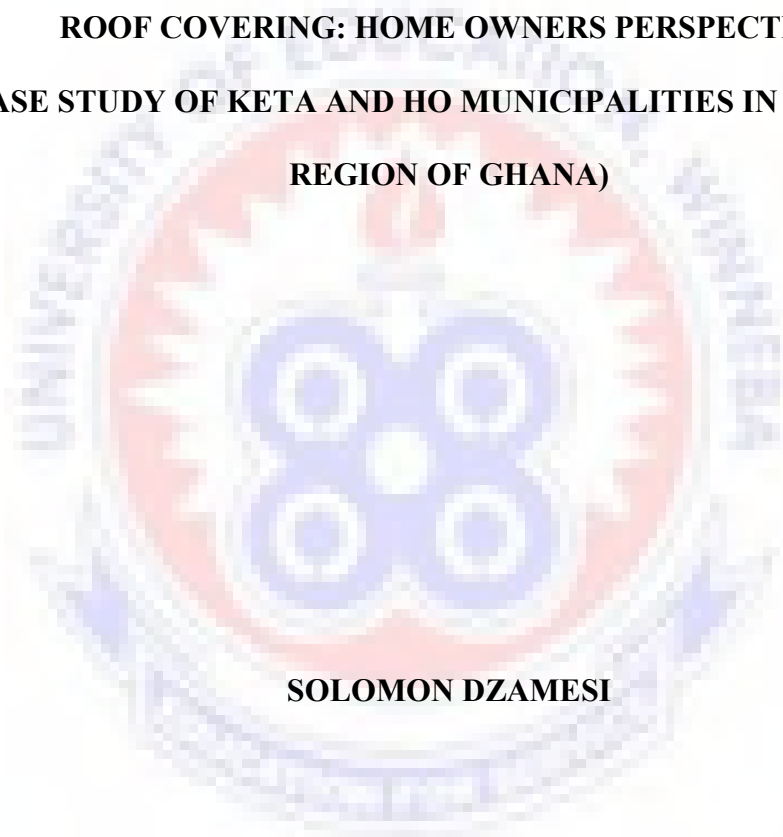


UNIVERSITY OF EDUCATION, WINNEBA

**INVESTIGATING FACTORS AFFECTING MATERIALS SELECTION FOR
ROOF COVERING: HOME OWNERS PERSPECTIVE
(A CASE STUDY OF KETA AND HO MUNICIPALITIES IN THE VOLTA
REGION OF GHANA)**



SOLOMON DZAMESI

2018



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**A Thesis in the Department of Construction Technology, Faculty of Construction
and Wood Technology, submitted to the School of Graduate Studies, University
of Education, Winneba in partial fulfilment of the requirements for award of the
Master of Philosophy (Construction Technology) degree.**

SEPTEMBER, 2018

DECLARATION

STUDENT'S DECLARATION

I DZAMESI SOLOMON, declare that this Thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole for another degree elsewhere.

SIGNATURE.....

DATE.....

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Thesis as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: **DR. NONGIBA A. KHENI**

SIGNATURE.....

DATE.....

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DEDICATION

I dedicate this thesis to my mentor, my dear father in the lord senior Prophet T. B. Joshua the founder and the general oversea of the Synagogue Church all Nation who nurtured in me the unwavering interest in the value of education, who provided the support and encouragement that, enabled me to complete my Master of Philosopher In Construction Technology.

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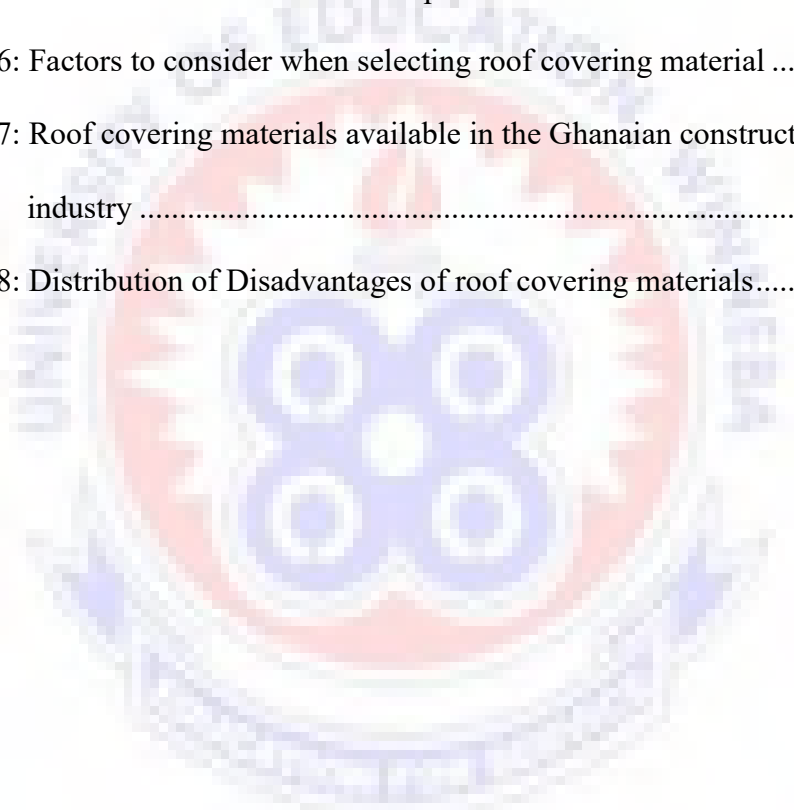
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LIST OF ABBREVIATIONS

RII	Relative Importance Index
UNEP	United Nation Environment Programme
UNESCO	United Nation Educational Scientific and Cultural Organization
LCCA	Life Cycle Cost Analysis
DCLG	Department for Communities and Local Government
MCDM	Multi Criteria Decision Making
AHP	Analytic Hierarchy Process
TOPSIS	Technique of Ranking Preferences by Similarity to the Ideal Solution
ELECTRE	Elimination and Choice Expressing the Reality
SMART	Simple Multy-Attribute Rating Technique
KDSMS	Knowledge-Based Decision Support System for Roofing Material Selection and Cost Estimate
SPSS	Statistical Package for Social Sciences

ABSTRACT

The construction industry plays an imperative role in boosting the economy and fostering infrastructural development in Ghana. Currently, there are several houses with leaking roofs, some are discoloured while some have totally lost their aesthetic value just few months after their construction. This study aimed at understand the decision making process in selection of roof covering material by home owners. One major challenge of this research work is finding relevant research papers and journals to help carry out the study. This research primarily reviewed the literary works of others concerning the subject. After the review of literature, questionnaires were designed to seek the opinions of home owners concerning the subject. The data collected was analysed using Descriptive Statistics and Analysis, Relative Importance Index (RII) and Content Analysis method. From the analysis, it was discovered that certain critical factors needs to be considered before making the final decision on the type of roof covering to used. Quality was ranked highest with uttermost importance in roof material selection. It was discovered that, there are several roof covering materials available to prospective home owners to choose from. It was observed that materials with low cost of maintenance were preferred choices by home owners. It is trusted that the recommendations from this research would be put to practice to help prospective home owners choose a lasting roof covering material. Home owners should always consult expert for good technical advice in the choice of roof covering materials. The wide variety of roofing materials available in the market affords home owners to make informed decision regarding material selection. Prospective home owners should be guided by cost implications of new roof covering materials. Keywords: Construction industry, prospective home owners, roof covering material.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

A roof is the uppermost part of a building whose main function is to enclose the space and to protect the same from the effects of weather elements such as rain, wind, sun and heat. A good roof is just as essential as a safe foundation. As a well-designed foundation secures the building against destruction starting at the bottom, similarly a good roof affords protection for the building itself and what the building contains and prevents deterioration starting from the top. To fulfil this main function efficiently, the roof should satisfy the following functional requirements such as, Durability, Resistance to moisture, Thermal insulation and Safety in fire in its design and construction. Roofing materials are exposed to the elements of weather namely; wind, sunlight, rain, hail, atmospheric pollution, and temperature variations as well as consequently degrade over time.

Different types of materials and technologies are available for building design and construction while new materials and advanced technologies are continuously being introduced into the market (Wong and Li, 2008). The selection of materials is a complex procedure and it is difficult to match materials based on design requirements (Ashby, Brechet, Cebon, and Salvo, 2004). Materials are generally selected from the existing catalogues of materials and traditionally experts apply trial and error methods or use experiences to choose new materials or materials having better performance (Shanian and Savadogo, 2006). It is acknowledged that the selection of appropriate materials may reduce the energy consumption and maintenance cost of buildings (Papadopoulos and Giama, 2007). As buildings are responsible for significant impact on the

environment, eco-friendly materials are becoming popular for housing construction (Hymers, 2006).

Moreover, there is an increasing demand for sustainable and energy- efficient construction (UNEP, 2001) and the use of environmental friendly materials (Chan and Tong, 2007; Roaf, Fuentes, and Thomas, 2007). Evidences from literature suggest that building owners and clients tend to emphasis the initial cost rather than operating cost (Wilson et al., 1998). Professionals need to consider several factors in order to select optimum materials to meet clients' requirements. In order to solve this problem of material selection in a way that meets design and clients' requirements and results in sustainable construction, it is required to analyse a multitude of criteria (Perera, Odeyinka, and Bi, 2009a, 2009b). Different approaches regarding materials selection have been devised for different purposes. For instance, knowledge-based or expert systems have been developed to select materials for different purposes.

Furthermore, new materials and advanced building technology are continuously introduced into the market (Soronis 2002, Wong and Li 2008). The array of techniques and materials available is cunning and it often requires some specialized skills from design and construction teams (Smith & Jaggar 2007). It consumes enormous effort, time and resources to choose materials from the array of possibilities according to the requirements. Thus the professionals in the construction sector as well as home owners usually select the same old technology and materials as well as they use their experiences from previous projects for this purpose. The mere focus on initial costs of materials and technology no longer fulfils modern day needs of the construction development. They need to consider several factors such as economic, aesthetic,

environmental, durability, quality and life span. The impact of selecting right materials can affect the durability, functions and quality of the product because it contributes to the safety and health of the end-users (Chan and Tong, 2007). The designers need the appropriate information to compare materials with the requirements (van Kesteren, 2008) and they have to find all information from different sources. The clients want the overall cost of the construction (Mohamed and Celik, 1998) and their houses according to their requirements and within the budget. Moreover, they demand high quality building with life time cost effectiveness (Schade, 2007). Material type has significant impact on the cost of a building (Malin 2000; Mohamed & Elik 2002). Moreover, the selection of appropriate materials may reduce maintenance cost. It is a complex procedure to select the suitable materials (Mahmoud *et al.* 1996) and it takes time and effort for home owners and professionals in the construction sector to select the appropriate materials according to the desired needs.

1.2 Problem Statement

There is a knowledge gap in the selection of requirements or criteria ranging from initial costs and durability to zero carbon footprints and sustainability and cost estimation. In order to fill this gap, it requires the ability to simultaneously evaluate multiple criteria in the optimization of materials selection for building. Based on the facts stated above, this research work seeks to investigate factors that influence material selection for roof covering in the Ghanaian construction industry with focus on home owners. Roof covering material is a very important component of a building. This is partly because it protects several other components of the building and its occupants against the vagaries of the weather. The continual action of elements of the weather against roof covering material is severe, due to this, it is very paramount to consider certain factors in order to make informed choice when selecting roof covering material.

1.3 Aim and Objectives

1.3.1 Aim

The aim of this study is to understand the decision making process in selection of roof covering material by home owners.

1.3.2 Objectives

Helping to successfully achieve the aim stated above are the following specific objectives:

1. To identify critical factors that determine the choice of material for roof covering by home owners.
2. To examine materials available for roof covering in the Ghanaian construction industry.
3. To investigate the strength and weaknesses of materials available for roof covering.
4. To develop criteria to assist prospective home owners in the choice and selection of roof covering materials.

1.4 Scope of Study

The scope of this study is limited to existing home owners experience in the choice and selection of roof covering materials. This will be examine in two areas namely Ho municipality and Keta municipality respectively. Ho and Keta municipality have lot in common i.e. they are both municipal capital, they have old existing buildings with beautiful roof designs same of which are nonfunctional, old and dilapidated. The study shall concentrate on both new and existing roof structures within these municipalities. These two municipalities are enjoying rapid infrastructure growth due to their elevation to municipal statues in 2012.

1.5 Methodology

The study was carried out by first of all critically reviewing existing literature relating to factors influencing material selection for roof covering in the construction industry; Home owners' perspective. It is important to be abreast with the field being studied. As such, reviewing preceding studies would aid in the identification of the previous works done, contributions made, reproaches, shortcomings, existing outcomes and their applications. The literature review ushered the study to the on-field collection of data through the distribution and retrieval of inquisitive questionnaires, which revolved around the above-mentioned aim and objectives of the study. Both quantitative and qualitative strategies would be used in the process of data collection. The qualitative in particular would be of utmost importance to the study due to the fact that causes and motives of phenomenon are pinpointed by the use of open-ended questions; interviews. A quantitative strategy would also be used in this research owing to the fact that quantitative research follows a deductive approach which involves design measurement and sampling (Kothari, 2009).

Below are the methods that would be used to achieve the research objectives.

To identify critical factors that determine the choice of material for roof covering by home owners. Literature relating to critical factors that determine the choice of material for roof covering were extensively reviewed. This was done with the help of conference papers, academic journals, newsletters as well as other sources. Questionnaires were also administered to collect information from existing home owners to help identify critical factors that determine the choice of material for roof covering. In order to examine materials available for roof covering in the Ghanaian construction industry, a review of related literature from journals and conference proceedings together with interview

were used to achieve this objective. The interview targeted professionals in the construction industry with a lot experience as well as home owners. This was to ensure the accuracy and quality of the data collected.

Investigate the strength and weaknesses of materials available for roof covering, questioners Interview were used to solicited information regarding available roof covers. To understand the decision making processes in selection roof covering materials by home owners. Based on the extensive review of related literature, questionnaire administrated and interviews conducted, this research would help prospective home owners to understand factors influencing choice and selection of roof covering materials.

1.6 Significance of the Study

This research work examined materials available for roof covering in the Ghanaian construction industry. This would help prospective home owners to know the range of roof covering materials to choose from. Additionally, this study examined the strengths and weakness of roof covering materials available in the construction industry. Moreover, this research proposed factors that influence choice and selection of fit for purpose roof covering materials.

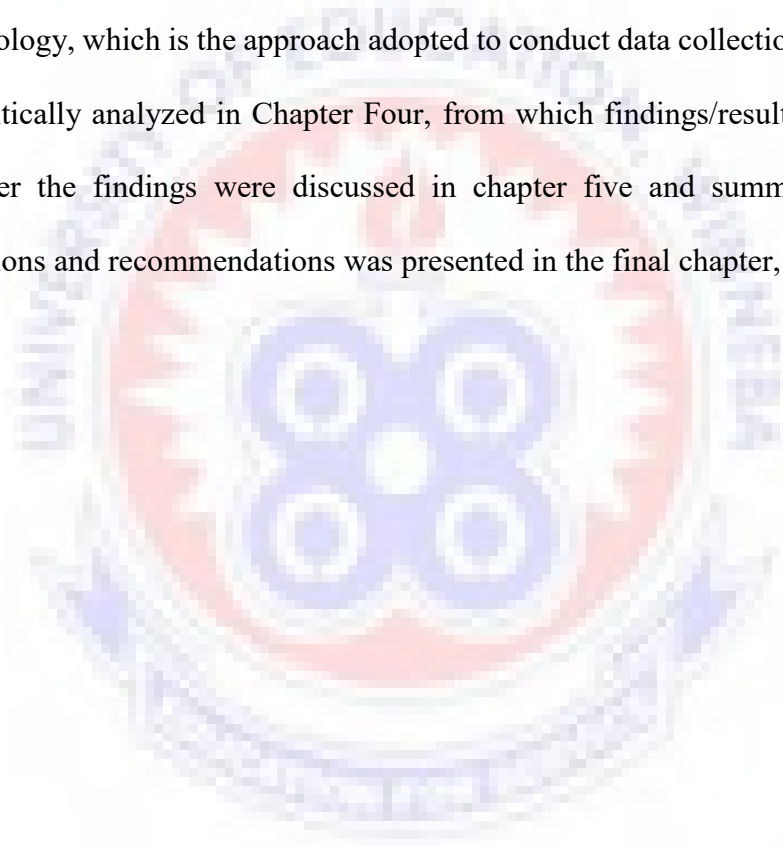
Finally the findings fit for this purpose would enable professionals in the construction industry to select roof covering material that are location appropriate with less effort.

1.7 Limitation

One major challenge of this research work is finding relevant research papers and journals to help carry out the study.

1.8 Structure of Study

The study is sequentially divided into six main chapters, as outlined in the following fashion. The first chapter, titled Chapter One, entails the Introduction, which includes the Background to the Study, Problem Statement, Research Aim and Objectives, Research Questions, Methodology, Significance of the study, Limitation and The Structure of the Study. Chapter Two shows findings from some relevant precedent research projects, the Literature Review. Chapter Three deals with the Research Methodology, which is the approach adopted to conduct data collection. Collected data were critically analyzed in Chapter Four, from which findings/results was presented. Moreover the findings were discussed in chapter five and summary of findings, conclusions and recommendations was presented in the final chapter, Chapter six.



CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter tries to elucidate the main subjects of this research work. This part discusses the important issue concerning the topic and throws more light on each single salient point. The main subjects to be discussed are;

- Overview Of The Construction Industry Of Ghana
- Functional Requirements Of Roof Material
- Factors That Determine The Choice Of Material For Roof Covering By Home Owner
- Materials Available For Roof Covering In The Ghanaian Construction Industry
- Characteristics Of Materials Available For Roof Covering
- Criteria For Selecting Material For Roof Covering

2.2 Overview of the Construction Industry of Ghana

As part of the public sectors contributing enormously to the Ghanaian economy development, the construction industry of Ghana forms a quota. This is similar in other parts of the world. This is because construction cuts across all sectors of the Ghanaian economy thus, construction activities are visibly undertaken everywhere. Construction works in Ghana together with agriculture, manufacturing and mining are the major income booster to the economy (UNESCO, 2006). It is worthy to mention that proactive construction industry overly contributes positively to enhance the labour industry in Ghana and elsewhere as more skilled and unskilled workers are employed, from engineers and consultants to artisans and laborers (UNESCO, 2006).

As compared to other construction industries, the Ghanaian sector has come of age but with few challenges. Most often, the challenges culminating the sector are well highlighted on the roads and housing sectors of the industry (Ofori, 1993). For example, the elastic nature of the housing sector makes the demand for housing which outwits or exceeds supply (UNESCO, 2006). Contrarily, Ghana's construction industry could boost of its synergistic viability buttress with innovative human resources. These should be identified and used as the basis for improving the performance of the industry (Ofori, 2012). Finally, the industry faces some major restrictions including the impact of globalization; increased privatization; opportunities offered, and challenges posed, by the growth of information and communications technology; and development in knowledge (Ofori, 2012).

2.3 Functional Requirements of Roof Material

According to Soronis (1992), roof covering materials should be able to perform the following functions:

Durability

The durability of the roof material lies heavily on its ability to withstand atmospheric pollution, frost and other harmful conditions. The more the degree of exposure, the higher and more durable the form of construction used. The roof material is usually subjected to temperature changes leading to its subsequent contraction and expansion, which must be allowed for. For buildings closer to industrial activities, they are affected by acidic rainwater. The solution to the problems of rainwater will bother so much on achieving effective flushing off of water which is possible with the use of sloping roof. An important consideration here is that the materials used in fixing the covering should have a comparable quality with the covering material.

Resistance to Moisture

The roof's main function is to protect the building from the weather. The roof covering material has to resist the effects of the sun, wind, snow and rain. The sun causes the expansion of the outer covering of the roof, the wind as previously analyzed exerts suction pressure tending to pull the covering from its support. Rain tends to penetrate and soak the fibers of the roof covering materials, and in the temperate regions, the effect of snow piles on the roof adds to the dead load and will easily find its way into the roof structure through any weak spot on the roof covering. The effect of water penetration into the roof has its disastrous consequences. To provide a roof able to satisfy the moisture resistance requirement, the following are recommended:

Flat roofs should be damp proofed with continuous sheets of felt to prevent water penetration. Sloping roof should have series of overlapping of the materials which are also impervious.

Keeping out water from the roof is not enough measure against water penetration. The water that falls out of the roof has to go somewhere. One of the functions of the roof is to ensure that water is collected and disposed of without affecting the rest of the building, therefore, gutters and down pipes are needed.

Thermal Insulation

The roof covering should be able to keep the heat in and not permit excessive heat loss. The roof is the most exposed part of the building, therefore, heat flow through the roof is a point to be considered in determining the heat loss from the building.

Heat is transferred through a number of methods:

- Through conduction as it flows through the material from the hotter to the cooler side (external walls).

- Through convection as air circulates around the surface. E.g. a cool wind blowing across the surface of the heated roof covering material will increase the loss of heat from the roof material.
- Heat can be gained by the roof covering material through radiation. In this case, heat from the sun will be absorbed by dark colored surface covering and be reflected by light colored materials.

Safety in Fire

The roof covering material may be attacked by fire either from the outside or the inside of the building. Fire from the inside will attack the framework, and from the outside, it attacks the covering. The roof covering should be of material that cannot easily catch fire or spread the fire across. On the other hand, the roof structure should have sufficient fire resistance to enable people escape the building before collapse of the roof.

2.4 Factors that Determines the Choice of Material for Roof Covering by Home

Owner

According to Radziszewska-Zielina (2014) Roofing is an important element in construction of roof. It is also one of the essential element of whole building. The choice of roofing should depend on technical parameters that affect the quality of the materials used and the price. The following are some of the factors to be considered when selecting material for roof covering

Price

Roofing price, in many cases, is crucial for its selection. Due to the fact that the roof covering is the part of the building which is the most vulnerable to the weather factors, one is not supposed to save money on the purchase of materials necessary for its

construction, in particular the roof covering. Buying cheap roof covering exposes one to the fact that one will soon be forced to bear the costs associated with the maintenance, repair and finally with its replacement.

Assembling

Deciding on a particular type of roofing material, we need to pay attention to both the cost of the roof and the time needed to accomplish this task. Some roofing, such as shingle or tiles (especially plain tiles) require considerable expenditure of time and special skills, which is why the overall cost of roofing tasks, including roof construction, increases significantly. In the case of covering the roof using ceramic tiles, a lot of time is absorbed by trimming the tiles and installation of finishes, especially when we are dealing with a very complicated roof (e.g. dormer windows, eyebrow windows). Depending on the roofing type, laths are placed and/or the roof surface is laid with wooden boards. Generally, a variety of insulating materials (bitumen sheet, insulating foil) are used, which affects the time of roof construction and, of course, the cost.

Maintenance

This term includes: painting, washing, impregnation, moss and rust removal. Moreover, what is taken into account is expenditure on possible replacement of damaged single roofing components, such as roof tiles or shingles.

Weight

Heavy roofing requires an adequately thick roof truss and proper construction, but has the advantage of greater stability on the roof slope and better resistance to the action of

wind, which in recent years, considering frequent hurricanes, has been of great importance.

Durability

Different types of roofing materials have different periods of durability. Roofing with short durability generally has a low price but the effect is that, after several decades, it has to be replaced, and this often involves the replacement of the whole wooden structure. The roofing which is fixed to the frame by means of nails or screws, corrodes or rots at fixing points, which reduces its strength.

Acoustics

Acoustics affects the comfort of living. Roofing materials with appropriate acoustics have the advantage of reducing the noise caused by rainfall and strong winds. As a result of expansion in periods of high or low temperature, certain types of roof covering produce characteristic sounds, such as cracking.

Finish

Finishing tasks include: rooftop finish, soffit and roofing detail installation, installation of roof windows, gutters, chimney flashing. The number and kind of finish depends on whether the roof is complex and varied or simple. In the case of the former, the cost of finish and its installation is significant.

Leak-Tightness

Leak-tightness is a basic feature, important for living comfort and durability because it prevents moisture in the roof truss. The higher the leak-tightness of the roofing, the

greater the confidence that individual elements will not become detached during strong wind, which could lead to the destruction of the entire roof.

Ventilation

Leak-tightness should interact with ventilation. Good ventilation of the roof allows for avoiding and minimizing the need for roof renovation. Water vapour must be transferred away from the roof as it poses a threat to the roof structure through the development of mold and mildew. Ventilation ensures proper air circulation.

Aesthetics

This is also an important issue, which has to be kept in mind when choosing a roofing material. A nice, aesthetic, attractive roof determines the owner's satisfaction and is eye-catching for passers-by. This is possible in so far as it is made of good, reputable, durable material, in a suitable, carefully selected colour and harmonizing with the environment in which it is located. In modern times, when the market offers a large selection of kinds, types and sorts of roofing, it is the owner's sense of aesthetics and beauty as well as their financial resources that determines what material will be used to cover the roof of their house.

Guarantee

Like any product on the market, roofing products have their warranty periods, during which one can submit complaints about the product.

Additionally, the focus in construction is on minimising the initial building cost. It has, however, since the 1930s become obvious that it is unfavourable to base the choice between material alternatives solely on the initial cost alone (Kishk *et al.*, 2003). An

inefficient building imposes a cost penalty on the owner throughout its lifetime. While the owner has an incentive to minimise whole life costs, the contractors and consultants do not, as they have no long-term interest in the building and are not accountable for performance in use (Sorrell, 2003). Increasingly, public sector guidance on construction procurement and best practice literature is emphasizing the importance of whole life costs (Her Majesty's Treasury, 2000c; Sorrell, 2003). The conventional material assessment methodology employs life cycle cost analysis (LCCA) as the main tool in the decision-making process, particularly in the public sector (Perkins, 1994; van Pelt, 1994; Durairaj *et al.*, 2002). Life Cycle Costing is an economic evaluation technique that concerns the assessment of the total cost of an asset over its operating life, including initial capital costs, maintenance costs, operating costs and the cost or benefit of the eventual disposal of the asset at the end of its life (Utne, 2009). Life Cycle Costing is a decision-making tool that could be used to select among alternative building materials (Arpke & Strong, 2006).

Literature on LCCA and environmental protection indicates that using a single objective in the evaluation process is insufficient when taking environmental issues into account (Spash, 1997; Glucha and Baumann, 2004; Thabrew *et al.*, 2009). The environment's complexity means its relationship with human activities remains largely unknown (van de Burgh, 1996; Harding, 1998; Garrette, 2006; Parker *et al.* 2008). Research on non-monetary techniques has been undertaken to search for alternative methods so that environmental values can be identified and evaluated in a proper manner. One such method is multi-criteria analysis which uses a weighted score approach to evaluate environmental issues. Completely replacing a monetary market approach with non-monetary techniques has limitations; however both methods are

regarded as complementary tools by many researchers (Gregory *et al.*, 1993; van Pelt, 1993; Powell, 1996; Joubert *et al.*, 1997; Mirasgedis and Diakoulaki, 1997; RICS, 2001).

2.5 Materials Available For Roof Covering in the Ghanaian Construction

Industry

Ceramic Tile

Radziszewska-Zielina (2014) on the list of parameters of the following, selected kinds of roofing: wooden shingle, asphalt shingle, galvanized steel, metal sheet with topping, ceramic tile, the highest rating was awarded to the ceramic tile. Already hundreds of years ago tiles were made for roofing, but they were used very rarely, mostly for the roofs of castles, palaces and places of worship. Ceramic tile was a high-class product and there were not many who could afford it. For many years people have searched for roofing material that could be used to replace ceramic tile, but so far nothing similar has been invented. The only product that in the evaluation of roofing materials ranks higher than ceramic tile is stone slate, but due to its high price it is available for few customers. Although high, the price of tile reflects its high quality. The product has high technical parameters, it is resistant to atmospheric effects such as rain and temperature and it is nonflammable. It has a porous structure which makes it highly vapour-permeable (a breathable roof), which results in a good microclimate inside the building. Thanks to the ability of large heat accumulation, the outdoor temperature is not transmitted to the interior of the building. Tile takes a very long time to heat up and cool down so that the temperature difference between day and night, summer and winter is perfectly balanced. An additional positive feature is the high sound insulation that provides users with a quiet interior when it is raining.

The raw material used to produce tile is clay so one can call it an ecological product. Roof tiles are coated with precious clays or glazed ensuring proper protective coating and colour, which ensures durability so that the tile is maintenance-free throughout its period of use. It is heavy and therefore requires a sufficiently strong truss, but its weight has the advantage that the storms and gusty winds will not destroy such roofing as detaching these tiles is very difficult. If one decides to purchase tiles for their roof, it must be remembered that the price of the tile is less than half the cost of other materials needed to cover the roof because the following elements also have considerable prices: groove tiles, decorative ridge tiles, edge tiles, plain ridge tiles, vents, accessories protecting against snow and aiding mobility on the roof, as well as clips, clamps, brackets, bands and seals.

The durability of this roofing type is estimated at 80 years, and the guarantee is granted for a period of 30 years. Such a long warranty period demonstrates the value and reliability of this product, because no one gives such a long warranty on poor-quality products. Compared with bituminous roofing or sheet metal, tiles slightly absorb rain, which increases their weight. During their installation, tiles do not become perforated, unlike wooden shingles or sheet metal, which also improves their durability. Due to the wide range of ceramic tile products (interlocking tiles, fish scale tile, Marseille tile, pantiles, mission style tile), one can use them to cover even the most complex roofs. In Poland, more and more buildings are covered with tiles, which undoubtedly affect the continuing trend to build multi-faceted slopes and overly complex roof shapes. It can be said that the use of tiles not only provides good conditions for draining precipitation, but also ensures that the building will look aesthetically pleasing and stylish from the distance because this is the greatest of the many advantages of tiles, which in this respect are among the most popular roofing materials.

Sheet Metal with Topping

Radziszewska-Zielina (2014) in the above comparison, sheet metal with topping received the second place. It is a steel sheet covered with natural mineral topping, protected with acrylic resin mixed with fungicides. The topping protects the metal against mechanical damage as well as moss and algae; it also revives its colour. Toppings also have the advantage of suppressing noise caused by rain in a much better degree than e.g. galvanized sheet. Its design imitates tiles or shingles. It is produced in a wide range of designs. Furthermore, it does not require the use of a thick truss because it is lightweight. The unique installation system of this roofing type makes it exceptional. This sheet is very strong, and galvanized coatings protect it from harmful factors in any environment. The unique installation system, minimal waste, low weight, high quality and durability allow for its use without restrictions. Undoubtedly, the drawback is that, like any sheet metal, this roofing requires insulation in order to protect the building from excessive heat loss.

Sheet metal with topping is used much less frequently than ceramic tile because its price, the price of roof finishes and the high cost of its installation do not make this roofing type a good alternative to ceramic tile.

Wooden Shingle

Radziszewska-Zielina (2014). Wooden shingle coatings are characterized by high durability. They are always in perfect harmony with the environment. They meet high aesthetic requirements. In comparison with e.g. sheet metal and galvanized shingle, they are more resistant to hail, storms, and better than the other roofing types in protecting the building from the heat of sun. Frost does not affect wooden shingles in any way. They are the most environmentally friendly of the listed examples of roofing.

If these shingles are cleaved, their manufacture is very time-consuming, which is obviously a large drawback, and which makes their price is very high, but they may have different widths and lengths, and can therefore be adapted to the various requirements of investors. In contrast to the colored sheet metal or bituminous shingle, wooden shingle is ideal for covering old wooden buildings in the process of their renovation. It looks very good on new buildings with soaring roofs, both wooden and brick or stone ones.

The drawback of wooden shingles is that the new material may have been affected by fungi, mold or insects before its installation and then it quickly begins to deteriorate, which is not found in other types of roofing. Moreover, mosses and algae appear very often in shaded places after a few years if maintenance is inadequate. Another disadvantage of wooden shingle is that, in contrast e.g. to sheet metal, it is not suitable for flat roofs, as then water has a small slope and flows down slowly, which in turn produces moisture and, consequently, affects durability. In the case of a flat roof, it also requires good ventilation. When we are dealing with a low slope roof, this roofing has to be tripled; and when the slope is greater, the roofing has to be doubled. Undoubtedly, this fact affects the price of the roof because more shingles are needed and their installation lasts much longer, which also adversely affects the overall cost of roofing. Covering the roof with wooden shingle takes the longest of all roofing types and is very labour-intensive. The biggest disadvantage of wooden shingles, which often disqualifies it as compared to other roofing types, is the fact that it is flammable, and fire protection is an additional cost which raises the price of the roof. What is also troublesome is the need to impregnate this roof every few years, but it must be performed so that the shingle lasts 50 years or longer. The warranty is provided by the

manufacturer usually for 20 years. Wooden shingle roofs have, however, the advantage that, when being installed, in principle do not require any type of finish: grooves, corners or ridges, since they are made from the same material as the roof slope. Unlike tile, wooden shingle does not put much weight on the truss because it is very light. Damaged individual components can be easily replaced. Roofing shingles are expensive, both because of the price of the material and the cost of the roofing installation and maintenance. This is, however, compensated by the fact that they are extremely stylish and environmentally friendly, and also gives the owner a sense that the roof is unique in that today few buildings become covered with shingles. This means prestige at a high price.

Asphalt Shingle

Radziszewska-Zielina (2014) the main advantage is the price. It is very cheap compared to other roofing materials. It is also very light, so opting for this type of roofing can save the expenses on the roof truss. It can be put on old roofing, such as roofing felt. Its flexibility allows for covering roofs with rounded, complex shapes and with different slope gradients, and because of the variety of shapes and colours it can make original and unique roofing. Asphalt shingle is very easy to install; it requires no special skills from the contractor, as opposed to wooden shingle or ceramic tile. As compared with tile, asphalt shingle is very light – the weight of the roofing is 8-11 kg/m², but in comparison with other roofing types (which are laid on laths), due to the fact that it is limp like all kinds of roofing felt, it requires a rigid base, made of chipboard or plywood, the weight of which can be up to 20 kg/m². The use of asphalt shingle makes the cost of finish very small, almost the lowest of all the roofing types listed above as ridge tiles and other finishes are made of pieces of shingles so that there is virtually no waste. In

use, the shingle does not require any maintenance operations and the roof cover is leak-tight and does not become deformed under the influence of temperature. Moreover, it is resistant to being detached by wind. Unfortunately, however, in the shade and under trees it becomes covered with moss and lichen. Undoubtedly, another drawback of asphalt shingle is its short durability. Its low price proves that it will not meet high expectations and requirements of investors because the roofs of this type of material are not very aesthetically pleasing and have an unattractive appearance. That is why asphalt shingle is not commonly used for the roofing of residential buildings; however, it is often used in small objects, such as arbours, wells, etc.

Galvanized Steel

Radziszewska-Zielina (2014) Roofs are commonly covered with galvanized steel sheet with a thickness of 0.5-0.6 mm. It is sold in the form of sheets with dimensions of 1000 mm x 2000 mm, but often the length of the metal sheet is adapted to the length of the roof to be covered.

This sheet does not require a thick truss structure because it is very light but the cost of the wooden structure increases because the sheet is placed not on laths but on the surface which is additionally covered with boards by nailing down boards with a thickness of no less than 25 mm. During the installation of laths and boards it should be noted that the nail heads must be driven deeply into the wood so as not to come into contact with the steel and not to cause corrosion. It is advisable to use galvanized nails. Galvanized steel is steel sheet coated with multilayer coatings protecting it against mechanical damage and corrosion. It is produced as flat, corrugated or trapezoidal sheets. In terms of the number of roofs covered, it has gained the second place after the

ceramic tile; however, there is a very big difference between these two types of roofing. The very low price indicates that the quality of this roofing material leaves much to be desired. This sheet is not suitable for complicated roofs because there is a lot of waste. Roofs covered with sheet metal are tight, but they have very poor ventilation. They require the use of good insulation. In contrast to the ceramic tile, galvanized steel heats up quickly and cools down quickly, and when it is raining and windy it does not suppress the noise but even enhances it. Another disadvantage is that it is highly susceptible to corrosion, and during the assembly it becomes punctured, which significantly weakens it and reduces its durability. Producers give it a short warranty period, in contrast to e.g. sheet metal with topping and even to wooden shingles.

During snowy winters, one must be careful of piles of snow left on the roof slopes and rapidly sliding down. Galvanized steel sheet can be used on all types of roofs, regardless of the angle of inclination. In highly industrialized regions, with high air pollution and sulfur dioxide or in coastal areas (with high salinity), its durability will be greatly reduced. Grooved and ridge tiles are made of the same material which covers the entire roof slope, i.e. flat metal sheet, which in the case of trapezoidal or corrugated sheet looks unaesthetic and affects the overall image of the roof. Because galvanized steel is produced in a large variety of colours, there are roofs in yellow, green or blue, which contrasts with the buildings with other roofing types and adversely affects the landscape, as it disturbs its harmony.

2.6 Characteristics of Materials Available for Roof Covering

Before making your choice, consider the life-cycle cost of your roofing material. Some materials, though much more expensive, require less maintenance and have a longer life expectancy than others. An asphalt composition roof might last just 20 years

whereas a metal roof might last more than 50. Consider both the current and potential value of your home, and its age when calculating whether a roofing material is actually "too expensive." It might just be more cost-effective in the long run.

The following table describes some of the roofing choices available.

The following table describes some of the roofing choices available (Table 2.1)

Roof Type	House Style	Strengths	Weaknesses
Composition (asphalt shingles) 	Can be used on any house from contemporary to historic.	inexpensive ranges from low-cost 3-tab shingle to architectural shingles with extra durability and style many colors, types, and manufacturers suitable for most residential applications easy to repair fire resistant	relatively short life-span (15–30 years) scars easily when hot subject to mildew and moss environmentally unfriendly
Wood shingles or shakes 	Bungalows, ranch, contemporary, cottage, historic	natural look weathering to a soft grey offers some insulation value blends in with the environment easy to repair or replace long lasting if maintained (30–50 years)	expensive usually requires professional installation high maintenance tends to rot, split, mold, and mildew poor fire rating unless pressure treated

<p>Metal (steel, aluminum, tin, copper)</p> 	<p>Bungalows, ranch, contemporary, cottage, historic (virtually all)</p>	<p>available in different looks including cedar shingles, slate, or standing seam many colors light weight durable long life span (at least 50 years) low maintenance can be installed over existing roofs excellent performance in high wind, hail and rain environmentally friendly</p>	<p>may be difficult to install can be expensive may need periodic painting</p>
<p>Tile (concrete, clay)</p> 	<p>Mediterranean, contemporary or ranch style homes.</p>	<p>non-combustible many colors and styles attractive fireproof easy to maintain extremely durable when maintained</p>	<p>expensive heavy used primarily in new buildings because of weight and structural requirements installation and repairs can be tricky fragile; walking on roof may break tiles</p>

<p>Slate</p> 	<p>Colonial, French, Italianate, Exotic Revivals, Chateausque, Beaux Arts</p>	<p>beautiful, distinctive appearance fireproof long life span low maintenance</p>	<p>very expensive requires specialized installation heavy fragile high maintenance</p>
<p>Concrete (fiber reinforced)</p>	<p>Virtually any style of home</p>	<p>many colors and styles including shakes, tile, and stone relatively lightweight fire and insect resistant; meet many of the more restrictive fire codes low maintenance extremely durable resource efficient</p>	<p>can be expensive uneven quality among products</p>
<p>Hot mopped asphalt with decorative stone</p>	<p>Flat roofed California-style modern</p>	<p>inexpensive easy to repair</p>	<p>stinks health risk to installers fumes promote smog</p>
<p>Engineered rubber/plastic</p>	<p>Virtually any style of home</p>	<p>about 1/3 the weight of slate long lasting (30–50 years) cost effective attractive available in a large range of styles and</p>	<p>new to market</p>

		colors with more appearing constantly made of reclaimed materials	
Eco-roofs	Flat to moderately sloped roofs.	Environmentally friendly; filters rainwater through a roof system of vegetation and soil Low maintenance; can extend the life of the roof membrane substantially Provides insulation to even out climate variations; in particular, keeps houses cooler in summer Attractive	initially expensive unconventional in US, though used more than 30 years in Europe

2.7 Criteria for Selecting Material for Roof Covering

Decision-making problems involve the process of searching or finding the course of actions from a given set of feasible alternatives which maximizes or satisfies certain criteria associated to the goals intended to be achieved (DCLG 2009). Decisions are made within a decision environment, which consists of the collection of information, alternatives, values and preferences available at the time when the decision must be made. Peldschus et al (2010) describes decision making as “a process involving activities that starts with recognition of a decision making problem and ends with recommendation for a decision”. The process can range from highly structured to highly

unstructured decisions (Belton and Stewart, 2002) using either an alternative-focused or value-focused approach (Peldschus et al. 2010). One of the main goals in decision-making for sustainable retail buildings is to identify and choose the most sustainable technological option from among different alternatives. This complex decision problem usually involves a large number of stakeholders with multiple, often conflicting, objectives (Wang et al. 2009). The selection of sustainable technologies requires a highly structured, alternative-focused approach as the decision problem starts with a choice of options and involves the process of selecting a preferred option from multiple alternatives in a structured way. Techniques such as multi-criteria decision making methods support decision makers when faced with such a problem with a set of criteria on a set of alternatives. The adoption of multi-criteria methods helps to organise the decision-making process and usually includes four main stages: alternatives' formulation and criteria selection, criteria weighting, evaluation, and final treatment and aggregation (Belton and Stewart 2002).

Multi Criteria Decision Making (MCDM)

MCDM is the study of methods and procedures by which concerns about multiple conflicting criteria can be formally incorporated into the management planning process. It could be categorized into single decision and group decision making problems. A major MCDM problem could be characterized as (a) the ratings of each alternative in respect of each criterion and (b) the weights given to each criterion (Fenton & Wang 2006). In MCDM problems, defining the criteria is an important element of the structuring process (Scheubreina and Ziontsb 2006). There are different MCDM methods, such as Analytic hierarchy process (AHP), Technique of ranking Preferences by Similarity to the Ideal Solution (TOPSIS) and Elimination and Choice Expressing

the Reality (ELECTRE) and Simple Multi-Attribute Rating Technique (SMART) are widely used techniques that have been adopted to solve MCDM problems in construction industry.

Currently, a Problematic selection approach is used in which many construction professionals choose to intuitively derive such decisions using their own perceptions of established professional experience. In such cases, the criteria evaluation process is very subjective and relies heavily on a manager's experience and knowledge, as well as intuition (Wang et al. 2009). This has led to bias in the decision making process as it is based on limited issues and the influence on other systems of the building are not taken into account (Odhiambo et al. 2010). A systematic approach is needed for the retail construction industry to identify value-based criteria and establish their relative importance to achieve decision making objectives for the selection of materials.

Multi-Criteria Decision Analysis (MCDA) emerged as a formal methodology to support decisions in many fields and has been valuable in environmental decision making (Huang et al. 2011). MCDA is not a tool providing the "right" solution but an aid to decision making to assist stakeholders organize available information, consider the consequences and minimize the possibility of a post-decision disappointment (Belton and Stewart 2002). Wang (2009) describes MCDA as an operational evaluation and decision support approach suitable for addressing complex problems with high uncertainty, conflicting objectives, different forms of data and information, multi interests and perspectives in order to provide an integrated sustainability evaluation. However, Bullinger, Warschat, and Fischer (1991) proposed a knowledge based system to select optimal materials for construction. Soronis (1992) proposed a method for the

selection of roofing materials where several factors have been taken into consideration to assess durability only. Mahmoud, Aref, and Al-Hammad (1996) developed a method for selection of finishing materials that covered floors, walls, roofs and ceilings. Mohamed and Celik (1998) proposed a knowledge-based method regarding materials selection and cost estimating for a residential building where users could choose their preferred ones from a list of materials without evaluation and synthesis of multiple design criteria and client requirements. Instead of expert or knowledge-based systems, Perera and Fernando (2002) proposed a cost modelling system for roofing material selection where several factors are identified and considered in the selection process. Chan and Tong (2007) acknowledged the fact that the decision to select appropriate material is not simply a consideration of cost and materials properties but also there is a need to consider environmental impacts. It is identified that the selection of material is a key issue for the environment (Chan and Tong, 2007) and the choice of material is the optimal way to achieve the cost efficient construction of a building (Krope and Goricanec, 2009). In view of the foregoing, the design team needs to consider several factors in order to select the more suitable materials to meet clients' requirements. In order to solve this problem of material selection in a way that meets the requirement of the design team and those of the construction clients and results in sustainable construction and cost effective solutions, it is required to simultaneously analyse and synthesise multitudes of criteria in order to achieve an optimum solution. It is identified that few decision support systems have been devised for roofing materials selection but the proposed systems do not have the facility to select the appropriate materials by evaluating them with respect to the multitudes of criteria to be considered in order to meet the clients' expectations. Some systems attempt to solve the problem of materials selection by adopting rule-based knowledge representation in terms of "IFTHEN" rules.

However, it is difficult to rank the most suitable materials using conditional expressions. This clearly indicates a research gap with respect to selecting the optimum roofing materials by analysing and synthesising a multitude of design and client's requirements that are both cost effective and sustainable. In order to fill this gap, it is necessary to develop a system that has the capability of simultaneously evaluating multiple criteria in the optimization of materials selection for roof design. Hence, this research aims to bridge the current knowledge gap by developing a knowledge-based decision support system, called Knowledge-based Decision support System for roofing Material Selection and cost estimating (KDSMS). Its aim is to optimize the selection of roofing materials by home owners and model the associated cost for the roof element at an early stage of building design. The advantage of this method is its efficiency and simplicity to use and the ability to rank the materials indisputably (Shanian and Savadogo, 2006). Architects, Cost Engineers, Quantity Surveyors, home owners and prospective home owners are the potential users of this system. It has the potential of assisting them in selecting optimal materials from the list of alternatives based on the level of importance of the criteria set by them. This system also can be used to educate the users about new materials by providing relevant information.

In conclusion choice of roof covering material is dependent on a wide range of factors some of which are beyond the understanding of the client. There is the need for professional consultation when making the choice of roof covering materials.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

In order to achieve the research aim and objectives, this chapter deliberates on research methods with the outlook of finding the best methodology to answer the research questions raised. This chapter lay emphases on the research strategy, research design as well as methods and procedures used in the data collection and analysis. This research adopts the form of integrative literature review and a survey, using a structured questionnaire. The integrative literature review was adapted as it has many benefits including identifying gaps in current research, identifying the need for future research, bridging between related areas of work, identifying central issues in an area and generating a research question.

Amidst, the drive of any research methodology and research design as recognised globally is to provide direction in the planning and implementation of the study in a manner most likely to attain the intended goal. Collis and Hussey (2003) argued that research methodology is the overall approach to the design process from the hypothetical foundations to the collection of data and analysis adapted for a study. Methodology is then a way by which we gain knowledge about the world, trying to discover how we can go about the task of finding out what we believe to be true (Christou et al., 2008).

3.2 Philosophical Point of the Research

Available literature opines that philosophical queries of existence, knowledge, and value, have significant influences in the research design (Koetting, 1996; Christou, *et*

al., 2008). Consequently, such philosophical matters of ontology, epistemology, axiology and methodology assumptions needs to be addressed explicitly since they shape the choice of research instruments (Christou, *et al.*, 2008). Epistemology is the branch of philosophy concerned with how individuals determine what is right; positivism and interpretivism (Streubert and Carpenter, 1999). This research follows the positivists approach to knowledge. For the positivists, through the accumulation of verified facts, scientific knowledge is established (Bryman, 1992 *c.f*Osei-Hwedie, 2010). The researcher is of the opinion that factors influencing material selection for roof covering for home owners must be carried out in an unbiased way.

3.3 Research Strategy

The explanation to the direction of the researcher towards the conduct of research is of paramount essence (Bryman, 1992; Baiden, 2006). Naoum (1998) defines research strategy as the enquiry of research objectives. Accordingly, Baiden (2006) asserted that, the three main types of research strategies are quantitative, qualitative, and triangulation. However, the choice to adapt any particular strategy depends on the purpose of the study, the type, as well as availability of information for the research (Naoum, 1998; Baiden, 2006). Hence, this research adapts a quantitative and qualitative strategy. According Robson, C. (1993) defines qualitative research as words and another which comes in other numerical form and quantitative analysis as data that can be transform into number in real word Hence this research falls in this category as describe by Robson C.

3.4 Research Design

A research design is a collection of guides or rules or data collection (Adams and Schvaneveldt, 1985; Ogoe, 1993). Available literature suggests that, this pacts with the structure for data collection and analysis; the structure that influences the technique for collection and analysis of data and provides the connection between empirical data as well as its conclusions in a logical sequence to the initial research question of the study (Yin, 2003; Bryman, 2004; Baiden 2006).

The research adopts a questionnaire survey in the quest to assess factors that influencing selection roof covering materials home owners. The need for generalization in the findings across the construction industry influenced the choice of questionnaire survey. Questionnaire survey enhances consistency of observations and improves replication due to its inherent standardized measurement and sampling techniques (Oppenheim, 2003).

3.5 The Study Area

This research was centered around Keta and Ho municipalities in the Volta Region of Ghana. These choices of locations were influenced by the following:

Both locations were upgraded to municipal capitals in the year 2012 and are currently undergoing rapid infrastructural development such as construction of schools, hospital, road networks and shops. They are both located within the southern belt of the Volta Region. These two municipalities have high number of dilapidated roofs and roof coverings scattered over the municipalities. This study will comprehensively concentrate on individual home owners and professionals in the construction industry in the Keta and Ho municipalities.

The mix of home owners and professionals in the construction industry is decisive, as this would help gather enough empirical data on investigating the factors affecting material selection. Moreover, Keta and Ho are among the most populated municipalities in Volta Region where construction of roofs are on ascendancy.

3.5.1 Sources of Data

This aspect of the research methodology addresses data collection instruments, methods, and procedures. It provides exhaustive explanations to each of the methods used in addressing the aim, objectives, and research questions. Data gathering is crucial in research, as the data contributes to a better understanding of a theoretical background (Bernard, 2002). It then becomes imperative that selecting the manner of obtaining data and from whom the data will be collected done with sound judgment, especially since no amount of analysis can make up for improperly collected data (Bernard et al., 1986; Tongco, 2007).

In this study, the strategy for gathering data involved both literature review (secondary data) and field survey (primary data). The literature review forms an essential aspect of the research setting the pace for the development of questionnaire (Fadhley, 1991). The field survey dealt with collection of empirical data based on the literature reviewed using survey questionnaires.

An important issue considered in this section was the level of details concerning survey instruments, data collection, and data management. The objective of the survey was to collect data for analysis on factors influencing material selection for roof covering for prospective home owners; Keta and Ho municipalities. The secondary data obtained

from reviewed literature on the area of study includes; relevant reports, journals, articles, and published works of interest.

3.5.2 Questionnaire Development

It was essential to establish the information to gather for relevant questions to be solicited (Oppenheim, 1996). Contemplations of appeal to respondents ease of reading and supplying the required data guided the format of the questionnaires. This enhanced proper usage of time during the data collection. The questionnaire designed included; close-ended questions, open-ended questions and scaled response questions. The likert response scale employed, measures the strength or intensity of respondent's opinion. Some of the advantages of the self-administered questionnaires used include, it remains an efficient way to collect statistically quantifiable information and an efficient method as many respondents can be reached within a short space of time (Twumasi, 1993). The questionnaires structured to align with the main objectives of this study. Notwithstanding, the questions have also been structured in such a manner that the answers received would help achieve the research aim. Therefore, the questions focused on fulfilling the requirements of this study. Measures also deployed to keep the questions in the questionnaire in simple language, null and void of technical terms in order to minimize potential errors from respondents.

3.5.3 Questionnaire Format

Available literature suggests that the optimum length of questionnaire ranges from one side of A4 paper to eight pages of A4 paper (Naoum, 1998; Oppenheim 2000; Saunders *et. al.*, 2000; Polgar and Thomas, 2005; Fellows and Liu, 2003). This research however designed a questionnaire that fell within this range.

3.5.4 Questionnaire Design and Distribution

As described earlier, the format of the questionnaires aligned to meet the objectives of this research has two main parts. Part one emphasis on the background of the respondents whiles part two focused on factors influencing material selection for roof covering for prospective home owners; Keta and Ho municipalities. The questionnaires were distributed and retrieved in person. This was to ensure that the intended recipients were reached in order to help improve the response rate.

3.5.5 Scope of Questionnaire Survey and Targeted Respondent

The validity of the data collected depended much on the structure and the format of questions addressed. As previously mentioned, data collected was solely by the use of self-administered questionnaires. The questionnaires were giving to home owners and professionals in the construction industry in the Keta and Ho municipality. These category of people in the Keta and Ho Municipalities targeted on the reasons that they owned a house and the professionals in the construction industry have expert knowledge on the topic under study. For ease of understanding, the questionnaires phrased to be self-explanatory and structured to elicit the needed information.

3.5.6 Sampling Technique and Sample size determination

According to (Naoum, 1998) term “sample” means a part of a whole (population) drawn to reflect the remaining. Thus, sampling refers to the process of selecting a quota of the population to characterise the entire population. A sample, then, consists of a subject of the units that constitute the population (Polit and Hungler, 1999) and normally used in large-scale survey research for the sake of economy and accuracy (Weisberg and Bowen, 1997). The study had 120 questioners administer to respondent. The

respondents were identified by snowballing, where the Identify home owners directed the researcher to another home owner within the two municipalities. Snowball sampling is a technique for finding research subject (Atkinson and Flint, 2001). This is because using a sample is more practical and less costly than collecting data from the entire population. Polit and Hungler (1999) asserted that, the major risk of using a selected sample is that it might not adequately reflect the behaviors, traits, or beliefs of the population.

The sampling technique for this endeavour based on its purpose, design, and practical implication of the research topic is purposive sampling. Simply put, the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience (Bernard, 2002; Lewis and Sheppard, 2006; Tongoco, 2007). In the context of this research, this strategy involves identifying home owners and professionals in the construction sector in Keta and Ho municipalities. The targeted group was contractors recognized by the Keta and Ho Municipal Assemblies as well as home owners. This class of companies and individuals were chosen for this study, because of the expert knowledge they have on the research topic.

This strategy viewed as a response to overcome the problems associated with concealed or hard-to-reach populations. The process based on the assumption that a 'link' exists between the initial sample and others in the same target population, allows series of referrals made within a circle of acquaintance (Berg, 1988; Atkinson and Flint, 2001). Hence, this implemented by acquiring initial list of contractors from Keta and Ho municipalities. These lead to location of the offices of the first line of contractors from

which the locations of subsequent contractors were obtained. These respondents selected have knowledge or expertise in factors influencing material selection for roof covering for the prospective home owners and therefore meet criteria of interest in this research.

3.5.7 Data Preparation and Statistical Tools Intended for the Analysis

The retrieved questionnaires were checked and arranged in a way that aided a stress-free analysis. Statistical Package for Social Sciences (SPSS version 21) was used to organise responses from the respondents. In data presentation, the data were tabulated, displaying their frequencies and corresponding percentages. The open-ended questions were analysed using Content analysis. This type of analysis was used so that the views of respondents could be critically examined and compared to make valid and reliable deductions.

Furthermore, Relative Importance Index (RII) was employed to portray the significance of individual variables found in similar classes comparatively.

The Relative Importance Index (RII) = $\frac{\sum W}{SN}$

Where W= weight given to each factor by the respondents and ranges from 1 – 5

Where ‘1’ is very poor and ‘5’ is excellent

S= the highest weight (i.e. 5 in this study)

N = the total number of respondents

Finally descriptive analysis was used describe the background of the respondents

3.6 Ethical Consideration

Ethics basically refers to the norms for conduct that distinguish between acceptable and unacceptable behavior when carrying out a research work. Respondents were assured

of the confidentiality of their personality. They were allowed to voluntarily participate in the research work. Furthermore, they were informed that the data being collected would solely be used for academic purpose. Respondents were communicated to in English Language. However, in situations where necessary, respondents were communicated to in a local language they understand.

3.7 Chapter Summary

This chapter outlined the various methodologies used for the research and the justifications for the adoption of the various strategies used. The research approach used and the method of data collection was discussed i.e. the use of survey questionnaires. The chapter concluded with the research process and covered issues such as; the study area, sources of data, questionnaire developments, questionnaire response formats, content and design of the questionnaires, distribution of questionnaire, targeted respondents, the scope of questionnaire survey, sample size determination, and data analytical tools as well as ethical consideration.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter is aimed at documenting the data collected from respondents, analysing them and discussing the results accordingly. Most importantly, this chapter looks into the views of home owners on their choice of roof covering materials. After the design of questionnaires, a total of 120 were distributed and 102 responses were retrieved with 69 home owners and 33 construction professionals, representing 85% of the total.

The researcher employed the use of Statistical Package for Social Sciences (SPSS) and Microsoft Excel for the organization of the data presentation, description and analysis. The statistical tools used for the analysis were the Frequency Index, and Relative Importance Index (RII) for examining the data collected. This chapter also presents the results of the analysis and discussions in the form of texts, figures and Tables.

4.2 Demographic/Background Information

Under this section of the questionnaire, questions were asked on elementary information to discover the characteristics of respondents. This section principally, is directed at knowing the background of the respondents in order to ascertain the basis of their corresponding response.

4.2.1 Construction Background of Respondents

From the questionnaires collected, the data showed 53.4% of the respondents were having construction background and 31.6% had no background in construction and 15% no despondence.

Table 4.1: Distribution of Respondent

	Frequency	Percent
No	38	31.6
Yes	64	53.4
No Response	18	15.0
Total	102	100.0

Source: Field Research, June 2018

4.2.2 Organization Respondents Belong To

Table 4.2 displays the results of the organizations respondents belong to. From the analysis, 15.63% of those who responded to the questionnaires work with an enterprise/sole proprietorship and 40.63% of them belong to private limited company. In addition, 15.63% of the respondents were engaged with other firms that are into partnership and joint ventures. Finally, 28.11% of the respondents belong to other forms of company. Apparently, this question was asked in order to know the background of the responses so as to draw valid conclusions. The analysis clearly reveals that majority of the respondents work with private limited company and this is due to the fact that in the construction industry, limited liability companies can afford to engage larger and complex construction works.

Table 4.2: Classification of Firm

	Frequency	Percent
Enterprise/ sole proprietorship	10	15.63
Private Limited Company	26	40.63
Partnership / Joint ventures	10	15.63
Other (Please specify)	18	28.11
Total	64	100.0

Source: Field Research, June 2018

4.2.3 Years of Experience in the Construction Industry

The table below indicates that 26.6% of the total numbers of respondents have work experience less than 10 years. Also, 54.7% of respondents indicated they have been practicing in the construction industry between 11 to 20 years. Additionally, 10.9% of the respondents have between 21 and 30 years' experience. Finally, the number of respondents who have been practicing in the industry for over 30 years indicated 4.97.8% of the total number of respondents. From the above percentages derived, it can be deduced that a greater percentage of the respondents have had a feel of the practices in industry; so could confidently make detailed assessment of roof covering materials available in the Ghanaian construction industry.

Table 4.3: Existence of construction firm

Under 10 years	17	16.7
11 - 20 years	35	71.5
21 - 30 years	7	6.9
Over 30 years	5	4.9
Total	64	100.0

Source: Field Research, June 2018

4.2.4 Respondents that Undertake Building Projects

The table below indicates that 59.4% do not undertake building projects while 40.6% undertakes building projects. This also affirms the facts that, most of the respondents are better placed to make logical assessment of roof covering materials available in the Ghanaian construction industry.

Table 4.4: Distribution of undertake building project

	Frequency	Percent
No	38	59.4
Yes	26	40.6
Total	64	100.0

Source: Field Research, June 2018

4.2.5 Respondents that Owns a Building

Table 4.5: Distribution of Hose Ownership

	Frequency	Percent
No	33	32.4
Yes	69	67.6
Total	102	100.0

Source: Field Research, June 2018

According to the table below 32.4% of the respondents do not own a building. However, 67.6% of the respondents are home owners which presents a better platform form for further analysis.

4.3 Factors to Consider when Selecting Roof Covering Material

According to Chan and Tong (2007) and Radziszewska-Zielina (2014) the factors below are highly to be considered when making the choice for roof covering; locational suitability, Environmental Impact, Availability of materials, Weight, Durability, Leak – Tightness, Heat Emission, Cost, Aesthetic, Acoustic, Thermal insulation, Resistance to Element of weather. From the analysis in table 4.5 Locational suitability is the most important factor to be considered when making a choice for roof covering. A good locational suitability of roof covering materials will last decades. Environmental

Impact, was ranked second in order of importance. Our choice of roof covering material should not have any adverse effect on the Environment. This is partly because our decisions today should protect and preserve the environment for future generations. Moreover availability of material and weight were ranked third and fourth respectively in order of importance. Durability, leak-tightness and heat emission placed fifth, sixth and seventh. These factors deserve much consideration when analyzing factors for selecting roof covering material. Resistance to element of weather was ranked least in order of importance, this was followed by Thermal insulation, Aesthetic and Cost.

Table 4.6: Factors to consider when selecting roof covering material

No.	Factors to consider when selecting roof covering material	Mean	RII	Ranking
1.	Locational Suitability	4.137	0.82745	1 st
2.	Environmental Impact	4.088	0.81765	2 nd
3.	Availability of Materials	4.049	0.8098	3 rd
4.	Weight	3.99	0.79804	4 th
5.	Durability	3.961	0.79216	5 th
6.	Leak - Tightness	3.833	0.76863	7 th
7.	Heat Emission	3.843	0.76667	6 th
8.	Cost	3.814	0.76275	10 th
9.	Aesthetic	3.804	0.76078	8 th
10.	Thermal Insulation	3.716	0.74314	11 th
11.	Resistance to Element of weather	3.618	0.72353	12 th

Table 4.6 is the breakdown of the analysis of roof covering materials available in the Ghanaian construction industry. Globally there are several roof covering materials in the construction industry but for the purpose of these research work, consideration is given roof covering materials that are available in the Ghanaian construction industry.

According to the table below, Metals (steel, aluminum, and tin, copper) was ranked first. Majority of the respondent are very likely to choose this type of roof covering material. This is because it is readily available, affordable and easy to fix. This was followed by galvanized steel, slate and tile in the order of choice by the respondents. However, wooden shingle was ranked least partly because it is not common on the Ghanaian market. Thatch, Concrete roof, Engineered Rubber/Plastic and Asphalt Shingles followed in that manner. Moreover it is clear from the analysis that most prospective home owners are likely to choose roof covering materials that they have much knowledge about, that can be trusted to withstand the vagaries of the weather. Additionally, respondents' choice of roof covering material has to with cost involved in buying, fixing and maintaining the roof covering material they are likely to choose

Table 4.7: Roof covering materials available in the Ghanaian construction

Roof Covering Materials Available in the Ghanaian Construction Industry	Mean	RII	Ranking
Metals (steel, aluminum, tin, copper)	4.4412	0.8882	1 st
Galvanized steel	4.3725	0.8745	2 nd
Slate	3.951	0.7902	3 rd
Tile	3.7843	0.7569	4 th
Asphalt shingle	3.5098	0.7020	5 th
Engineered rubber/plastic	3.5	0.7000	6 th
Concrete roof	3.1078	0.6216	7 th
Thach	3.0882	0.6176	8 th
wooden shingle	2.8235	0.5647	9 th

4.4 Weaknesses or Disadvantages of Roof Covering Materials in the Ghanaian Construction Industry

Below is the analysis of some weakness of disadvantages of roof covering materials in the Ghanaian construction industry. Majority of the respondents would not choose a roof covering material with high cost of maintenance. This is obvious from the table below since high cost of maintenance was ranked first. Construction is an expensive venture and no client will opt for a roof covering that will continue to incur cost throughout its life span.

Roof covering materials that are expensive was ranked second by the respondents. As compared to the first one, most prospective home owners will rather choose a roof covering material that is less expensive and of good quality. This was followed by roof covering materials that requires professional installment, the ones with short life span as well as poor fire resistance. However roof covering materials that are fragile was ranked last. This was followed by roof covering materials that have the tendency to scar easily, the ones that are heavy in weight, difficult to install and the ones that are environmentally unfriendly.

Table 4.8: Distribution of Disadvantages of roof covering materials

Weaknesses or Disadvantages of roof covering materials in the Ghanaian construction industry	Mean	RII	Ranking
High maintenance cost	3.8725	0.7745	1st
Expensive	3.8235	0.7647	2nd
Requires professional installation	3.7745	0.7549	3rd
Short life span	3.3725	0.6745	4th
Poor fire resistance	3.3235	0.6647	5th
Environmentally unfriendly	3.0882	0.6176	6th
Difficult to install	2.8922	0.5784	7th
Heavy in weight	2.7157	0.5431	8th
Tendency to scar easily	2.5784	0.5157	9th
Fragile	2.4804	0.4961	10th

Source: Field Research, June 2018

4.5 Strengths or Advantages of Roofing Materials in the Ghanaian Construction Industry

The choice of roof covering material is dependent on several interrelating factors. The table is the detailed analysis of the strengths or advantages of roof covering materials available in the Ghanaian construction industry. Details from the analysis indicate that roof covering materials with low cost of maintenance was ranked first by most of the respondents. This is the obvious choice for most the respondents. This was followed by insulation, light weight and natural look. Moreover roof coverings with many manufacturers, environmentally friendly, durability and ability to blend with the environment were ranked fifth, sixth, seventh and eighth respectively. Additionally, roof coverings with strengths such as many colors, long lasting, range of style and suitability for residential use were ranked ninth, tenth, eleventh twelfth respectively. In

conclusion, roof coverings that are inexpensive was ranked fifteenth, this was followed by easy to repair and fire resistance.

Table 4.9: Distribution of Advantages of roofing materials

Strengths or Advantages of roofing materials in the Ghanaian construction industry	Mean	RII	Ranking
Low cost of maintenance	4.000	0.8333	1 st
Insulation	3.9307	0.8078	2 nd
Light Weight	3.7353	0.800	3 rd
Natural look	3.3039	0.7863	4 th
Many manufacturers	3.8529	0.7843	5 th
Environmentally friendly	4.1667	0.7824	6 th
Durability	4.2451	0.7667	7 th
Ability to blend with Environment	3.9314	0.7647	8 th
Many colours	3.8137	0.7627	9 th
Long lasting	3.8235	0.7471	10 th
Range of Style	4.0784	0.7412	11 th
Suitability for residential use	3.6373	0.7275	12 th
Fire resistance	3.0686	0.6608	13 th
Easy to repair	3.1569	0.6314	14 th
Inexpensive	2.7647	0.5529	15 th

Source: Field Research, June 2018

CHAPTER FIVE

FINDINGS

5.1 Introduction

This research work examines factors that affecting the choice of roof covering material, specifically from the home owners' perspective. This chapter basically deals the the research findings that were made.

5.2 Findings

Basically the primary aim of this research is to do an investigating factors that influence the choice of roof covering material from home owners' perspective. In order to achieve this aim four objectives were set out. Below are how the objectives were achieved.

To identify critical factors that determine the choice of material for roof covering by home owners. From the literature review, the analysis and discussion of the responses, several factors determine the choice of roof covering material, among these are; cost, aesthetic, environmental impact, durability, Locational suitability, Resistance to Element of weather, leak-tightness and Heat Emission.

Locational suitability is the factor that was ranked as the one with uttermost importance followed by environmental impact and availability of materials .in conclusion, home owners should put the above factors in consideration when selecting roof covering materials for their dream house.

Examine materials available for roof covering in the Ghanaian construction industry.

There are several roof covering materials in the construction market globally but for the purpose of this research work, only roof covering materials in the Ghanaian

construction industry was considered. As a results of the intensive literature view, several roof covering materials available on the Ghanaian construction industry was analyzed in chapter four of this research work. The following are some of the roof covering materials available in the construction industry in Ghana: Metals (steel, aluminum, tin, and copper), Galvanized steel, Slate, Tile, Asphalt shingle, engineered rubber/plastic, Concrete roof, Thach and wooden shingle

Investigate the strength and weaknesses of materials available for roof covering.

Roof covering materials plays an important role when it comes to providing safety and comfort to the occupants and its properties. As a result of this, careful consideration must made before making a decision on the type of roof covering to choose. From the analysis and responses, it was discovered that home owners will consider the following strengths before making a decision on the choice of roof covering; Low cost of maintenance, insulation, Light Weight, Natural look, Many manufacturers, Environmentally friendly, Durability, Ability to blend with Environment, Many colors, Long lasting, Range of Style, Suitability for residential use, Fire resistance, Easy to repair, Inexpensive. Moreover, it was discovered that, weaknesses will also be put into consideration: High maintenance cost, Expensive, Requires professional installation, Short life span, Poor fire resistance, Environmentally unfriendly, Difficult to install, Heavy in weight, tendency to scar easily and Fragile.

Help home owners to understand factors influencing choice and selection of roof covering.

In conclusion, the finding from this research work is reliable and home owners can depend on these findings to make a choice for roof covering.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This is the final chapter of these research works, it sums up what was done in the previous chapter. The main introduction to the research covered in Chapter One. The review of literature on the topic which covered background discussions, overview of Ghanaian construction, factors that influence the choice of roofing covering material, the types of roof covering materials available in the Ghanaian construction industry, strengths and weaknesses of roof covering materials in the industry was captured in Chapters two. In Chapter three, the methodology adopted for the study including the research design and strategy were discussed. The research process was in one main phase; survey questionnaires. Chapter four presented the empirical analysis and provided detailed discussions on the survey results. This chapter (Chapter five) outlines findings of the study. Chapter six summarizes the findings, conclusion and recommendations for future research works.

6.2 Summary of Findings

This research work made significant findings that will serve as a yardstick for home owners in choosing roof covering materials for their homes. As a results of the findings from the research work, it was discovered that home owners in the Keta and Ho Municipality will put certain factors into consideration before making the final decision on the choice of roof covering material to use. This stems from the fact that, in order to achieve total comfort and security which is the primary focus of every home owner, the

roof covering material must be of optimum quality. It is for this reason, home owners will consider the following factors when choosing roof covering materials: cost, aesthetic, environmental impact, durability, quality, Resistance element of water, leak-tightness and ventilation.

Moreover, it was discovered that, there are several roof covering materials available to home owners to choose from. The following are some of the roof covering materials available in the construction industry in Ghana: Metals (steel, aluminum, tin, and copper), Galvanized steel, Slate, Tile, Asphalt shingle, engineered rubber/plastic, concrete roof, Thatch and wooden shingle.

However, aside the factors and the roof covering materials stated above, home owners will also do careful analysis of the strengths and weaknesses of roof covering materials before deciding on the one to choose. This is because, aside the aesthetic value of roof covering materials, the roof is the top most part of a building and it is exposed to harsh weather conditions. As a result of this, home owners will need to examine the strengths and weaknesses of the various roof covering materials before making a final decision for a roof covering material that last for several decades.

In conclusion, with the above findings, choosing roof covering material will be less challenging to home owners.

6.3 Conclusion

The beauty of a house is so much dependent on the type of roof covering material that is used. It is for this reason that this research work has done a careful study of the various kinds of roof covering materials available in the Ghanaian construction

industry. Home owners should rely on the findings from this research work when making the choice of a roof covering material for their dream house.

6.4 Recommendations

The findings from the survey generated several proposals which have helped to come out with the following recommendations for home owners.

1. Home owners should understand the important role roof covering materials play in the life of a building. The roof covering material is part of the building that receives all the bashing from the rain and sun. Due to this, home owners should do careful analysis of the factors to consider before opting for a roof covering.
2. Home owners should familiarized themselves with the various types of roof covering materials available in the Ghanaian construction industry so as to be able to make a lasting choice.
3. Home owners should do careful analysis of the strengths and weaknesses of the various types of roof covering materials when deciding on the one to use.

A further research would be conducted in the area of whether the decision of choice for roof covering materials depended on home owners or professionals. Further research can also be carried out in the area of home owners understanding locational suitability and cost of roof covering materials.

It will help informed prospective home owners make inform decision in choosing and selection of roof covering materials for their project in other to avoid any mismatch.

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APPENDIX

QUESTIONNAIRE

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FACULTY OF TECHNICAL EDUCATION

DEPARTMENT OF CONSTRUCTION AND WOOD TECHNOLOGY

MASTER OF PHILOSOPHY IN CONSTRUCTION TECHNOLOGY

This study entitled assessment factors influencing material selection for roof covering; Home owners perspective. (Case study at Keta and Ho municipality in the Volta region of Ghana) is to identify factors that influence material selection for roof covering and also to examine the strengths and weakness of materials available in the Ghanaian construction industry.

Please , kindly respond to the questions by ticking the appropriate box for each item. Please note that all information provided will be strictly treated as confidential.

PART ONE: Background Information on Respondent and Company

1. Do you work in a construction firm?

Yes No

2. If yes what is the status of your firm?

A. Enterprise / sole proprietorship

B. Private Limited company

C. Partnership / Joint venture

D. Other (Please specify)

3. How long has the firm been in existence?

under 10 years 11 – 20 years 21 – 30 years over 30 years

4. Do you undertake building projects? Yes No

5. Do you own a building? Yes No

Q6. The table below indicates factors to consider when choosing roof covering materials. Please indicate how important these factors are in selecting roof covering material. Please use the key: 1 = Not important; 2 = Less important; 3 = Moderately important; 4 = important; 5= Very important

No.	Factors to consider when selecting roof covering material	1	2	3	4	5
1	Cost					
2	Aesthetic					
3	Environmental impact					
4	Durability					
5	Locational suitability					
6	Resistance to Element of weather					
7	Thermal Insulation					
8	WEIGHT					
9	ACOUSTICS					
10	LEAK-TIGHTNESS.					
11	Heat Emission					
12	Availability Materials					

Q7. The table below indicates various roof covering materials available in the Ghanaian construction industry. Please indicate how likely you are to choose a particular roof covering material. Please use the key: 1 = Not likely; 2 = Less likely; 3 = Moderately likely; 4 = likely; 5= Very likely

No.	roof covering materials available in the Ghanaian construction industry	1	2	3	4	5
1	Metal (steel, aluminum, tin, copper)					
2	Wooden shingle					
3	Asphalt shingle					
4	Galvanized steel					
5	Tile (concrete, clay)					
6	Slate					
7	Engineered rubber/plastic					
8	Concrete roof					
9	Thatch					

Q8. The table below indicates the weakness or disadvantages of roof covering materials available in the Ghanaian construction industry. Please indicate how likely you are to choose a particular roof covering material based on the weakness or disadvantage stated. Please use the key: 1 = Not likely; 2 = Less likely; 3 = Moderately likely; 4 = likely; 5= Very likely

No.	Weakness or Disadvantages of roof covering materials in the Ghanaian construction industry					
1	Short life Span					
2	Tendency to scar easily					
3	Environmentally unfriendly					
4	Expensive					
5	Requires professional installation					

6	High maintenance cost					
7	Poor fire resistance					
8	Difficult to install					
9	Heavy in weight					
10	Fragile					

Q9. The table below indicates the strengths or advantaged of roof covering materials available in the Ghanaian construction industry. Please indicate how likely you are to choose a particular roof covering material based on the strengths or advantages stated. Please use the key: 1 = Not likely; 2 = Less likely; 3 = Moderately likely; 4 = likely; 5= Very likely

No.	Strengths or Advantages of roofing materials in the Ghanaian construction industry	1	2	3	4	5
1	Inexpensive					
2	durability					
3	Range of styles					
4	many colors					
5	Many manufacturers					
6	Suitability for residential use					
7	Easy to repair					
9	Fire Resistance					
10	Natural look					
11	Ability to blend with Environment					
12	Long lasting					
13	Light weight					
14	Low cost of Maintenance					
15	Environmentally Friendly					
16	Insulation					

(For those in construction practice only)

Q10. How will you help a prospective home owner in making a choice when selecting roof covering material?

NB, Should you need a copy of the research, please contact

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