; this could cause damage to building foundations leading to possible foundation failure or collapse. This being as a result of the fact that every material has a natural angle of repose, with time this will be achieved, meaning that the vertical edge can not remain vertical but will achieve a certain slope, with possible damage to nearby infrastructures. This is an area that may need more investigations. The quarry shown on plate 5.6 is a new one and operations are at the initial stages. With time as quarrying progress, the depth becomes very deep.

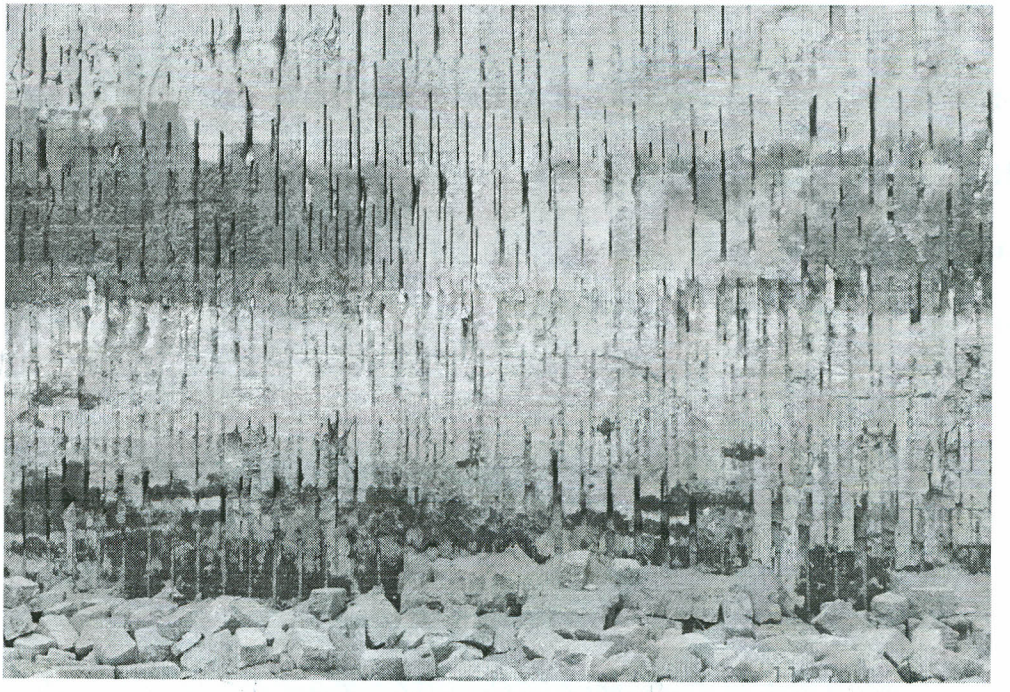


Source: field survey 2007

Plates5.6: Wall at a machine operated quarry

Vertical Walls at Machine Cutting Quarries

Quarrying activities where machines were used, were very efficient in production of stones and maximized benefits derived from the land hired for the purposes. Vertical wall were left that were very deep. These vertical walls had questionable stability and their long run implication to ground stability within their area of influence had not been considered. Plate 5.8 illustrates such a vertical wall at Juja Ndarugu quarries.



Source: field survey 2007

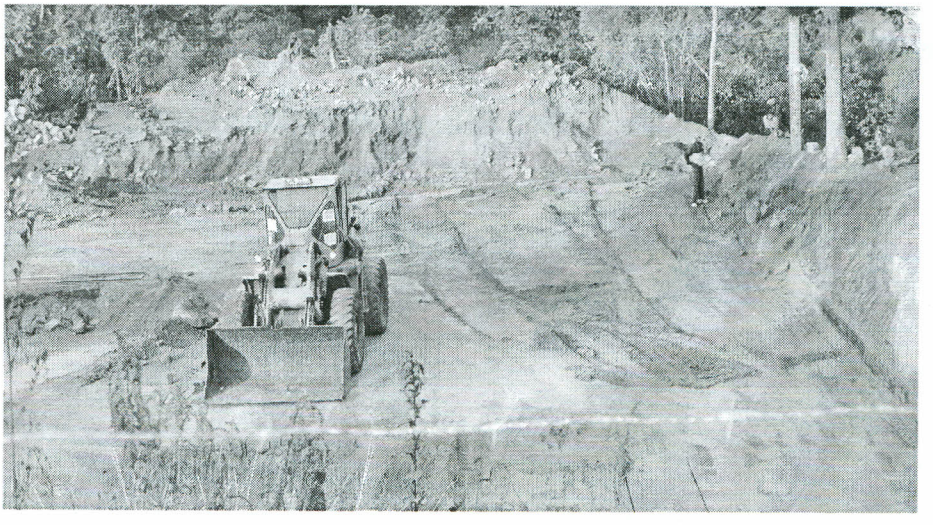
Plates 5.8: Wall at a machine operated quarry

The different colourations on the wall indicate varying geological formation. The dark portions indicate formations that are more permeable to water. This indicates

that such quarrying activities also interfere with ground water movements that no-one yet knows what the future implications to water resource management may be.

Effects on Water Resources

Possible negative effect on water resources was observed in the plate 5.7. The water course was threatened with being submerged as a result of continued mining activities. This is as a result of generation of waste materials in form of quarry dust and broken stones. The stone merchants tended to move this waste toward the watercourse as seen in the plate 5.7. This was common in most quarries that were close to water courses; most quarrying activity takes place along the river. Hence this had the potential of threatening the natural movement of the water, therefore likely to have negative repercussion on both wildlife people down stream of the quarries.



Source: field survey 2007

Plate 5.7: Threat of sub-merging the water course

5.4.3 Socio- economic implications of quarrying Dimensional Stones

Stones are quarried mainly by two entities: By large companies that have machinery cutting and earth moving equipments and by the small scale quarrying done by individual persons that have rented quarry space from landowners. The soci-economic benefits derived from stone quarrying are dependant on the mode of quarrying and the size of the company involved. The small entrepreneurs get little in the way of profits but these are distributed well among the parties that are involved. The licensed explosive operator gets his share, the casual labourer who moves and arranges stones, the mason etc, all have beneficial opportunities from the earnings of the quarry. The landlord rents the quarries to a few individuals, who either sublet them to persons that hand cut stone after using explosives to blast the rock into small fragments. Plate 5.9 shows a hand operated quarry where there are many operators working in the same location. The rock fragments have been blasted from the parent rock by a licensed explosive operator.



Source: field survey 2007

Plates 5.9: Blasted rock ready for hand cutting

In the hand quarried stones, the production is about one lorry load per day , small quarries employ masons, who are paid per foot of the stone cut or about ksh 500 per day , the loading of the lorry about Ksh 300, and the payment to the landlord is about Ksh 100 per day, the unit cost of one foot of hand cut stone is Ksh 10 and the production per one mason is about 100feet per day. Simply put the person renting the quarrying takes home less than Ksh 500 per day but has employed at least a mason, an explosive expert, the loader etc. Simple arithmetic indicated that in hand quarrying the outputs are small, the incomes are also small but are evenly

distributed, and hence there was some positive contributing to the welfare of the ordinary citizens.

For the large companies the scenarios was different, here machinery owned by the company was utilized in production of stones. The employments are relatively minimal for the people within the community with respect to the volume of production. Figures regarding how much is produced, how much are the running costs, emoluments etc were sketchy and therefore not reliable but it was evident from production and the number of lorries that are taking away materials from the quarries and the fact that production went on thought out the day and even at night. It was approximated that large companies have an out put production of over 25,000 pieces per day. The price of one unit being about Ksh 20 to 25 per block of stone, loading is about Ksh 1 per stone; Ksh 500 per lorry. Quarries are leased for a specified period of time or the land bought by the operator. The sums of money involved are not public information and were difficult to obtain. The license to quarry is paid to the local government is a sum of about Ksh 20,000 per year; this amount was usually never paid. Therefore it can be said that machine operated quarries had high production of stones, with huge profit that went to a few quarry owners and the rest of the workers are paid the low wages hence this wealthy was not being distributed well to the communities living around the quarry area. In other words machine quarrying enterprises compared to hand operated quarrying, exploited very huge the rock resources in Juja, degrading the environment,

threatening the water source that supplies water to most of the residents of Juja ie Ndarugu river etc, while the benefits were to a few individuals hence the socio-economic benefit to the general public was minimal.

Concrete Blocks

The concrete blocks in the area were supplied by two companies from Nairobi and a few Jua kali producing enterprises. The cost of the concrete products was quite expensive compared to the dimensional stones. Concrete production utilized natural rock products and cement that also have same negative impacts to the environment, perhaps even more than the dimensional stones. As much as people had preconceived notion that concrete block were a viable alternative to natural rock, due to its' high market price and the cost to environment, it was perhaps not the best alternative to dimensional stones.

Fired Clay Products

Clay products are supplied by two main clay producers in the country. These companies source their raw material from within Nairobi environs. The production is mechanized with few relatively well paid workers and the bulk of the employments on casual terms. Production of clay products requires energy for firing the raw mixture. The energy used is electricity and biomass, thus increasing the cost of production and negative environmental effects. The cost of the product to the developers is quite high compared to dimensional stone (refer to table 5.1)

Timber Products

Timber products are produced national wide, with every space of land having potential to produce trees. The supply of timber products was by hardware outlets that were located strategically in the study area. They are within reach and every developer can choose from a number of such suppliers. The supplier indicated that the product that they were selling had been sourced from all over the country and even outside the country. The prices were close to those of natural stone and yet the needs for other materials to provide a good finish are not much. Timber can be painted directly to give a good finish, and it is also a renewable material. Its production would and enhances the environment. It preparation for use does not require much energy input. It has potential of being used raw, processed or in making the load bearing frame that can be cladded by other cheaper options. Option like timber is viable but rarely utilized. The local government would not approve of a timber designed house, since there is potential in utilizing this material for sustainable housing. Timber can be grown all over the country and would contribute to environmental welfare through a forestation, increase in soil fertility, increase in biodiversity habitats reduction of global warming etc. at a time like this when people are unable to construct effectively with dimensional stone, and incidents of collapsing building are increasing with accompanied increasing death toils then timber buildings should be encourage.

Other Earth Based Products.

These products have been used since time in memorial for housing. They too, like dimensional stones require quarrying and are likely to have negative environmental impacts. But on a less extensive scale since they can be mined on site and produced on site. As much as the people thought that they could provide an option for housing everyone adequately, very few are willing to utilize this option.

Chapter 6

6.0 Summary of findings, Conclusions and Recommendations

6.1 Summary of findings.

The evaluation of the policies, laws, and by-laws that govern or affect how the materials of housing are managed showed that: 1) The housing policy has provided a very broad guideline that has effectively allowed anything and everything to be done. It can be said to be very permissive. On the other hand, the basic principles in the housing policy are good but lacks clarity on, how they will implemented. 2) As for the laws that govern the mining and use of natural stones for housing, they were found to be archaic, and not in line with the present state of environmental requirements, the technological advancement, the needs of the people and the future generation needs and a lack of capability to enforce them, therefore:

- They have not incorporated sustainable principles of development that involve conservation and wise utilization of the available resource.
- They have also not considered the technological advancement of mining and the extent of damage it can do to the environment.

NEMA does not seem to have capacity to enforce the rules and regulation they make, neither do they seem to have the capacity to audit the quarrying activities to countercheck whether the mitigation measures given in the EA and EIA were

taken or not. This has resulted in environmental degradation with large areas where rock for quarrying existing becoming large and deep holes that may have no benefit to the people and may contribute to disasters. The insistence of the building code and by- laws on use of permanent materials: stone or cement blocks or fired clay products, has contributed to increased demand for stone building blocks.

On assessing the environmental, and social -economic implication of using dimensional stones, the following was found; 1) That dimensional stone production was an activity that exploits huge volumes of rock formation with very little social-economic benefit to the communities living nearby, while large profit goes to individuals. 2) The Local government does not have much control; neither does it benefit much from these quarrying activities, since they take part mostly on private land.

The assessment of the factors that determine why people seem to over rely on dimensional stone showed that the developers are utilizing materials that they perceive to be the best option. There is a general perception that other materials of construction are not durable and that maintenance is a problem for the entire alternatives range. This perception has been given weight by the following factors:

- Lack of information on the factors that should be considered in selection of building materials.

- Lack of expert advice. Very few people consult professional advice on which material to use.
- Lack of research input into positive changes in housing.

The developers responses, indicated building by- laws and regulations have not been a major consideration in making the choices, probably they have already internalized the colonial by-laws as if they that the way it should be.

Interestingly that the developers are aware that dimensional stones cannot sustainable house every one, yet the local councils are insisting on natural stones and fired clay products, which apart from the price tags on each building material, there are other environmental cost and social economic implications implication that are more crucial to the nation at large yet they are not being given the attention and serious that they should in deciding on what material is viable and sustainable in adequate shelter provision.

6.2 Conclusions

The policies, laws and building by-laws have discouraged the use of other more appropriate locally available materials and encouraged the predominant use of dimensional stones. This necessitates continued quarrying activities that have little social-economic benefit to the communities living nearby. Quarrying activities have also lead to environmental degradation and hence flouting of sustainable development principles.

There was evidence of lack of information on key issues that a housing developer needs in making decision on what material they should use housing construction. This lead to decision making that is based not on facts but fallacies. Therefore:

- The current policies, laws and by-laws governing extraction, acquisition and utilization of natural stones do not enhance sustainability in housing.
- There exist viable alternatives to dimensional stones that can use in the housing industry to provide adequate housing that are not being utilized.
- The environmental and social economic cost of the present use of dimensional stone far out weights the benefits.

6.3 Recommendations; Framework for Sustainable Material Exploitation to realise Sustainable Housing

Solution must be found to house everyone adequately. Housing is a basic need. Resources available locally must be harnessed through affordable technology as a matter of priority, to meet the basic needs of the people. What is available in abundance must not be misused but planned for and managed to get the highest returns. All the resources that Juja area has must be sustainably used to meet the needs of the community. This should be done through proper planning and management of locally available resources and if the need be then outside assistance can be sourced. For example dimensional stones must not be misused to

build every shack and structure. Natural resources of this land must belong to the nation, why should a few individual earn such large profit at the expanse of the poor Kenyan. Should a house cost beyond what a man can work for? The needs of the people must be planned for, resource available managed within the principles of sustainable development to benefit of all. To achieve this, there is need for a paradigm shift at all levels of governance; this shift is possible only through appropriate education. Hence Juja location can be a model town for utilizing its' resources sustainably.

6.3.1 Legal Framework

Legal issues that encourage the use of natural stones in spite of environmental degradation, lack of adequate housing due to material costs, related issues should be dealt with by addressing first and foremost the basic needs of the people. Policies that consider the needs of the people should be formulated; putting the goals of adequate housing for all at all time using the resources the nation has optimally. These policies should target at, meeting the housing needs of everyone and sustaining the environment. Laws on the other hand should not curtail the avenues for people to meet their basic needs, but must be tailored to protect and not facilitate exploitation of the poor by the powerful.

NEMA and mining department should work hand in hand to facilitate effective decision making based on prevailing socio-economic and environmental conditions of every particular locality. Determination of geological information should be crucial in determining where it is most beneficial to quarry stones and produce other materials of construction. This is only possible through geological mapping, to identify: the extent of the rock formation, type of rock, the soils etc. so that informed decision can be made. The mining department should have details of every area or a prospective miner should pay for this ground exploration to determine the rock extent and the possible effects on land use in the area. This information must be available to NEMA before they approve of the EIA or EA reports, to determine whether the quarrying activities will be allowed to commences or continue.

The building laws, since not in line with the needs of the people, complete overhaul of existing building by-laws should be done. Current By-laws should be declared obsolete or should only apply to government and public buildings that are of national interest. They are irrelevant to the private and individual citizen and have managed to curtail innovation, creativity, investments by ordinary citizens towards provision of sustainable housing.

- All means of encouraging people to use the cheaply available local materials should be used.

- A stock of land based resource should be evaluated in terms of spatial allocations to various land uses. According to what the land is best suited for, the areas that can best be used for housing, infrastructure and other amenities should be evaluated and zoned for that devoid of colonial ideas.
- Valuable, natural resource like natural stone should be preserved for buildings of national importance that are likely to remain for hundreds of years
- Terms like semi- permanent materials should be declared obsolete as it implies in the current building code. For example, Option like timber is viable but rarely utilized. The local government would not approve of a timber designed house. Yet there is potential in utilizing this material for sustainable housing. Timber can be grown all over the country and would contribute to environmental welfare through a forestation, increase in soil fertility, increase in biodiversity habitats reduction of global warming etc. People should be allowed to use all locally available materials; through these research innovations will be encouraged.

6.3.2 Institutional Framework

From the research findings, there was evident of lack of capacity at the institutions that deal with housing therefore, need to make changes at both the national and "grassroots" levels is inevitable if solution have to be found.. Institutions should be created at the community level to allow the communities to tap optimally on the

existing locally available materials and human resource. This is only possible with development of true leadership. A leadership structure that has a abroad perspective and understanding of problem issues, yet can focus on all resources available to solve prevailing problems is needful. The formation of housing bodies at the local community levels; will ensure that the vision of the nation expressed in the housing policy is translated into to actions that will grantee a positive output at the place where need is felt. The issues below are suggested for consideration:-

The housing department must work at the grassroots level in providing adequate housing for all; - slum upgrading and a few projects that are currently going on are not enough. Let the central government officials be seen in the communities, giving valuable information, disseminating knowledge to the people, and creating an enabling environment for people to access adequate housing. This should be enhanced by involving all: knowledgeable persons within the community and elsewhere, with representation from the various groups within the communities and willing to contribute to shelter delivery. These people will have an integrated outlook towards housing; Issues of sustainability and the needs for housing the current community must be integrated to produce a healthy mix.

Talents, gifts, skills, education

Talents, gifts, skills, education should be tapped and utilized, to benefit the entire nation. The elderly people in this nation for example have traditional skills and

technology that can be tapped. These must not be looked down on upon but should be held in high regard and become a base for developing home grown solutions. On the other hand since many people are not able to get the professional help that they need, the local authority need to expand it personnel base to involve stakeholders, not just councilors but willing community members with no knowledge of the magnitude of the problems of housing, technical issues involved in providing housing and a commitment to change.

Research information must be translated in viable solution.

Innovative materials should be utilized to build prototypes with price tags, and all the information a builder may require so that they can have alternatives to choice from. Most of the research done is in form of a few building blocks or paperwork. This does not have credibility, no-one will adopt an idea that has not be tried out elsewhere- they need to see, touch and understand the cost implication etc..

Research funding must include proto type buildings this may necessitate a **national build centre** that can demonstrate all the potential of all the locally available materials, especially those that have been demonstrated to be viable, on a credible scale.

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Appendix A.1
Questionnaire for the general public (developers)

KENYATTA UNIVERSITY
DEPARTMENT OF ENVIRONMENTAL PLANNING AND MANAGEMENT AND COMMUNITY DEVELOPMENT

MASTER OF ENVIRONMENTAL PLANNING AND MANAGEMENT

RESEARCH PROJECT
EVALUATING THE EXPLOITATION OF WALLING MATERIALS FOR SUSTAINABLE HOUSING

Declaration: The information and data obtained from you is intended for academic work

General information
(Tick where appropriate)
Q1Gender
1) Male [ ] 2) female[ ]

Q2 Ages
1) 18 30 [ ] 2) 30-40 [ ] 3) 40 -55 [ ] 4) 55-and above[

Q3. Highest education attained (tick where appropriate)
1) Primary [ ] 2) Secondary [ ] , 3) college [ ] 4) university [ ]
Q4. Type of building
1). Rental [ ] 2).Owner occupied [ ]

Material choices
Q5 In construction of your house what materials have you used
1) Natural stones [ ] 2) concrete [ ] 3) Timber [ ] 4) Stabilized earth [ ] 5) Burnt clay bricks [ ] 6) mud/rammed earth [ ]
7) Iron sheets[ ]

Q7.why would you or why did you choose this material and not the others?
Indicate in order of preference 1 being the most preferred to 8 the least preferred

1. Affordability ----------
2. Maintenance ----------
3. Durability ----------
4. Aesthetics(looks good) ----------

5. It is the requirement of the law ----------
6. I was advised by professionals ----------
7. I do not know ----------
8. Everyone is using it ----------
9. availability ----------

Q8 Did you /would you consider other alternatives?

1) Yes [ ] 2) No[ ]

Q9. And if Yes, which ones?----------

Q10. What materials do you wish/ /would you have wished to use for walling, indicate in order of preference 1 being the most preferred to 7 the least preferred

Natural stones --------
Concrete --------
Timber -------
Stabilized earth --------
Burnt clay bricks ---------
Mud ---------
Iron sheets --------

Q11 Using natural stones as the main building material, do you think it is possible to house everybody adequately n Kenya?

1) Yes [ ] 2) No [ ]

Q12. What material do you think can be used if everyone was to be adequately housed?----------
---

Q13. Various organizations have done research into alternative materials that have been shown to be more appropriate and sustainable in providing housing for all in Kenya. Are you aware of any of these alternative materials? And if Yes which one

1) Yes [ ] 2) No [ ]

Professional input

Q14. Did you /would you consult a professional on which materials to use?

1) Yes [ ] 2) [ ]

Q15. Did he/ she advice you on material to use, which ones and why? ----------
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Appendix A 2
Questionnaire for the materials producers/suppliers

KENYATTA UNIVERSITY
DEPARTMENT OF ENVIRONMENTAL PLANNING AND MANAGEMENT AND COMMUNITY DEVELOPMENT

MASTER OF ENVIRONMENTAL PLANNING AND MANAGEMENT

RESEARCH PROJECT

EVALUATING THE EXPLOITATION OF WALLING MATERIALS FOR SUSTAINABLE HOUSING

Declaration: The information and data obtained from you is intended for academic work

Background information
(Tick where applicable)

Q1 Name of the person/ company

Q2 Nature of company
1) Small enterprise [ ] 2) Jua kali [ ] 3).Large Corporation[ ]

Q3 what material production activity are they involved in?
1) supply of raw products [ ] 2) process of raw materials [ ] 3)Importer[ ]

Q4 Number of years they have been in involved in this activity

Q5 Nature of materials produced
1) Natural stone products [ ] 2) Soil based products [ ]
3) Timber products [ ]
4) Synthetic materials [ ] 5) Waste based products [ ]
6) Ceramics products [ ] 7) Composites [ ]

Q6 Who are your customers?
1) Individuals, [ ] 2) private companies, [ ] 3) public institutions [ ]

Q7 Where do you customers come from?

1) Within Nairobi, [ ] 2)All over the country [ ]

Environmental effects

Q 8Where do you get your raw materials?

1) Within the locality [ ] 2) Within short haul distance [ ]
3) Within the country [ ] 4) Imported products [ ]

Q9. What is the source of energy used in production?

1) Petroleum products [ ] 2) Electricity [ ] 3) Biomass [ ]
4) Man power [ ]

Q10. Do you use any water in you production and if yes how much?

Yes [ ] No [ ] ----------

Q11. Is there waste water generated and if yes, is it treated before disposal to receiving streams?

Yes [ ] No [ ] ----------

Q12 Does the production process produce any other waste materials? If yes which ones?

Yes [ ] No [ ]

Q13 How is the waste product disposes of?----------

Q14.Is there any of the following generated during the production?

1) Noise, [ ] 2) Smoke [ ] 3) Dust [ ] 4) smell [ ]

Q15. What are some of the mitigation process that they have in place?

----------Q16. What is the mode of transportation of raw materials?

1) Trucks and Lorries [ ] , 2) hand carts, [ ] 3) rail transport
[ ] 4)N/A [ ]

Q17what is the mode of transportation of the finished products

1) Trucks and Lorries [ ] , 2) hand carts, [ ] 3) rail transport
[ ] 4)N/A [ ]

Q18.What environmental management system are they utilizing in there production any ISO methods adopted and which one

Sustainability of production

Q19 How much do you produced per day/ per week/per month

---------Q20 How much is the demand

---------Q21 Are you able to meet the demand?

Social economic benefits

Q22 Number of employees and their nature of work and employment

Cadre	**Permanent**	**non permanent**	**Wages/salary**		**remarks**
			per day	**per month**	
Professionals					
Cashiers/clerks					
Machine operator					
supervisors					
Watchmen					
Casual labourers					

Q23 What is the unit sale price for your product?

Calculate cost per square metre

Q24 How much fees do you pay for the license per month per year

- To who local government
- To the central government

Q25.Any community services offered to the community around them

Yes [ ] No [ ]

And which one

Problems and challenges

Q26 what problems experience

- With production
- Sales
- Others

Q28 what is your opinion regarding your products for housing in relation to:

1) Affordability----------

---

2) Sustainability (future generation to house themselves)?

Q29 What - can be done to make production of materials sustainable for housing production?----------

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Appendix A.3

Interview guide for the local government authority

KENYATTA UNIVERSITY
DEPARTMENT OF ENVIRONMENTAL PLANNING AND MANAGEMENT AND COMMUNITY DEVELOPMENT

MASTER OF ENVIRONMENTAL PLANNING AND MANAGEMENT

RESEARCH PROJECT
EVALUATING THE EXPLOITATION OF WALLING MATERIALS FOR SUSTAINABLE HOUSING

Declaration: The information and data obtained from you is intended for academic work

Background information

Q1 Name of the local authority----------

Q2 who was the respondent? ----------

Information on quarries

Q3. How many quarries have you licensed to operate in you area of authority,

Q 4 How many of these are

1) Manual operated----------
2) Use explosives, ----------
3) Use machines-for cutting stone----------

Q5. What are the requirements to operate a quarry?----------

Q 6 What are the charges in Kenya shillings for the license on each per month / year? For the following type of quarries

1. Manual operated
2. Use explosives,

3. Use machines for cutting stones

Q 7 Are there any other levies drawn from the quarries operating in your area? And if yes, which ones and how much?

Q 8.Are there any laws regarding conservation and control on natural materials exploitation for building exist within your by-laws that have any bearing on quarrying and if yes which ones?

1. private land ----------

Appendix A4

Interview guide for government ministries
Ministry of housing

Materials of construction and choices

Q1) The government has a strategy of creating an enabling environment for providing
Housing. In the issues of cheap and low cost alternatives what are these alternatives

Q2) How is the ministry going to encourage the use of alternative materials?

Q3) Why is that that Kenya housing sector seems to be relying on natural stones and its
products for what seems to be the acceptable housing material

Q4), what is your perception on alternative materials quality

1)Raw earth----------

---

2) Stabilized earth----------

---

3) Clay bricks ----------

---

4) Timber----------

Sustainability of material exploitation and the way forward

Q5, There has been an over reliance on natural stone for housing construction, Why
And how sustainable is the current exploitation of natural stone? ----------
---

Q6, Various organizations have done research into alternative materials that have been shown to be more appropriate and sustainable in providing housing for all in Kenya yet they are not embraced by the public.
What do you think can be done to promote the use of these materials?

Appendix A.5

For the ministry of environment and natural resources development

National environmental management authority

Name of the respondent/ office

Date

Q1, There seems to be an over reliance on quarrying of natural stone for construction industry .how is this affecting the environment. ----------
---
- ---

Q2. There is apparent environmental degradation due to stone quarrying, yet this activity has continued without much change. What is you stand on this.

Q3. Sustainability in use of natural resources is a global principle. What is being done on the issue of our resource and especially the natural stone?

Q4) Quarries apparently create a lot of wealth for the operators and especially the big companies, yet why aren't they classified mining minerals? ----------
---
----------Q5 Do you have geological maps for Nairobi and it its surrounding areas

1) Yes [ ] 2) No [ ]

Q6 Do you have the current land use plan for –Nairobi and the surrounding areas and if No why not

1) Yes [ ] 2) No [ ]

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