

UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION - KUMASI

**TRENDS IN THE USAGE OF TIMBER SPECIES FOR BUILDING CONSTRUCTION
AMONG SMALL AND MEDIUM SCALE CONTRACTORS IN GHANA.**



OCTOBER, 2021

**TRENDS IN THE USAGE OF TIMBER SPECIES FOR BUILDING CONSTRUCTION
AMONG SMALL AND MEDIUM SCALE CONTRACTORS IN GHANA.**

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**A DISSERTATION IN THE DEPARTMENT OF CONSTRUCTION AND WOOD
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REQUIREMENTS FOR AWARD OF THE MASTER OF TECHNOLOGY IN
CONSTRUCTION TECHNOLOGY DEGREE.**

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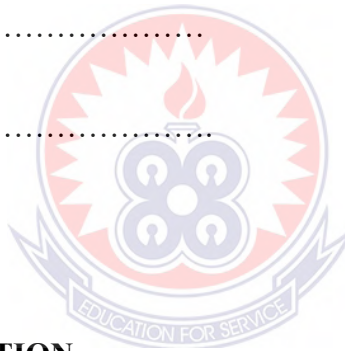
DECLARATION

STUDENT'S DECLARATION

I, JUSTICE APPIAH ASANTE, declare that this research work, with the exception of quotations and references contained in the published works which have all been identify and duly acknowledged, is my own original work, and it has not been submitted, either it 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 Dissertation as laid down by the University of Education, Winneba.

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DATE:

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To my dear wife, Eudora Kwayie and son, Donald Oppong Appiah.



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ABSTRACT

The research aimed at determining the trends in the usage of timber species among small and medium scale building contractors in Ghana. The specific objectives were to determine timber species that have been used in the past decade by small and medium scale building contractors in Ghana; to determine the current timber species being used by small and medium scale building contractors in Ghana and to determine factors that influence the choice of particular timber species in building construction in Ghana. Questionnaires, on site observations and unstructured interviews were the instruments used for data collection from 45 stakeholders in the timber and construction industry such as building contractors, lumber traders, saw millers, carpenters and chain saw operators.. The study employed quantitative and descriptive techniques to analyze data collected.

It was observed from the findings that, there are over 20 lesser known timber species on the Ghanaian local timber market predominantly Essa, Konkroma and Teak that can serve the same purposes as the traditional known timber species. It was concluded that, the extinction of the traditional known timber species used by small and medium scale building contractors is as a results of their over exploitation in the construction industry. Essa, Konkroma, Apro, Teak, Bese, Subaha, Ofram and Nyamedua are the most current timber species being used in building construction works.

The research recommend that, more research is carried out on the strength properties and application of lesser-used species (LUS) among Small and Medium Scale building contractors in Ghana to reduce their total reliance on the traditional known timber species in their construction work. The use of lesser-used timber species should be promoted to sustain the trends in the usage of timber species in building construction in Ghana.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Construction refers to the creation, repair, maintenance, alteration and demolition of buildings, highways, streets, bridges, roads, sewers, railways and communication systems. Key construction subsectors in Ghana include housing and urban development - residential buildings; municipal and commercial buildings; infrastructure - water and sanitation; energy; and transport infrastructure – roads, airports, ports and harbors. The government of Ghana is working to provide sufficient investment in the construction sector so as to be able to respond adequately to the oil-fueled increase in demand for construction and infrastructure development.

The \$8 billion Ghanaian construction sector, which accounted for 18.8 percent of the nation's annual GDP in 2018, is a central pillar of Ghana's National Development Plan. Provisional estimates released by Ghana Statistical Service indicate that the construction industry recorded a growth rate of 18.3 percent year-on-year for the third quarter of 2018. The industry provides employment for approximately 420,000 people and an estimated 2,500 active building and construction contractors currently operate in the Ghanaian market. Players range from indigenous micro-enterprises and individual contractors to foreign multinational civil engineering and construction giants (International Trade Administration (ITA) Ghana,2020).

Baas et al. (2020) describes timber for construction as one of the many forest products used around the world. It has been used for many centuries for the construction of buildings, bridges, furniture, mass timber buildings and a variety of other structures. It remains an important building

construction material today as research and improved technology have led to a better knowledge of the materials' behaviour. This has helped designers to use timber more efficiently and safely and in more challenging and exciting applications.

Adebara et al. (2014) identified timber as the most useful and important material for construction in buildings and roads without which entire process is incomplete. Selecting timber is not an easy task as it seems to be, because timber has different types and selecting the right material is an important key as far as building construction is concerned. It is again an expensive material to be incorporated in roads and buildings for different purposes for example, as roofing members, door and window frames, beams and columns, form works etc, for which it should be necessarily strong and tough. Other useful needs of timber during the construction of buildings are facial boards, props, form works, wardrobes, balusters, cabinets and railings which contribute a lot in the beautification and overall look of interiors. Timber has many other uses but their availability and which type of timber should be used for the right purpose is important to know because if timber used in building construction comes out to be of low quality then one may need a replacement again and again.

Timber is a highly sustainable building construction material, as it is an environmental friendly, affordable, flexible in usage and durable materials; while the problems associated with its usage such as attack by insects, fungi, fire, depletion of natural resources etc. can be improved with the aid of preservative treatments, fire retardant and afforestation. However in some countries timber for construction is too expensive for local people and concrete has become the major construction material instead. In general timber/wood has many good properties such as module of elasticity, compressive to parallel grain, shear strength, hardness, impact bending etc. There are a number of timber species available on the local market. (Mbreyaho et al.2019).

With a high demand for timber in the building construction sector resulting in over-exploitation and scarcity of well-known trees such as *khaya senegalensis*, *khaya grandifoliola* etc. there is a shift to a diversity of other timber species comprising unpopular species (Zziwa et al., 2006b).

Ishengoma et al. (1994) argue that in order to efficiently and economically utilize various timber species, detailed knowledge of their properties was necessary. This is in agreement with Winandy(2002), who noted that users will increase their demand with more reliable and durable building materials available.

Users of timber, especially small and medium scale Building Constructors will continue to be challenged with problems of quality wood identification and availability of the desired timber species in time of need. Collapsing of building roofs, warping and shrinking of doors and windows usually occurs in buildings such as public offices, schools and domestic houses. These structures are often undertaken by small and medium scale contractors. This research however, seeks to investigate the trends in the usage of timber species among small and medium scale contractors in Ghana and to make recommendations to the construction industry in general on the available timber species on the Ghanaian local timber markets.

1.2 Statement of the Problem:

There are different timber species in the Ghanaian forest but only the traditional known species have been harvested and used by construction professionals and other timber users over the years. This has led to the extinction of these traditional known timber species, a serious challenge facing the building construction industry in recent times. To sustain the construction industry, the attention has been shifted to other lesser known timber species for building construction works without thoroughly considering their strength and chemical properties due to high demand for timber, all as

a result of the fast disappearance of the traditional known timber species. This has also brought about finding other alternatives to timber in the building construction industry such as aluminum and steel for trusses, door and window frames etc. by construction professionals.

This research seeks to determine the trend in the usage of timber species in building construction among small and medium scale building contractors in Ghana to help protect the total disappearance of the traditional known timber species and the promotion of other timber species for the survival of the building construction industry in the near future in Ghana.

1.3 Objectives of the Study:

The objectives for this research are;

1. To determine timber species that have been used in the past decade by small and medium scale building contractors in Ghana.
2. To determine the current timber species being used by small and medium scale building contractors in Ghana.
3. To determine factors that influences the choice of particular timber species in building construction in Ghana.

1.4 Significance of the Study:

The significance of this research is to unravel “The Trends in the usage of Timber species for Building Construction among Small and Medium scale contractors in Ghana”. It will in the end assist the small and medium scale building contractors to make informed choices of timber species being used currently in the building construction industry despite the disappearance or the scarcity of the traditional known species. It is however designed to answer the questions “How long have you been using this timber species in your building construction work?”, “Are they always available?”, “What determines the choice of particular timber species over others?”

Professionals in the Building and Construction Industry have used different kinds of wood as roofing members, door and window frames, panels, cabinets, props, decking, formworks, scaffoldings etc and yet continues to use other species for their construction work as and when they are available without knowing or considering their chemical and physical properties and more importantly a major usefulness of trees to mankind (Hoadley, 1990).

It is hoped that, among the over one hundred known timber species in the Tropical African forest including Ghana; (Oteng-Amoako, A. A. 2006); our small and medium scale building contractors can identify and rely on about twenty (20) timber species that are of higher grade as the traditional known ones in terms of durability, availability among other wood properties to improve the efficiency in their construction work, value for money and also protect the over-utilized known traditional timber species in Ghana.

1.5 Delimitations:

The research was to establish the trend of usage of timber species in building construction among registered small and medium scale construction firms in Ghana. It was however disclosed that most of these small and medium scale construction firms contacted during the administering of questionnaires were unregistered making this research partially complete.

The reluctance of some construction professionals and wood traders to accept and respond to the questionnaires could not help to obtain all the needed information to make the research a remarkable one. The few that responded to the questionnaires too could not give much detailed information as expected.

The outbreak of the Corona Virus Disease (*COVID-19*) that hit the country in early January, 2020 which resulted in the locking down of some major cities in Ghana including Kumasi and its

environs retarded the rate of investigation, sites visits and questionnaire administration. Due to this, enough data could not be gathered for a perfect result of the research.

Another delimitation is choosing only Kumasi and its environs. This stifled the research since it made its scope and sample size very limited. Choosing the entire Ashanti region or at least two regions could have produce more and better results on the trend of usage of timber species among the small and medium scale construction firms. The concentration on registered small and medium scale building construction firms was also a setback in the research work. Good and reliable results could be obtained to establish the expected outcome if construction companies in general are involved (i.e. either registered or unregistered)in such research in future.



CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter discusses the literature reviews of the research on the trends of timber usage in Ghana among construction professionals, the most traditional known timber species and the promotion of new timber species being used in the building construction industry to serve as a replacement of the over exploited traditional known ones.

2.1 Effect of over exploitation of some timber species

The effect of over exploitation of some timber species as a result of the trend in their usage in building construction and other areas where timber is used has been a major concern over the years. A number of researches have been undertaken in this area of protecting the forest and its products including logging of timber.

Debara et al. (2014) in a publication titled “Quality and Utilization of Timber Species for Building Construction” in Minna, Nigeria, stressed on the need to sustain the building construction industry by using other timber species in construction other than following the local trends of using only the traditionally known timber species in the construction industry.

The research further emphasized on the lack of quality timber utilization for building construction in Minna which formed the basis for the study. The specific objectives were to identify the timber species utilized in Minna; to determine the most quality timber species used in Minna metropolis and factors that influence the choice of a particular quality timber species. In the same research, information was obtained through interviewing of traders and observing timber yards and construction sites. The research revealed that there were over 18 timber species on the market

without quality control measures; where timber grading methods in Minna were mainly subjective with visual grading technique as the predominant method of assessing timber quality. It was concluded that, the absent of quality timber standards has impeded efficient utilization of timber and has affected the market value and building construction industry (Bowyer et al. 2003; Ishengoma et al. 2004). The research further discovered timber as the most useful and important material for construction in building without which entire process is incomplete. It stated that selecting a good timber specie for building construction work is not an easy task as it seems to be, because timber has different types and selecting the right material for the required job is an important key. Timber is again an expensive material to be incorporated in a building for different purpose for which it should be necessarily be strong and tough.

There are many useful needs of timber during the construction of building such as in doors, windows, roofing members, cupboards, cabinet and railings which contribute a lot in the beautification and overall look of a building and it interiors. Timber has many other uses but which type of timber should be used for right purpose is important to know because if timber used in construction comes out to be of low quality then one may need replacement again and again.

Timber while selecting should be considered for its quality aspect which must be free from any decay like rotten, warp, knot, fungi and mold or termite so that it would not give problem afterward. Before purchasing timber material for the construction, one must be well informed regarding timber types and forms to select as a single knot can bring down the show of whole wood work. With wood utilization one should therefore, recognize the fact that properties of wood vary with species age, site and environmental conditions. (Bowyer et al., 2003; Ishengoma et al., 2004) in a report in Minna, Nigeria; stated that with a variety of timber species in her natural forest and the recent increase in the importation of the commodity from southern part of the country, timber species such

as *Gmelina (Gmelina arborea)*, Neem tree (*Azadiarata indica*), Teak (*Tectona grandis*) etc. have come under serious attack leading to their extinction. An identified situation affecting the use of timber in construction industry.

With a high demand of quality timber in the building construction sector resulting in over-exploitation and scarcity of well-known timber species such as *khaya senegalensis*, *khaya grandifoliola* etc. there is a shift to a diversity of species comprising unpopular species (Zzwa et al., 2006b). In Minna, systematic approaches for predicting timber strength have not yet been employed. Yet these would assist timber dealers and consumers to have rough idea of timber quality at the outlet with proven track record, a practice which unfortunately exerts pressure on well-known timber species leading to their scarcity and abnormal prices.

The dynamic nature of the building environment couple with population growth dwindling wood resources globally that necessitate research into optimal use of multiple tree species with quality control procedures (Leicester, 2002; Mackenzre et al., 2005). Ozden, (2008) revealed that, the relatively low priority given to environmental protection often leads to poor land management decisions, which may result from specific economic conditions or inappropriate land laws or customs. In many cases unregulated access to land resources may lead some individuals to maximize their own gain by over exploiting the land at the expense of the community as a whole. Human factors such as over-cultivation, overgrazing and over fuel wood consumption are some of the causes of desertification that lead to the unavailability of quality timber species in Minna and its surrounding.

Odokonyero, (2005) attributed inaccurate dimension of sawn timber to poor condition of saws and poor workmanship. Bill et al. (2004) and Zziwa et al. (2006c) stressed the economic importance of sorting timber according to its strength quality at the time of merchandising and construction.

Ishengoma et al. (1994) argue that in order to efficiently and economically utilize various timber species detailed knowledge of their properties was necessary. This is in agreement with Winandy (2002), who noted that users will increase their demand with more reliable and durable building materials available.

The Forestry Commission of Ghana in 2011 in their bid to regulate the utilization of timber species in Ghana undertook a study titled; “Helping the Timber Industry to come to a Right Decision”. In this study, the Commission outlined some local timber species, their uses, Botanical Names and Alternative Names. To save the over demanded timber species for building construction and other timber industries, a number of promoted species were also given by the commission. The table below discusses some of the findings of the Commission.

Table 2.1 Applications of some timber species

Doors	<u>African Mahogany</u>	Khaya ivorensis; K., anthothea, (Dry Zone Mahogany K., grandifoliola regarded as separate commercial species)	K. Ivorensis: Acajou D'Afrique, Caoba Del Galon, Dubene, Kumankra K. Anthothea: Ahafo, Akwantannuro, Krala, Krumben, Mangona
	<u>Edinam</u>	Entandrophragma Angolense	Abebegne, Edoussie, Gedunohor, Lifuma, Tiama
	<u>Kosipo</u>	Entandrophragma candollei	Atom-Assie, Candollei, Ceda-Kokote, Heavy Sapelewood, Lifake Mpembe, Omu, Penkwa-Akoa, Pepedom
	<u>Niangon</u>	Heritiera utilis, Tarrietia utilis	Anguekong, Kwaeduma, Nyankom, Ogoue
	<u>Papao</u>	Afzelia africana; A. bella	Afzelia, Apa, Apal, Azodou, Chanfuta,

	<u>Sapelewood</u>	Entandrophragma cylindricum	Doussie, Lingue, M'Banga Aboudikro, Lifaki, M'boyo, Penkwa, Sapelli
	<u>Yaya</u>	Amphimas pterocarpoides	Asanfran, Bokanga, Edjin-Edzil, Edzui, Lati, Muizi, Va Tue
Carpentry	<u>Bompagya</u>	Mammea Africana	Aborzok, African Apple, Bokoli, Bombegya, Djimbo, Oboto, Pasin, Pegya, Pompagya
	<u>Essia</u>	Petersia Africana, Petersianthus africanus, P. macrocarpus, Combretodendron africanum	Abale, Abine, Abing, Esia, Minzu
	<u>Kyere</u> <u>Okoro</u>	Pterygota macrocarpa Albizia zygia	Koto, Obonawa Kassa-kassa, Ohura, Okuro, Red Nongo
Bridges	<u>Bompagya</u>	Mammea Africana	Aborzok, African Apple, Bokoli, Bombegya, Djimbo, Oboto, Pasin, Pegya, Pompagya
	<u>Denya</u> <u>Potrodom</u>	Cylicodiscus gabunensis Erythrophleum africanum; E. guineense; E. ivorensis	Adoum, Edum, Okan Alui, Elon, Elondo, Eloun, Missandra, Odom, Potrodom, Tali
Furniture	<u>African</u> <u>Mahogany</u>	Khaya ivorensis; K., anthotheca, (Dry Zone Mahogany K., grandifoliola regarded as separate commercial species)	
	<u>Afrormosia</u>	Afrormosia elata- Pericopsis elata	Asamela, Awawai, Kokrodua
	<u>Aprokuma</u>	Antrocaryon micraster	Akoua, Angonga, Etwi, Mugongo,

<u>Avodire</u>	<i>Turreanthus africanus</i>	Onzabili Apapaye, Apaya, Engan, Lusamba, Wansenwa
<u>Awiefosamina</u>	<i>Albizia ferruginea</i>	Iatandza, Kulo, Muchole, Musase, Sifou-Sifou, Yayatandza
<u>Ofram</u>	<i>Terminalia superb</i>	Afara, Afraa, Akom, Faraen, Frake, Limba
<u>Okoro</u>	<i>Albizia zygia</i>	Kassa-kassa, Ohura, Okuro, Red Nongo
<u>Otie</u>	<i>Pycnanthus angolensis</i>	Akomu, Eteng, Etsi, Ilomba, Walele
<u>Papao</u>	<i>Azelia africana; A. bella</i>	Azelia, Apa, Apal, Azodou, Chanfuta, Doussie, Lingue, M'Banga
<u>Yaya</u>	<i>Amphimas pterocarpoides</i>	Asanfran, Bokanga, Edjin-Edzil, Edzui, Lati, Muizi, Va Tue

Source: (The Forestry Commission of Ghana, 2011)

The Forestry Commission of Ghana in 2011 further under-listed some timber species that are found in commercial quantities in Ghana's forest reserves which have not been subjected to any serious levels of exploitation but are equally good construction materials that can be used to bring dynamism in the trend of timber usage in the building construction industry:

Ananta, Rosewood, Essia, Bompegya, Avodire, Berekankum, Dahoma, Essa, Danta, Teak, Essakokoo, Ohaa, Sindro, Wawabima, Watapuo, Yaya, Kokote, Afina, Ofram (Black & White), Bodwe, Bubinga, Papao/Azelia, Tetkon, Cedrella, Kaku, Aprokuma, etc. are a few of the promoted timber species.

Ayarkwa et al. (1998) in a research at the Forestry Research Institute of Ghana (*FORIG*) titled “New Marketable Ghanaian Timber Species for Furniture and Construction” stated that properties of selected 'pink star' timber species have been studied and the species categorized into three usage groups: building and general construction, heavy construction as well as furniture and decorative works.

The outcome of the studies on the properties of the selected species as well as field trials indicated that most of the timber species were suitable alternatives to the over-used traditional timber species. The present stocking levels of the species also gave a bright future of sustained supply. As the traditional species become scarcer, engineers and wood specifiers are encouraged to utilize these species, as recommended in this paper, to broaden the species base for products manufacture and sustain the dwindling resource base of the traditional commercial species.

The study further revealed that the timber production area of Ghana's forest, which is about 1.2 million ha, is fast declining in size and productivity partly due to unecological logging practices and overutilization of the main traditional species. This state of the forest has therefore resulted in the adoption of more strict control on timber exploitation, which is undoubtedly expected to affect both the furniture and the building construction industries.

The study gave a vivid account of the annual allowable cut (AAC) of 1.0million cubic meters, from the 32 main traditional timber species, comprise of 500,000m) from reserved forest and 500,000m) from off-reserves (Ministry of Lands and Forestry,1996). With the recent expansion of the timber processing and the construction industries in Ghana, as a result of the prevailing buoyant domestic economy, the allocated AAC seems insufficient and indicates a gloomy future for raw material supply to the local wood processing industries.

Ghana, however, has considerable wealth in tropical hardwood species. It is on record that about 680 different tree species exist in the Ghanaian forest (HallandSwaine, 1981), out of which 420 trees attain timber sizes and are of potential economic value. About 126 of the existing species are also said to occur insufficient volumes to be considered exploitable as raw material base for the timber industry (Ghartey, 1989).

A serious contributing factor to the trend of usage of timber species in Ghana, according to the Ministry of Lands and Forestry, 1996 stated that most of the 32 main traditional timber species are now very scarce. Fifteen of them are already rated as scarlet star species (i.e. species which are being seriously over-exploited and some of them almost to the point of commercial extinction).

Pericopsis elata (Afromosia), *Milicia excelsa* (Odum), *Khaya spp.*(Mahogany) and *Entandrophragma angolensis* (Edinam), for example, have been subjected to more than 1300%, 800%, 900% and 600% exploitation respectively, and there have been significant decreases in the cut since 1989 (Ministry of Lands and Forestry, 1996; Ghana Forestry Department,1994).

Seventeen of the traditional species have also been rated as red species (i.e. species whose current rate of exploitation present significant danger of economic extinction). Among the Ghana Forestry Department's list of commercial species, however, are also 37 pink star species or lesser-used species (LUS), which have very low levels 13 of exploitation compared to the resource and therefore of great potential as, commercial species of the future (Ministry of Lands and Forestry,1996; Ghana Forestry Department,1994). A more prudent way of ensuring sustainable timber supply to the furniture and construction industries, therefore, is to shift attention to the pink star species. By so doing, the pressure on the known traditional timber species may be reduced and the natural balance of species in the forest ensured.

2.2 Some causes of over-utilization of the traditional timber species in Ghana

A critical examination of the past and present trends in the usage of timber species in Ghana shows its highly selective nature, dominated by a small number of preferred timbers. A reluctance to use a great variety of timbers, especially the lesser-used species, may be attributed to several factors among which are:

2.2.1 Traditional marketing practice.

The traditional marketing practice in Ghana has been such that timber is sold by species. Only well-known species like Odum are sold for construction whilst the Khaya and the Entandrophragma species are sold for furniture. Species whose characteristics are well known are those commonly available on the market. The construction industry in Ghana also has high requirements for timber quality and performance. (Ministry of Lands and Forestry, 1996; Ghana Forestry Department, 1994).

2.2.2 Lack of guidance on selection for a purpose

There seems to be a general lack of guidance in Ghana on selection for a purpose from among the many timber species with promising characteristics. Even though the foremost concern of the end user should be a product and not a material, information required on property requirements and comparative performance of different timbers for a purpose, until recently, had been few and scattered. (Ministry of Lands and Forestry, 1996; Ghana Forestry Department, 1994).

2.2.3 Familiar species

Engineers, wood specifiers and end users(customers/clients) have been holding fast to the few preferred species in Ghana because they are sure of their technical suitability in terms of mechanical properties, durability characteristics, wood stability in service and wood working characteristics and their sustained availability in the required dimensions on the market.

2.2.4 Risk involved

There is lack of readiness on the part of lumber producers and sellers on the local market to take investment risk of producing and selling lumber of the pink star species or LUS in large volumes. This is due to the fact that wood specifiers (ie customers/clients) or users usually request for only the traditional known species. As a result, there has been non-availability of the pink star species or LUS insufficient and sustained volumes and in the required dimensions on the local markets to warrant intensive utilization in the furniture and construction industries. This trend therefore results in over-utilization of the preferred species.

2.3 Effects of over-utilization of the few traditional known timber species

The over-dependence of the furniture and construction industries on the Mahoganies, Entandrophragmas and the Milicias do not only result in the destruction of the forest of the future, but also in exorbitant prices of timber.

Cost of the final product such as furniture, building, etc. also increase beyond the reach of the average person. (Ministry of Lands and Forestry, 1996; Ghana Forestry Department, 1994).

2.4 Promotion of selected timber species for furniture and construction

According to Ayarkwa et al.(1998), the Forestry Research Institute of Ghana (FORIG) and the Timber Export Development Board (TEDB), in their collaborative research and promotional efforts, have studied the properties and possible end-uses of the following species for promotion to the local furniture and construction industries. Denya(*Cylicodiscusgabunensis*), Danta(*Nesogordoniapapaverifera*),Essia(*Petersianthusmacrocarpus*), Wawabima(*Sterculiaspp.*), Esa(*Celtispp.*) Ofram(*Terminaliasuperba*), Potrodom(*Erythrophleumsauaveolens*) Avodire(*Turreathusafricanus*), Ananta(*Cynometraananta*) Ayan(*Distemonanthusbenthamianus*), Awiemfosamina(*Albiziaspp.*) Chenchen(*Antiaristoxicaria*) and Ceiba(*Ceibapentandra*).

2.5 Property requirements for utilization of timber

Properties required in wood for a particular purpose such as furniture and construction need to be defined before a choice of timber is made. Through experience from field and research work, the following property requirements for construction are defined.

2.5.1 Building and general construction.

The important properties required in wood for purposes such as roof trusses, door and window frames and panel doors are

- ❖ High mechanical properties
- ❖ High or moderate durability or treatable wood species
- ❖ High to medium dimensional stability
- ❖ Satisfactory wood working properties e.g. sawing, planing, boring, nailing, etc. (especially for panel doors)
- ❖ Attractive appearance (i.e. wood colour and grains) for polished panel doors.

2.5.2 Heavy construction

The important properties required in wood for purposes such as railway sleepers, bridges, industrial floors, etc. are:

- ❖ High durability or amenability to treatment
- ❖ High density and mechanical properties
- ❖ High dimensional stability

2.6 Export data on the selected species

Ghana's timber export trade has been dominated by the preferred traditional species for a very long time. However, recent export statistics on timber and lumber products indicate that the pink star species are gradually coming up. The 1996 timber export statistics (Forest Products Inspection Bureau, 1996) indicate that all the selected species were exported from Ghana in one form or the

other., although their share of the total volume of wood products exported from Ghana 1996 was small, it indicated a promising future for the pink star species or LUS. The Table indicates that the selected species were exported from Ghana in the form of lumber (kiln-and air-dried), veneer, mouldings, furniture parts, boules, floorings and profile boards.



Table 2.2: Export products and volumes from selected timber species from Ghana in 1996

Value-added products	Timber species	Quantity exported
Lumber	Ofram, Ayan, Awiemfosamina, Wawabima, Denya, Danta, Esa, Ananta, Potrodom, Chenchen, Avodire, Ceiba, Essia	18,886.94m ³ (7.0%)
Sliced veneer	Ofram, Awiemfosamina, Avodire, Ceiba	280,139.67 m ³
Rotary veneer	Ofram, Awiemfosamina, Esa, Chenchen, Essia, Ceiba.	(0.6%)
Boules	Ofram, Ayan	20,942.94 m ³ (82%)
Mouldings	Ofram, Esa, Danta, Ceiba	3,215.20 m ³ (9.0%)
Furniture parts	Avodire, Chenchen	588.82 m ³ (6.0%)
Flooring	Esa	86.40m ³ (6.0%)
Profile boards	Avodire	27.76m ³ (0.8%)

The figures in brackets are proportions (in percentage) of the total quantity of the particular product exported in 1996. (Forest Products Inspection Bureau, 1996)

2.7 Properties of selected species

Strength properties of the selected timber species as reported in this paper were determined in accordance with the American Society for Testing and Materials (ASTM) Specification D143-52 (1979), using a 5000 kg Universal wood testing machine on small clear specimens. The machining properties were also determined in accordance with ASTM D143-52 (1970) and D 1666-64 (1978). All the tests were done using randomly sampled wood from three ecological forest zones in Ghana. The other wood properties reported in this paper were assessed through field trials and actual utilization of timber of the selected species. A summary of the important wood properties of the selected timber species are presented in tables 1, 2 and 3. Properties of *Milicia excelsa* (Odum), the

most commonly used traditional timber species for construction in Ghana (Addae-Mensah et al., 1989) have also been included in Table 2 for comparison. The species have been categorized into three main usage groups for which they are being promoted: building and general construction, heavy construction as well as furniture manufacture.



Table 2.3 Construction timbers: Structural work, door/window frames, panel doors, etc.

Timber Specie	Density (12% m.c) kg/m ³	Mechanical Properties N/mm ²	Natural durability or treatable	Dimensional stability	Woodworking properties	Appearance
Essia	Heavy 800	Stronger than Odum, Bending strength 132, Comp. strength 72, MOE 13,700	Moderately durable to durable	Medium	Satisfactory Saws easily, Planes well and smoothly, Fastening easy	Attractive reddish brown colour, Rotten cabbage odour when fresh but disappears when dry
wawabima	Heavy 760	Stronger than Odum, Bending strength 127, Comp. strength 66, MOE 14,000	Moderately durable	Low under extreme weather, Quarter sawn lumber stable	Satisfactory Saws easily, Planes well and smoothly, Moderate fastening properties	Brown colour
Esa	Heavy 740	Stronger than Odum, Bending strength 104, Comp. strength 60, MOE 12,700	Non-durable but treatable with approved preservatives	Medium stability	Satisfactory Saws easily with little blunting, Planes well and smoothly, Moderate fastening properties	Attractive yellowish whitecolour

Danta	Heavy 740	Stronger than Odum, Bending strength 137, Comp. strength 65, MOE 12,700	Moderately durable to durable	Medium stability	Satisfactory Saws easily , Planes well and smoothly, Pre-boring necessary	Attractive fine grain redwood
Odum	Heavy 650	Comp. strength 52, MOE 10,000	Moderately durable to durable	Medium	Satisfactory Saws easily, Planes well and smoothly, Fastening easy	Structural work Roofing Doors windows
Albizia	Heavy 700	Stronger than Odum, Bending strength 102, Comp. strength 59, MOE 11,577	Durable	Stable	Satisfactory Saws easily, Planes well and smoothly, Good fastening properties	Roofing Door frames Window frames Panel doors
Ayan	Medium heavy 670	Stronger than Odum, Bending strength 118, Comp. strength 63, MOE 12,700	Moderately durable	Stable	Satisfactory Saws easily, Planes well and smoothly, Good fastening properties	Roofing Door frames Window frames

Gustavson (2017), in a press release gave a narration on the strong trend of Swedish construction timber which has a similar link to this study being undertaken and was as follows:

Demand for timber remains strong in the Swedish construction market. Södra's sales to the Swedish building trade have risen for the third consecutive year.

The use of timber as a building construction material is becoming increasingly popular in Sweden – for both large-scale residential construction and home DIY projects. Sales are partly seasonal, since both construction levels and sales are higher during the warmer months. 2017 began on a high note, despite the relatively cool weather, and May is looking very strong.

“We see a broad social trend. Wood is becoming increasingly popular as a building material for both private construction and multi-unit solutions,” said Fredrik Gustavson, Sales Director at Södra Wood. “There is a growing awareness that wood is by far the most climate-smart alternative for construction.”

According to Gustavson (2017) in the first quarter, Södra’s deliveries to the Swedish building trade rose 6 percent year-on-year. The increase for Swedish construction timber has remained stable since 2015 but 2016 was a very strong year, and Södra delivered nearly 285,000 m³ of construction timber. The Swedish market is the largest single market for Södra’s sales of construction timber to industry and the building trade and accounts for approximately 30 percent of Södra’s total sales.

One trend, according to Fredrik Gustavson, is house extensions in wood, such as garages, car ports, balconies and decks. The high rate of house production is generating increased sales. The use of wood to build outdoor environments, in particular, has become increasingly popular.

“Spacious, high-quality outdoor areas are a growing trend,” said Fredrik Gustavson. “Many people see the double benefits of using a material that is both comfortable and aesthetic, as well as climate-smart. We are continuously looking into new solutions to meet these needs, and recently launched a new type of decking for exterior environments all made from timber species.

From the above press release, it could be observed that the demand for timber in building construction is on the ascendancy day-in and day-out and where the choice of particular timber

species are preferred by clients, then there is the need to control the trend in usage of such timber species to save them from total extinction in future.

In a recent survey conducted in Rwanda by Mediterranean Journal of Basic and Applied Sciences (MJBAS, 2019) on the theme “Timber Application in Construction Industry And Its Promotion” it was established that timber as a construction material has been in use from prehistoric time until today with different types of timber under application in various structures even multi storied buildings. It envisaged wood as environmentally friendly from the time it is planted to when it is processed into timber and used as structural elements like roofing members, panels, door and window frames, formwork, beams, columns etc. compared to other construction materials like concrete and steel.

In Rwanda, while the plantation of trees has been promoted, their application in construction was still limited to simple houses in rural areas or in some cities where attention was made to touristic expression. To regulate the trend in the usage of timber species in the construction industry (ie. not relying on only the traditional known timber species, but other equally good and available timber species), the government of Rwanda has set a target of increasing the national forest cover from the present 10 per cent to 30 per cent of the national territory by the year 2020 (www.rema.gov.rw).

The construction industry is one of sectors which have been developing fast in Rwanda from last 15 years, many infrastructure facilities are being put in place and while artificial modern building materials such as concrete are in demand throughout the country, not only their costs have never decreased, but also the extraction of respective raw materials has been contributing to environmental degradation. This led to the need for other sources of local materials, especially based not only on their potential performance and affordability, but also on their green aspects and timber was considered as one of these sources.

Globally, timber has been in use from prehistory to current times, and even with the introduction of other more modern construction materials like steel, concrete, Cross-laminated Timber (CLT) that have been developed over the years. It is seen as a material for the future for the construction industry due to its numerous physical and chemical properties and architects and construction engineers are encourage reconsidering the use of concrete and steel materials but instead use sustainably harvested wood to reduce the amount of carbon dioxide associated with construction activities.

Baiden et al. (2005) in a research conducted titled “Exploring the barriers to the use and potential of timber for housing construction in Ghana” saw timber as one of Ghana’s most readily available natural resource which occupies one-third of her total forest area and has about 400 timber species. To promote the use of timber as a building construction material, two high-level educational institutions; Building and Road Research Institute (BRRI) and Kwame Nkrumah University of Science and Technology (KNUST), per-form various tests on timber species for use in construction. The study further emphasized that due to the potential properties of timber such as durability, fire resistance, thermal conductivity and expansion, appearance etc, existing timber houses constructed, which have lasted for tens of years and are still standing, attest to timber as a reliable building material.

2.8 Timber availability

According to Baiden et al.(2005), the timber producing forest of Ghana occupies an area of approximately 78,000 km², about one-third of the total area of the country. The timber resources are estimated at about 350 million cubic metres of the total are considered to be matured stock. There are over250 wood species that grow to timber size in the forests of Ghana. The study grouped timber species into two; Primary and Secondary categories. There are 14 primary timber species of

major economic value (based on export potential) and about 12 timber species of lesser economic value. Most of these are durable woods with established properties. They are processed mainly for export in the form of logs, lumber, veneer and plywood. There are 23 secondary timber species made up of species of possible future economic value, and over 200 hundred others that are not well known. The properties of these woods have therefore not been sufficiently studied. They are consequently considered to be relatively less durable (although there are a few durable ones). On the other hand, the secondary species are in abundance and have the potential of being a great source of material for the construction industry in Ghana. The wood-processing industry has long been established in the country. There are about 70 sawmills in the country, conveniently located in the forest zones. These mills process almost exclusively primary timber species.

The annual production rates from the mills are listed in the Table below;

Table 2.4 Timber production in Ghana

Region	Annual processed volume (m3)		
	Log	Lumber and plywood	
		Export	Local use
Eastern	52,000	1500	20,000
Western and Central	290,000	103,000	31,000
Brong-Ahafo	85,000	31,000	10,000
Ashanti	278,000	76,000	40,000
Total	705,000	211,500	101,000

Source: Forest Products Research Institute(2005)

The above discussion clearly shows that the raw material potential of the country, which can support a major timber construction development, is vast. Researchers have, however, had difficulties in getting data on physical and mechanical properties of most timber species because of the confusion of local names, specific trade or standard names and botanical names.

2.9 Timber usage in the construction industry

Timber products used in the construction industry may be classified into two main categories of end use: structural and non-structural. Structural timber species are normally used for structural construction such as load bearing wall, frames, roof trusses, columns, floor systems and beams. Non-structural timber species are however used for wall sidings, paneling, ceiling, floors, doors and windows frames. Not all of the available timber species from the tropical rain forest are suitable for construction. For use in construction of building elements, however, the choice of species are determined by strength in tension, compression and shear. Other factors are natural durability, easily treatment and seasoning, workable, availability and attractive appearance.

Even though wood has its limitation due its susceptibility to decay and insects attack, the number of inherent factors above, keep it in the forefront of building materials (Baiden et al., 2005).



Figure 2. 1: Formwork for the construction of drains (Site Visit).

2.10 Thermal conductivity and expansion

Another potential property of timber that has led to the over utilization of some few species is its thermal conductivity and expansion. Dry timber is a poor conductor of heat and therefore suitable for internal wall paneling, wall sheeting in timber framed house construction and cladding. The thermal conductivity of timber is therefore very low, only 0.4% of that of steel or 0.5% of copper. The low conductivity of timber makes it a natural insulator, which is two to four times that of common insulating materials. The effect of temperature on thermal conductivity is relatively low, 2–3% per 10°C. Most materials expand on heating but the behavior of timber is dependent on the moisture content. Dry or seasoned timber expands on heating and contracts on cooling. Thermal expansion is generally insignificant and therefore not considered in timber structures. Moist timber, however, expands due to normal thermal expansion but shrinks because of moisture loss and because the moisture loss is greater than the expansion, there is a net loss. Timber that is suitable for construction is mostly dry and will overcome this behavior (Baiden et al., 2005).

The researchers (Baiden et al., 2005) identified another physical property of timber species that has made the commodity highly demanding by users in the building and construction industry “appearance”.

2.11 Appearance

Timber can be an attractive decorative material if the right specie is selected. The cells arrangement, grain, growth ring, knot and rays account for its attractive appearance. Other properties include texture, figure, colour and lustre. Their extensive use in furniture and decorative works are due to its appearance. Veneers, for example, are the sheets of timber produced for decorative purposes and are cut in a manner to expose the natural beauty of the wood to its best advantage. The decorative effects are obtained by cutting the log to reveal its colour, grain and figure. The tremendous range

of colour, grain and figure provides the architect or designer with an almost endless variety to choose from, a variety which can provide all purposes.

Oduro et al., (2014) in their bid to help sustain the building construction industry in Ghana and to enhance an effective trend of usage of the traditional known timber species outlined some modalities. That;

1. Reform in the management practices is required to align timber harvesting levels to sustainable timber production in Ghanaian forests.
2. Current plantation establishment efforts are not sufficient to bridge the gap between demand and supply of timber, partly due to low establishment rates and lack of appropriate management of newly established plantations.
3. A secure tenure and rights to on-farm trees, a key condition to stimulate large scale planting of forest trees by farmers and other investors must be given the needed attention, and
4. Forest degradation and deforestation is high in Ghana and must be tackled swiftly as this poses severe threats to the sustainability of the building construction industry as well as the resource itself.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter discusses the methodology used for the research. It is made up of the research design, the sources of data, the research population, sample size and sampling techniques used in the research. Others include the data gathering instruments, data collection procedures and methods for data for analysis.

Interview of stake holders namely site engineers, saw millers, timber dealers, Questionnaires and on site observation of building project sites were carried out.

Spreadsheet application was used to interpret the results of the research in the form of tables, charts and graphs. Photographs of building construction sites, saw mills and timber markets visited have been inserted to enhance readers understanding.

3.2 Research Design

The researcher employed the quantitative data research method for the conduct of this research. Quantitative research according to (Pritha Bhandari, 2020) is defined as the process of collecting and analyzing numerical data. It is used to find patterns and averages, make predictions, test causal relationships, and generalize results to wider populations. “Quantitative research can also be defined as an inquiry into a social problem, explain phenomena by gathering numerical data that are analyzed using mathematically based methods e.g. in particular statistics” (www.ukessays.com). Surveys and experiments are examples of quantitative research.

3.3 Sources of Data

Data was obtained by both the primary and secondary sources.

3.3.1 Primary data

The primary data was obtained by the conduct of interviews and the administration of questionnaires to the various stake holders.

3.3.2 Secondary data

The secondary data are data which already exist and have been preserved for further use and studies. These data were obtained from sources such as books, journals, textbooks and the internet.

The secondary sources are very important because they give an in-depth knowledge to future researchers on the subject matter and how to improve upon the earlier findings.

3.4 Research population

The target population for the research was registered Small and Medium Scale building contractors in Ghana. This is because they are the most affected group in the construction industry as far as the trends in the usage of timber are concerned and meets the target of the researcher. Population according to www.scribbr.com is defined as the entire group that the researcher want to draw conclusion about.

3.5 Sample and sampling technique

Purposive sampling technique was used in this research. The researcher's choice of purposive sampling stems from the fact that it significantly meets the location requirement, how the research needs to be done and also the objectives of the research.

Palys (2008), to engage in purposive sampling signifies that one sees sampling as a series of strategic choices about whom, where and how one does one's research.

The sample size for this research was 70 small and medium scale building construction professionals in Kumasi Metropolis and its environs. This sub-group was carefully selected to be representative of the whole population with the relevant characteristics. A sample is a smaller group or sub-group obtained from the accessible population (Mugenda and Mugenda, 1999).

3.6 Data gathering instruments

The researcher used questionnaires and unstructured interviews to obtain data for the study. In designing the questionnaires, efforts were made to ask questions, considering the background of respondents in order to generate understanding and interest and also the analytical tool to be employed in the data analysis. The questionnaires were distributed to construction industry professionals (quantity surveyors, project managers, Supervisors/foremen, Architects, Civil engineers and Structural engineers) in Ghana working with consultancy firms and contractors of categories D2K2, D3K3 and D4K4 (Danso, 2010; Amoah et al., 2011). These respondents were asked to list the timber species they have been using for their building construction works for the past ten (10) years and their uses, state the most recent used timber species and the also outline the factors that determines the choice of a specific timber specie over others. The pattern of questions were made so flexible to enable respondents to answer in few minutes. A questionnaire may be defined as research data collection instrument which consists of a series of questions usually called items for the purpose of gathering information from respondents (Cresswell, 2003).

70 questionnaires were distributed to building construction professionals to collect key information from the areas under research. The questionnaires were used for the following reason: its potentials

in reaching out to a large number of respondents within a short time, its ability to give the respondents ample time to respond to the items, offers a sense of security (confidentiality) to the respondents and it is objective method since it gives no bias resulting from the personal characteristics (as in an interview) (Owens 2002). Sites visit were also employed as data gathering instruments.

The questionnaires used by the researcher were related to the objectives as well as the research questions of the study. The researcher used open-ended questionnaires in which the questions allowed the respondents to willingly provide as many information they may have on the topic. The questionnaire was grouped into two sections (A and B). Section A described the demographics of respondents and section B discussed questions on the topic under study. Both questionnaire items can be seen in Appendix A.

3.7 Data collection procedures

The researcher prepared and administered the questionnaires by hand to the respective respondents. In all, 70 questionnaires were issued to respondents to fill. Due to the COVID-19 pandemic which restricted regular personal contacts with people, the researcher adopted the technique of incessantly calling and reminding the respondents to help fill the questionnaires. It took the researcher a period of eight weeks to successfully administer the questionnaires. Prior to the commencement of data collection, the researcher obtained all the necessary documents including an introduction letter from the Department of wood and construction technology, college of Technology Education, Kumasi. Upon getting clearance, the researcher personally distributed the questionnaires to the stake holders. 45 out of the 70 questionnaires were fully completed with the researcher obtaining a response rate of 64.3%.

The use of questionnaires eased the process of data collection as all the selected respondents were reached within the six week period. During the distribution of the instruments, the purpose of the research was explained. For confidentiality, some respondents requested their company names and contacts should not be written on the questionnaires of which the researcher obliged.

3.8 Methods for data analysis

Quantitative and Descriptive analysis were adopted by the researcher to expand the data obtained for the research. It was carried out using the Spreadsheet application in the form of tables, bar charts, histograms and pie charts to establish the relationship between the various variables obtained.



CHAPTER FOUR

RESULTS AND DISCUSSION OF FINDINGS

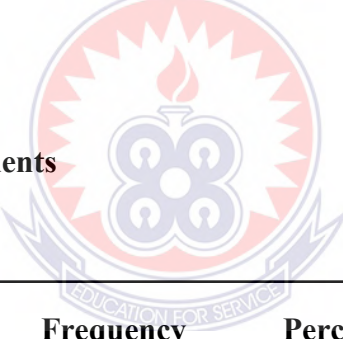
4.0 Introduction

This chapter presents the results and discussion of findings of the study. That's the demographic characteristics of respondents and uses of timber species in the past decade.

4.1 Response rate of Questionnaires

The researcher administered 70 questionnaires to building construction professionals to answer. Out of the 70, 45 were properly answered and received. The analysis of the questionnaires was based on 64.3% response rate.

Table 4. 1: Gender of Respondents



Demographic Characteristics	Frequency	Percentage (%)
Gender		
Male	44	97.80%
Female	1	2.20%
Total	45	100%

From table 4.1, out of a total of 45 respondents, 44 representing 97.8% were males while 1 representing 2.2% was a female. This indicated that majority of the small and medium scale building construction professionals are males. It is however prudent to encourage more females to develop interest in building construction and technical courses as a whole.

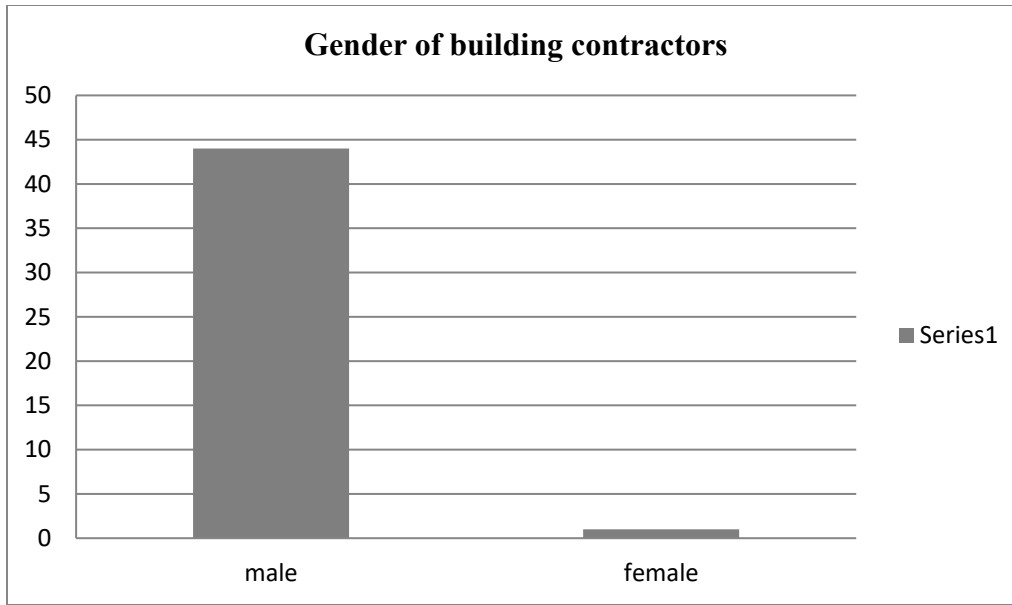


Figure 4. 1: Gender of building contractors

Table 4. 2: Area of Specialization

Area of Specialization	Frequency	Percentage (%)
Supervisor/foreman	15	33.30%
Project manager	2	4.40%
Structural engineer	5	11.10%
Architect	3	6.70%
Quantity surveyor	4	8.90%
Civil engineer	5	11.10%
Other	11	24.40%
Total	45	100%

With respect to area of Specialization of the respondents from table 4.2, 15 respondents representing 33.3% were Supervisors/foremen, 2 representing 4.4% Project managers, 5 representing 11.1% were Structural engineers, 3 representing 6.7% were Architects, 4 representing 8.9% were Quantity surveyors, 5 representing 11.1% were Civil engineers and 11 representing 24.4% were others (carpenters, chain saw operators and other construction site workers).

The above information indicates that, there are few Project managers, Architects and Quantity surveyors in the building construction industry. There is therefore the need to encourage Small and Medium Scale building contractors to upgrade themselves in their Areas of specialization.

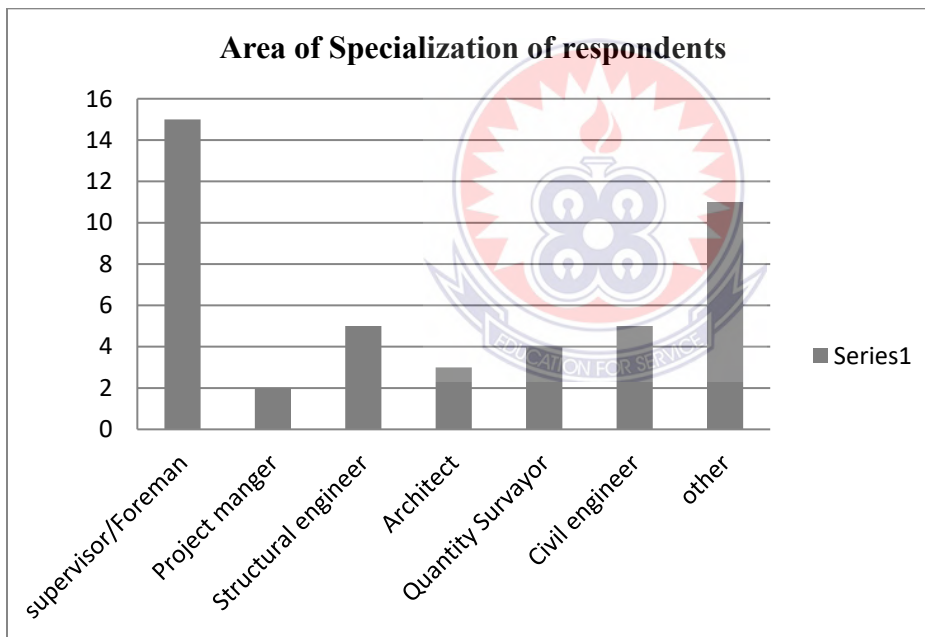


Figure 4. 2: Area of Specialization of respondents

Table 4. 3:Level of Education

Level of Education	Frequency	Percentage (%)
WASSCE	11	24.40%
HND	13	28.90%
BSc.	16	35.60%
MSc.	5	11.10%
PhD	0	0%
Total	45	100%

From table 4.3, on the levels of education of respondents, 11 representing 24.4% were holders of WASSCE, 13 representing 28.9% were HND holders, 16 representing 35.6% were BSc. holders, 5 representing 11.1% were MSc. Holders. There was no PhD holder among the respondents and that constituted 0%. The statistics given above shows that, there are more Bachelor of Science (BSc) holders among Small and Medium Scale building contractors. No PhD holder was recorded among respondents.

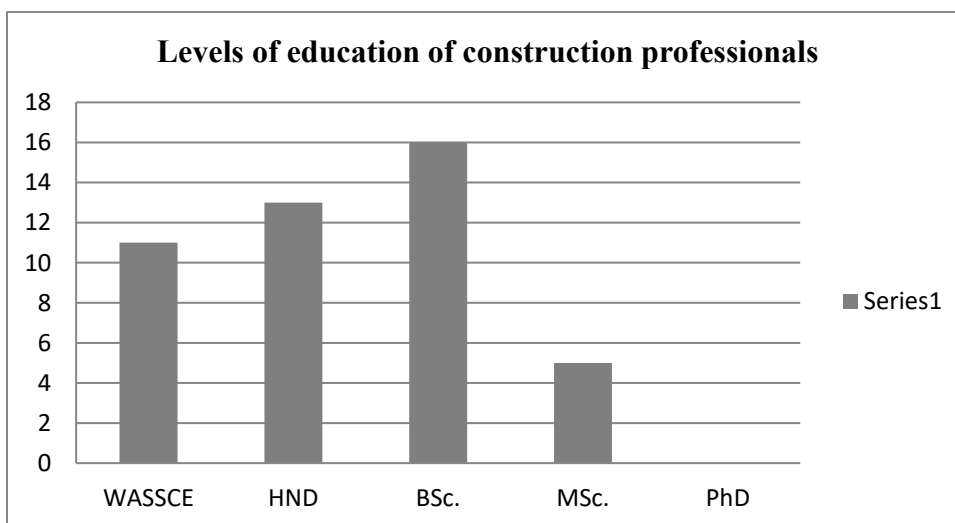


Figure 4. 3: Levels of education of respondents

Table 4. 4: Years of working Experience

<i>Years of working Experience</i>	Frequency	Percentage (%)
1 - 5 years	9	20%
6 - 10 years	18	40%
11 - 19 years	10	22.20%
20 years and above	8	17.80%
Total	45	100%

(Source: Field survey, 2020)

On the years of working experience from table 4.4; 9 representing 20% have worked between 1 – 5 years, 18 representing 40% have worked between 6 – 10 years, 10 representing 22.2% have worked between 11 – 19 years and 8 respondents representing 17.8% have been the building construction business for 20 years and above. This gives a clear picture of the years of working experience among respondents for the research work. The information given above reveals that, a large number of Small and Medium Scale building contractors have experience between 11 – 19 years and there are however a few with 20 years and above working experience. Organizing of frequent refresher conferences for Small and Medium Scale building contractors could give the less experience the opportunity to tap the knowledge of the more experience to their performance.



Figure 4. 4: Years of working experience of respondents

The researcher, out of questionnaires administered, construction sites visited, informal interviews of wood workers like carpenters and chain saw operators, saw millers, timber traders and other information acquired through the internet, was able to obtain about twenty-nine (29) timber species and their uses among small and medium scale building and construction professionals in Kumasi and its environs. A total of 97 uses were involved.

Table 4. 5: General uses of Timber Species in the past decade.

Timber Species	Uses
Odum	Door frames, Door panel, Roofing, Flooring, Cabinet
Wawa	Lintels, Form work, Decking (flow), props, Profile board, scaffold
Essa	Roofing, Door Frames, Window Frames.
Dahoma	Roofing, Door frames, Window frames
Emire	Roofing, Door frames, Window frames, Facial board
Ofram	Door panels, Facial board, Ceiling joist
Mahogany	Roofing, Door & window frames, Door panels, Cabinet, Flooring
Ceiba (Onyina)	Props, lintel, boarding, Profile board, form work, Ply wood
Chenchen	Lintel, Form work, boarding, Facial board
Konkroma	Roofing, Door frames, Window frames
Nyamedua	Lintel, Form work, Profile board
Senya	Roofing (mainly)
Essia	Roofing, Door frames, Window frames
Teak	Roofing, Door frames, Window frames, Cabinet, Door panel
Sapele	Door panels, Door frame, Window frame, cabinet
Yaya	Roofing, facial board
Gyenyene	Facial board, Ceiling joist, lintel
Amangyedia	Roofing
Koteramfo	Facial board
Subaha	Roofing
Watapuo	Roofing, Door frames, Window frames, Scaffold
Sesɛ	Door frames, Window frames
Bese	Roofing, Door frames, Window frames
Oteɛ	Ceiling joist, lintel, props, Facial board
Okoro	Roofing, Door frames, Window frames
Awiamfoosamina	Lintel, props, boarding, Form work, profile board
Apro	Roofing, scaffold, Door frame, Window frame
Rosina	Roofing, Door panels, Door frames and Window frames

(Source: The internet and field survey, 2020)

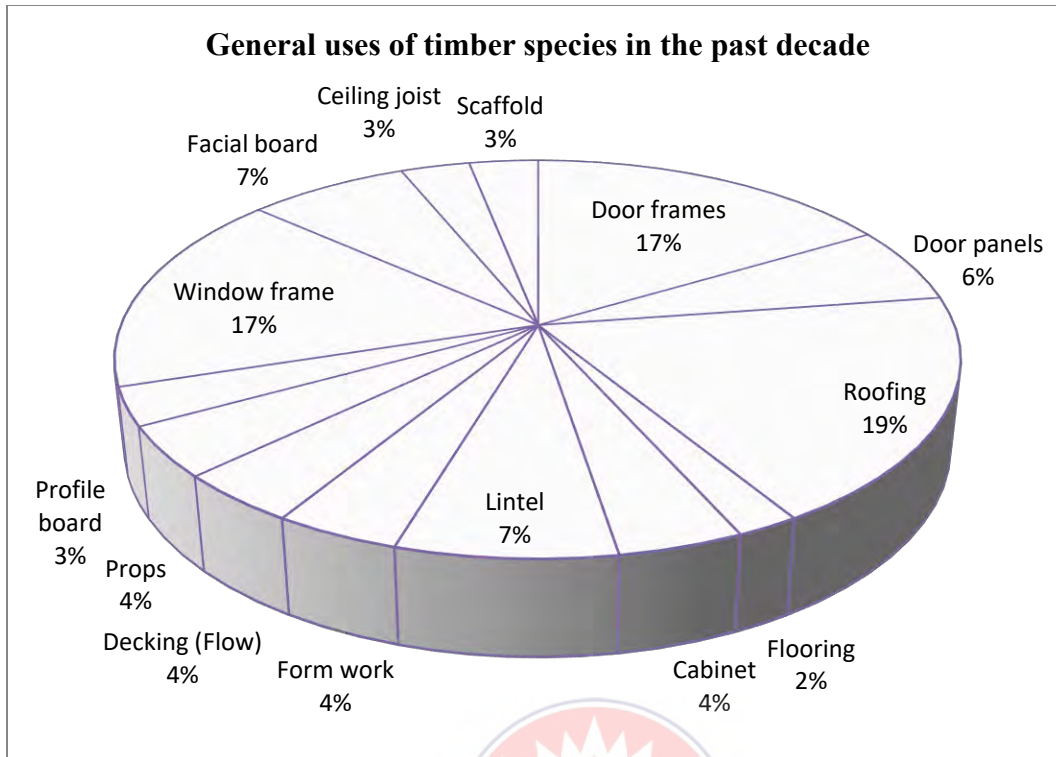


Figure 4. 5: General uses of timber species in the past decade.

Table 4. 6: Specific uses of timber species as in table 4.5 above.

Uses of timber species	Frequency	Percentage (%)
Door frames	16	16.49%
Door panels	6	6.19%
Roofing	18	18.56%
Flooring	2	2.06%
Cabinet	4	4.12%
Lintel	7	7.22%
Form work	4	4.12%
Decking (Flow)	4	4.12%
Props	4	4.12%

Profile board	3	3.09%
Window frame	16	16.49%
Facial board	7	7.22%
Ceiling joist	3	3.10%
Scaffold	3	3.10%
Total	97	100%

(Source: Field survey, 2020)

Table 4. 7: Timber species used for roofing in the past decade.

Period	Timber species	Frequency	Percentage (%)
2010-2013	Odum, Essa, Dahoma, Emire, Mahogany, Bese, Okoro, Essia, Senya, Konkroma, Apro, Subaha	11	24.4%
2014-2017	Essa, Dahoma, Senya, Konkroma, Emire, Bese Okoro, Watapuo, Essia, Apro, Rosina, Subaha	15	33.3%
2018-2020	Subaha, Essa, Dahoma, Emire, Bese, Okoro, Watapuo, Essia, Senya, Konkroma, Apro, Rosina	19	42.2%
Total		45	100%

(Source: Field survey, 2020)

Table 4.7 gives detailed presentation of respondents on the uses of timber species for roofing in building construction between the years 2010 - 2020.

From table 4.7, out of the total of 45 respondents, 19 representing 42.2% used Subaha, Essa, Dahoma, Emire, Bese, Okoro, Watapuo, Essia, Senya, Konkroma, Apro and Rosina as roofing

members in their work between the years 2018 – 2020. 15 representing 33.3% used Essa, Dahoma, Senya, Konkroma, Emire, Bese, Okoro, Watapuo, Essia, Apro, Rosina and Subaha for roofing in their building construction works between the years 2014 – 2017. The remaining 11 representing 24.4% also used Odum, Essa, Dahoma, Emire, Mahogany, Bese, Okoro, Essia, Senya, Konkroma, Apro and Subaha as roofing members in their building construction works between the years 2010 - 2013.

This indicates that many of the small and medium scale building construction professionals used common timber species for roofing except Odum and Mahogany due to their scarcity in recent times.

However, Subaha, Essa, Dahoma, Apro, Bese, Konkroma, Okoro and Emire were consistent in the Ghanaian local timber market indicating a 100% availability and reliability in the past decade.

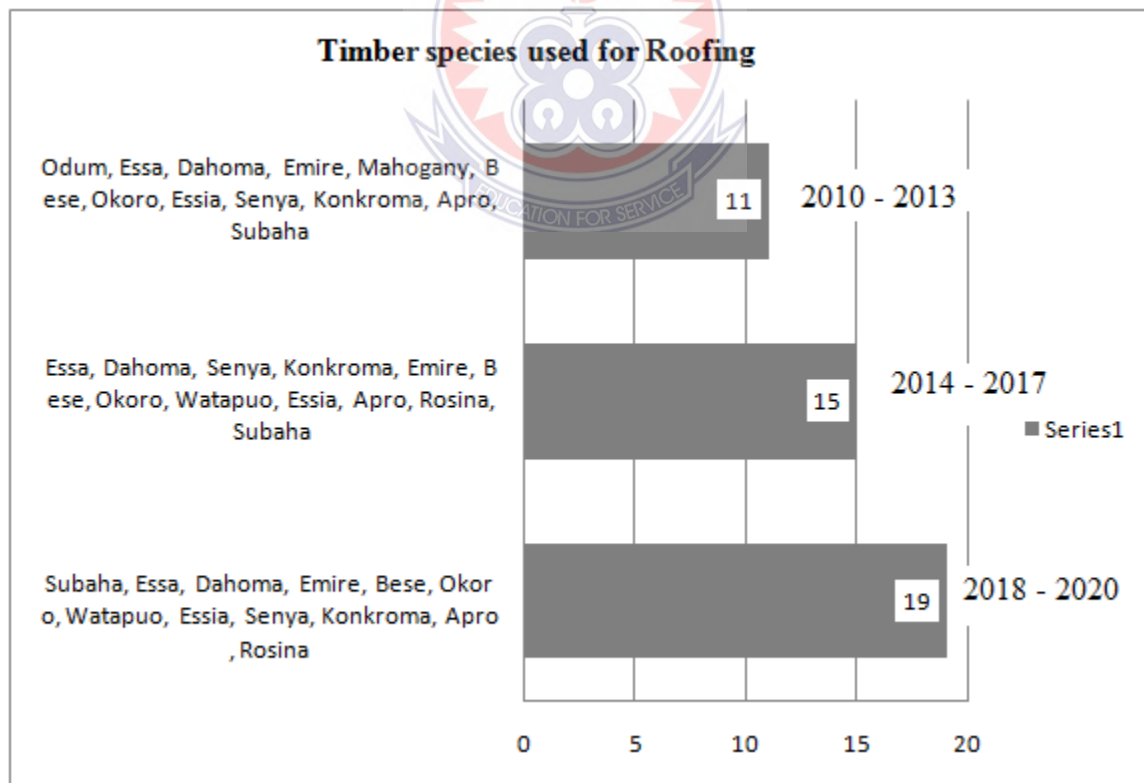


Figure 4. 6: Timber species used for roofing in the past decade

Table 4. 8: Timber species used for Door frames in the past decade.

Period	Timber species	Frequency	Percentage (%)
2010-2014	Odum, Essa, Dahoma, Emire, Mahogany, Konkroma, Senya, Essia, Teak, Sapele, Watapuo, Sese, Bese, Okoro, Apro.	21	46.7%
2015-2020	Konkroma, Senya, Essia, Teak, Sapele, Watapuo, Essa, Dahoma, Emire, Sese, Bese, Okoro, Apro, Rosina.	24	53.3%
Total		45	100%

(Source: Field survey, 2020)

Table 4.8 gives a clear presentation of respondents on the timber species used for door frames in building construction among small and medium scale building contractors in the past decade. It could be observed that 21 respondents out of the total of 45 representing 46.7% used Odum, Essa, Dahoma, Emire, Mahogany, Konkroma, Senya, Essia, Teak, Sapele, Watapuo, Sese, Bese, Okoro and Apro for door frames in their building construction works during the period 2010 – 2014, while 24 out of the 45 respondents representing 53.3% also used Konkroma, Senya, Essia, Teak, Sapele, Watapuo, Essa, Dahoma, Emire, Sese, Bese, Okoro, Apro and Rosina for the same purpose during the period 2015 - 2020. It was however observed that all the timber species listed above were consistent on the Ghanaian local timber market during the period of study except Odum and Mahogany due to their over exploitation by the Small and Medium Scale building contractors in Ghana.

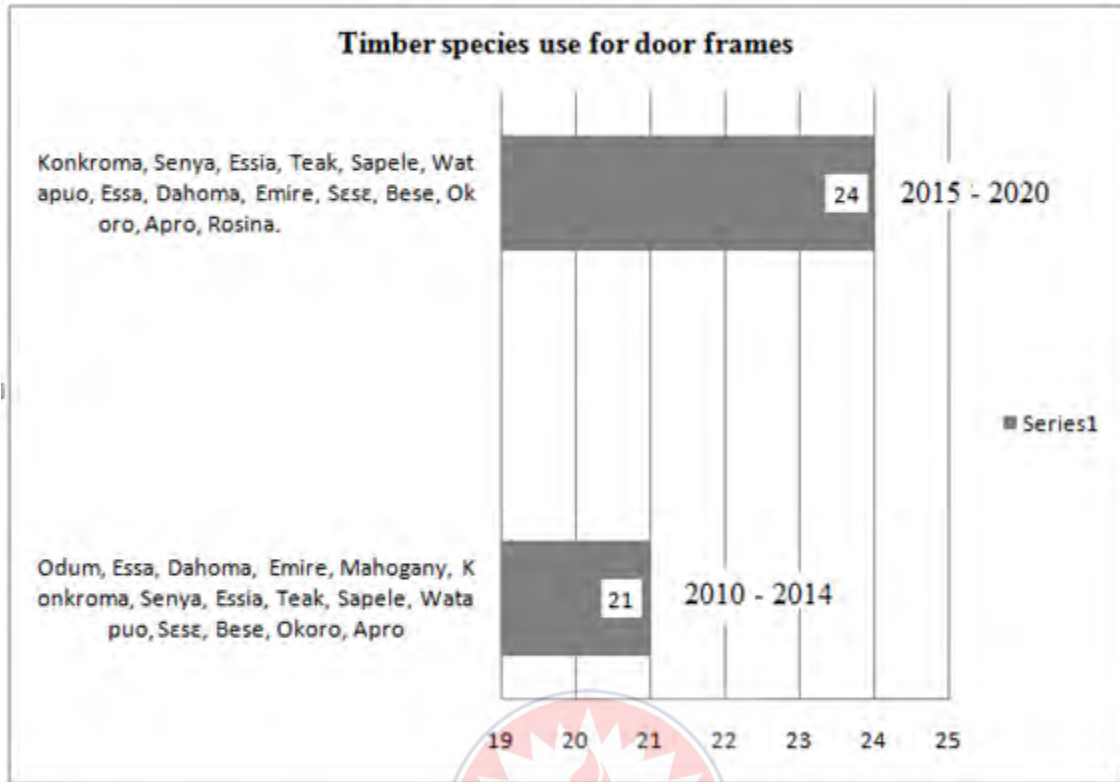


Figure 4. 7: Timber species used for door frames in the past decade



Door frames made of timber used in building construction

Table 4. 9: Timber species used for Window frames in the past decade.

Period	Timber species	Frequency	Percentage (%)
2010-2013	Odum, Mahogany, Emire		
	Dahoma, Essa, Konkroma	9	20%
2014-2017	Rosina, Okoro, Dahoma,		
	Essa, Sapele, Teak, Sɛsɛ	16	35.6%
2018-2020	Essa, Bese, Watapuo, Konkroma, Essia,		
	Dahoma, Sɛsɛ, Sapele, Teak, Okoro	20	44.4%
Total		45	100%

(Source: Field survey, 2020)

Table 4.9 above shows the distribution of responses by Small and Medium Scale building contractors on timber species used for window frames in the past decade. As can be observed from the table, 16 out of the 45 respondents representing 35.6% used Rosina, Okoro, Dahoma, Essa, Sapele, Teak and Sɛsɛ for window frame, 9 out of the 45 respondents representing 20% used Odum, Mahogany, Emire, Dahoma, Essa and Konkroma for the same purpose and 20 out of the 45 representing 44.4% also used Essa, Bese, Watapuo, Konkroma, Dahoma, Sɛsɛ, Sapele, Essia, Teak and Okoro for the construction of window frames in their building construction works. Odum, Emire, and Mahogany were not consistent on the Ghanaian local timber market due to their scarcity. However, the remaining timber species were available for the sustainability of the Small and Medium Scale building construction firms in Ghana.

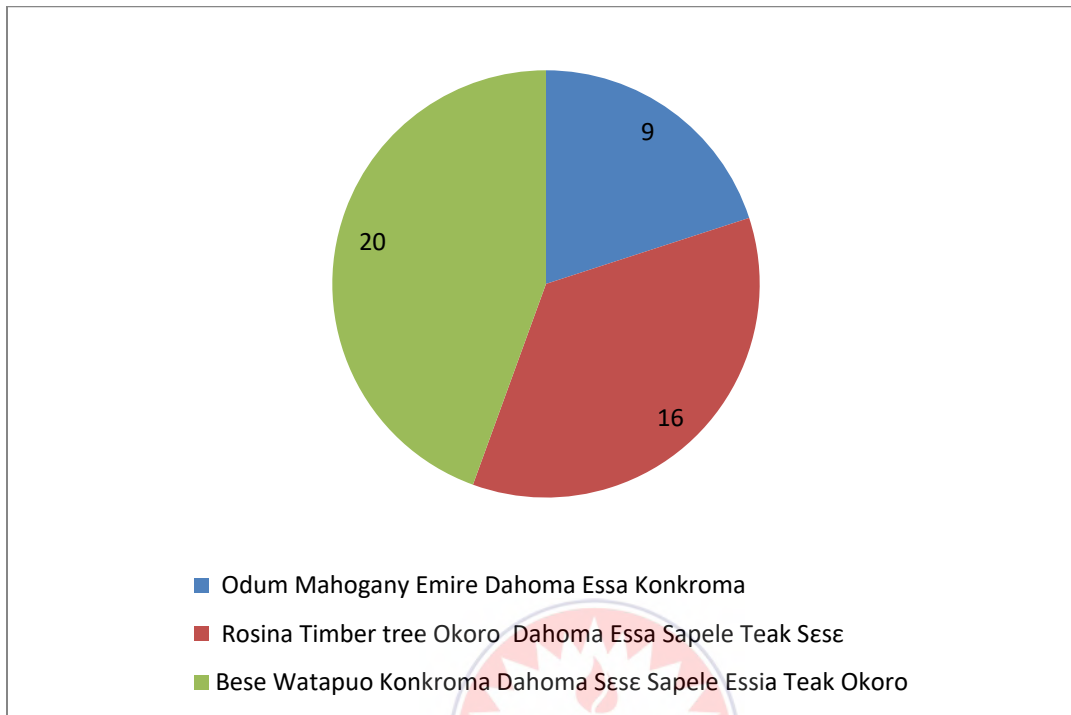


Figure 4. 8: Timber species used for window frames

Table 4. 10: Timber species used for Door panels in the past decade.

Period	Timber species	Frequency	Percentage (%)
2010-2014	Ofram, Odum, Mahogany, Rosina	14	31.1%
2015-2020	Ofram, Sapele, Teak, Rosina	31	68.9%
Total		45	100%

(Source: Field survey, 2020)

Table 4.10 above depicts respondents' response on the timber species used for making door panels in their building construction works in the past decade. Out of a total of 45 respondents, 14 representing 31.1% used Ofram, Odum, Mahogany and Rosina and 31 respondents representing

68.9% indicated they used Mahogany, Ofram, Sapele, Teak and Rosina in making door panels in their construction works. From the above table, it can be seen clearly that Odum and mahogany are on the verge of extinction. Ofram, Sapele, Teak and Rosina are being considered as options to sustain the building construction industry as far as door panels are concerned.

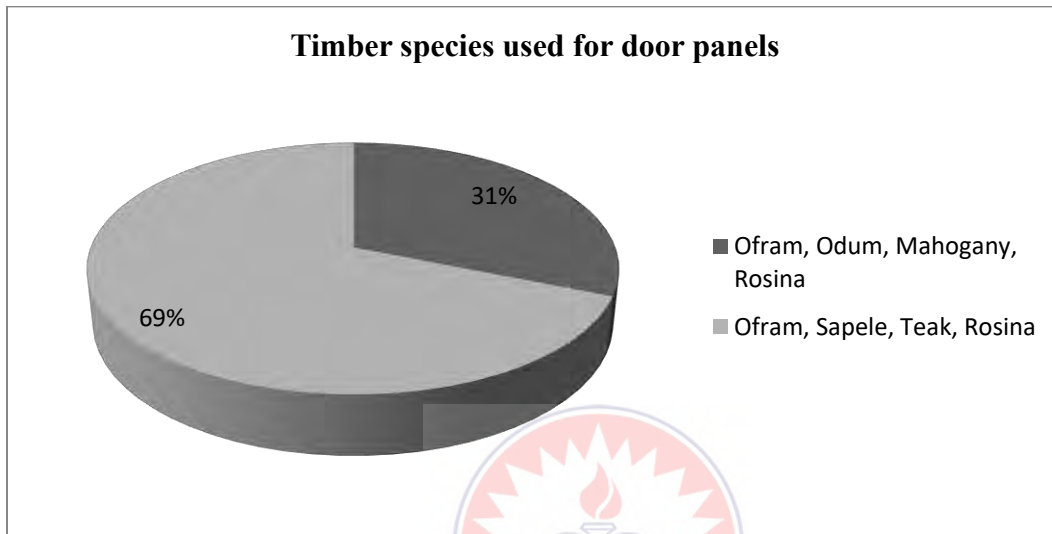


Figure 4. 9: Timber species used for door panels



Door panels made of timber

Table 4. 11: Preference for specific timber species in the past decade

Items	Frequency	Percentage (%)
Yes	45	100%
No	0	0%
Total	45	100%

(Source: Field survey, 2020)

The Table 4.11 above indicates that all the 45 respondents responded “Yes” resulting in a 100% output. None of the respondents answered “No”. This implies that, Small and Medium Scale building contractors in Ghana consider certain characteristics of timber species such as durability, resistance to termite and fungi attacks, warping, knots, availability and colour of the species in time of need. This has been the trend in timber usage in the past decade.

Table 4. 12: Reasons for preferring specific timber species to others

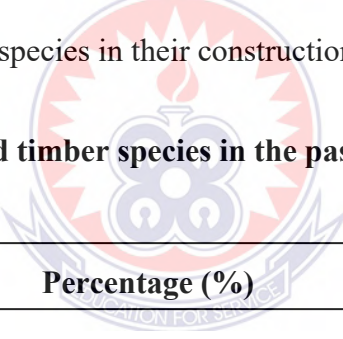
Timber species	Reasons
Essa	Very strong, artistic, easily obtained, resistant to insect attack, good for roofing.
Konkroma	Good for roofing, door and window frames, always available, does not warp.
Bese	Has self-protective chemical that prevent insect attacks, very strong for roofing, door and window frames.
Ofram	Has good patterns, gives nice finish when polished, easily obtained.
Mahogany	Very durable, gives good finish when polished, high resistant to termite and fungi attacks.

Okro	Good for roofing, door and window frames, last longer if well-seasoned.
Sapele	Easily acquired, good for door paneling, has very good finish when Polished.
Senya	Easily obtained, good for roofing, door and window frames.
Teak	Very strong, has nice patterns, resistant to insect and fungi attacks, gives good finish when polished.
Odum	Very tough and durable, can be used as beams columns in wooden Structures, has a good finish when polished.

(Source: Field survey, 2020)

The Table 4.12 above give reasons why Small and Medium Scale building contractors in Ghana prefer the usage of some timber species in their construction works to others in the past decade.

Table 4. 13: Usage of preferred timber species in the past decade.



Items	Frequency	Percentage (%)
Yes	19	42.2%
No	26	57.8%
Total	45	100%

(Source: field survey, 2020)

Table 4.13 above clearly shows that although timber plays a major row in building construction, building contractors in recent times are facing challenges of getting their preferred timber species for their construction works. Out of 45 respondents, 19 responded “Yes” representing 42.2% and 26 respondents representing 57.8% responded “No”. This is a clear indication that the traditionally known timber species used by Small and Medium Scale building contractors in Ghana in the past decade are gradually losing their place in terms of usage in the building construction industry due to

their extinction. Equally good timber species such as Essa, Dahoma, Teak, Bese and Subaha are predominant on the Ghanaian local timber market for building construction purposes.

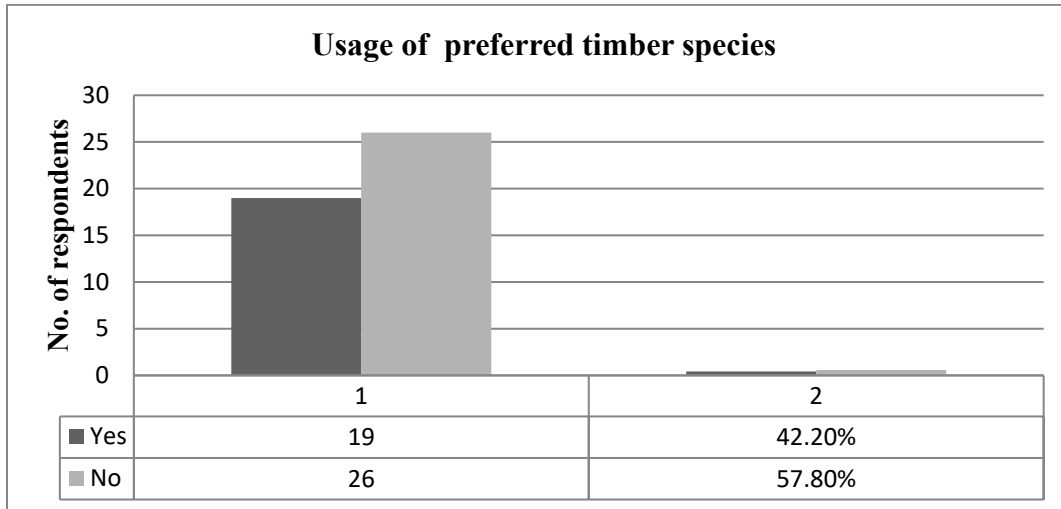


Figure 4. 10: Usage of preferred timber species in the past decade.

4.2: Challenges in the usage of preferred timber species

Among the challenges for the 26 respondents responding “No” as shown in figure 4.13 in the usage of their preferred timber species in their construction works include;

1. Unavailability of the traditionally known timber species for example Odum and mahogany in the forest and on the Ghanaian local timber market.
2. High cost of the few traditional known timber species on the local timber market.
3. The forestry commission’s refusal to renew the logging permits for timber firms and chain saw operators.
4. Lack of re-planting of the over exploited traditionally known timber species.
5. Negligence of the forestry commission to check on the poor logging practices, for example cutting of immature timber species by timber companies and some chain saw operators.

6. Lack of education on the importance of some timber species to the building construction industry especially to the charcoal burners.
7. Smuggling of important timber species to Europe, Asia and America to the detriment of the Ghanaian local building contractor.

Table 4. 14: Most current timber species on the Ghanaian local timber market.

Timber species	Frequency	Percentage (%)	Ranking
Essa	10	22.2%	1 st
Dahoma	7	15.6%	2 nd
Konkroma	5	11.1%	3 rd
Teak	5	11.1%	3 rd
Apro	4	8.9%	5 th
Subaha	4	8.9%	5 th
Ofram	3	6.7%	7 th
Okoro	3	6.7%	7 th
Bese	2	4.4%	9 th
Nyamedua	2	4.4%	9 th
Total	45	100%	

(Source: Field survey, 2020)

Through the questionnaires administered, ten (10) timber species were identified as the most current species being used by Small and Medium Scale building contractors in Ghana. This was also confirmed by some saw millers and timber traders the researcher interviewed verbally.

From table 4.14, 10 respondents representing 22.2% out of 45 mentioned Essa as the most current timber species being used in their building construction works and ranked 1st. 7 respondents representing 15.6% stated Dahoma and was ranked 2nd. Konkroma and Teak were ranked 3rd with 5 respondents each and representing 11.1% each as well. 4 respondents each mentioned Apro and Subaha representing 8.9% each and were ranked 5th. 6.7% representing 3 respondents each mentioned Ofram and Okoro and were ranked 7th. Another 2 respondents each representing 4.4% each out of the 45 respondents also mentioned Bese and Nyamedua as the most current timber species being used for building construction activities and were ranked 9th. These timber species are readily available on the Ghanaian local timber market.

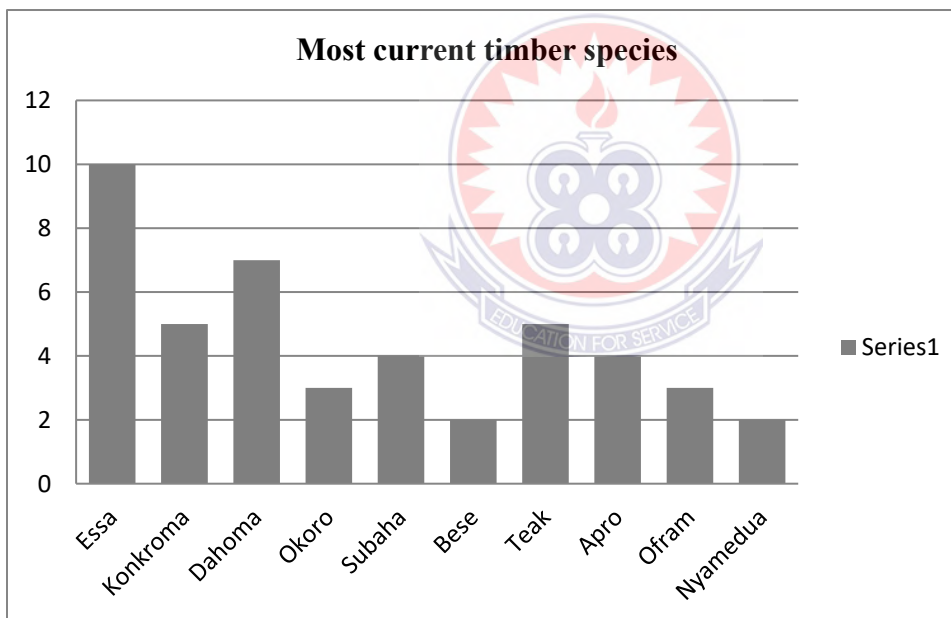


Figure 4. 11: Most current timber species on the Ghanaian local timber market.

Table 4. 15: Factors that influence the choice of particular timber specie.

Item	Frequency	Percentage (%)
Customer preference	16	35.6%
Strength of timber	10	22.2%
Availability of timber	12	26.7%
Appearance of timber	5	11.1%
Others	2	4.4%
Total	45	100%

(Source: Field survey, 2020)

Apart from the chemical properties considered when choosing timber species for building construction, there are other factors that influence the choice of the timber species as well.

From table 4.15 above, out of a total of 45 respondents, 16 respondent representing 35.6% are of the view that a major factor that influences the choice of particular timber specie for building construction was the preference of the customer. 10 out of the total 45 respondents representing 22.2% stated the strength of timber as a factor that influences the choice of particular timber specie for construction work. Availability of the timber specie was the response of 12 out of the total 45 respondents representing 26.7%. 5 respondents representing 11.1% of the total of 45 respondents also stated that the appearance of the timber specie was another determinant the influences the choice of timber for construction works. It was however disclosed by 2 respondents representing 4.4% of the total 45 respondents that, the cost of timber and the type of work to be used for sometimes also influences the choice of particular timber specie. This constitutes 'other' from table 4.15 above.

In conclusion, the above information indicates that customer preference was a major factor that influences the choice of particular timber specie among Small and Medium Scale building contractors in Ghana.

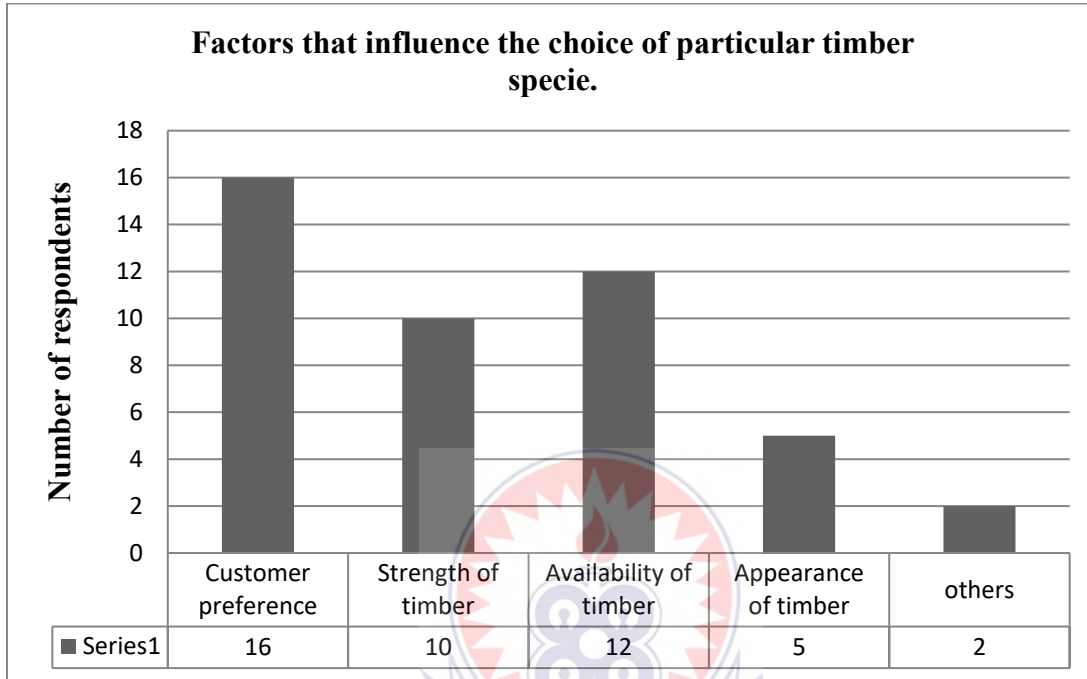


Figure 4. 12: Factors that influence the choice of particular timber specie

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the summary of findings, conclusion and the recommendations of the research. Appropriate recommendations have been made to address the issue of total extinction of the traditional known timber species used in building construction and the sustenance of the trends in the usage of timber species among Small and Medium Scale building contractors in Ghana.

5.1 Summary of the Study

This research was made to establish the trends in the usage of timber species in construction among Small and Medium scale contractors in Ghana in the past decade. This was necessitated as the results of the disappearance of the traditional known timber species such as Odum, Mahogany, Wawa, etc used in construction activities. To sustain the Small and Medium scale building construction industry in Ghana, a number of equally good timber species were identified through this research to be promoted and use to serve the same purposes as the traditional known timber species used in construction in Ghana.

The chapter was organized based on the following research objectives.

1. To determine timber species that were been used in the past decade by small and medium scale building contractors in Ghana.
2. To establish the current timber species being used by small and medium scale building contractors in Ghana.
3. To determine factors that influences the choice of particular timber species in building construction in Ghana.

The following research questions were formulated to guide the study:

1. What timber species have you been using over the last ten (10) years? Please list them in the table below and indicate what you use them for.
2. Do you have preferences for specific species? Yes [] No [], List those species and indicate why you prefer it or them over others.
3. Are you still using your preferred species for your construction works? Yes [] No [], If No, what do you think is/are the challenge(s)?
4. What timber species are being used by your company for construction? Kindly list the species and their uses in the table below.
5. What are the factors that influence the choice of particular timber species for building construction?

The research established that;

1. A greater number of Small and Medium scale construction professionals (contractors, quantity surveyors, Civil engineer, Supervisor/foreman etc) have relied on the use of the traditional known timber species over the past decade, hence their unavailability on the local timber market resulting in a change of trend in the use of timber species in Ghana.
2. Subaha, Essa, Dahoma, Emire, Bese, Okoro, Watapuo, Essia, Senya, Konkroma, Apro and Rosina are best used for roofing of buildings in the absence of the traditional known timber species among small and medium scale contractors.
3. 53.3% of small and medium scale contractors use Konkroma, Senya, Essia, Teak, Sapele, Watapuo, Essa, Dahoma, Emire, Sese, Bese, Okoro, Apro and Rosina for door frames in their building construction works.

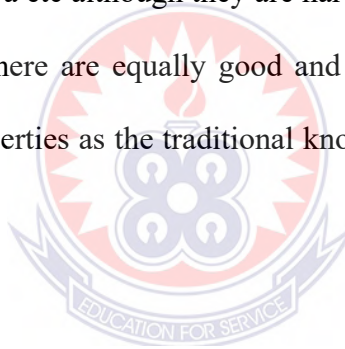
4. Essa, Bese, Watapuo, Konkroma, Dahoma, Sese, Sapele, Essia, Teak and Okoro are used for the construction of window frames in building construction works in recent times.
5. Ofram, Sapele, Teak and Rosina are considered the options to sustain the building construction industry as far as door panels are concerned.
6. Essa, Dahoma, Konkroma, Apro, Teak, Bese, Subaha, Ofram, Okoro and Nyamedua are the most current timber species being used among Small and Medium Scale building contractors in Ghana.
7. Customer preference was a major factor that influences the choice of timber species as far as building construction is concern.
8. Bamboo, a non- traditional timber specie trough the research was found to play a major role in the building construction industry.

5.2 Conclusion

Based on the findings of the research as summarized above, it is concluded that;

1. The extinction of the traditional known timber species used by small and medium scale building contractors is as a results their over exploitation in the construction industry.
2. The properties of many of the lesser-known timber species are good substitutes for the traditional known timber species.
3. Essa, Konkroma, Apro, Teak, Bese, Subaha, Ofram and Nyamedua are the most current timber species being used in their building construction works.
4. To be used as roofing members, small and medium scale contractors can rely on the following timber species; Essa, Okoro, Apro, Watapuo, Dahoma, Konkroma, Senya, Teak, Bese, Subaha and Ofram.

5. For door and window frames, Essa, Okoro, Rosina, Apro, Dahoma, Watapuo, Sese, Teak, Subaha, Bese and Konkroma are best substitutes to the traditional known timber species.
6. Despite the durability and the artistic nature of Odum and Mahogany; Ofram, Sapele, Teak and Rosina are the most current timber species used for door panels.
7. Lack of re-planting of the over exploited traditionally known timber species.
8. Negligence of the forestry commission to check on the poor logging practices, for example cutting of immature timber species by timber companies and some chain saw operators.
9. Lack of education on the importance of some timber species to the building construction industry especially to the charcoal burners.
10. Odum, Mahogany, Wawa etc although they are hard to be obtained in recent times for use in building construction, there are equally good and important timber species on the market which have similar properties as the traditional known timber species for the survival of the construction industry.



5.3 Recommendations:

Based on the conclusion of the research as above, the following recommendations were made;

1. The application of lesser-used species (LUS) in building construction be promoted to prevent the total disappearance or extinction of the traditional known timber species.
2. More research should be carried out on the strength and properties of other timber species to be used to serve the same purposes as the traditional known species in the construction industry. This will reduce the over exploitation of the traditional known timber species.
3. Essa, Okoro, Apro, Watapuo, Dahoma, Konkroma, Senya, Teak, Bese, Subaha and Ofram are popular timber species among small and medium scale contractors.
4. Essa is very strong, artistic, easily obtained, resistant to insect attack and good for roofing.

5. Bese has self-protective chemical that prevent insect attacks, very strong for roofing, door and window frames.
6. Okoro is good for roofing, door and window frames, last longer if well-seasoned. Always available on the Ghanaian local timber market.
7. Senya, easily obtained, good for roofing, door and window frames.
8. Teak is very strong, good for furniture, roofing, door and window frames, has nice patterns, resistant to insect and fungi attacks, gives good finish when polished and easily obtained.
9. Sapele, easily acquired, good for door paneling, has very good finish when polished.
10. Konkroma, good for roofing, door and window frames, always available on the Ghanaian local timber market, does not warp.
11. There should be the urgency of education on the importance of some timber species to the building construction industry especially to the charcoal burners and other stake holders to protect the identified and promoted timber species.

5.4 Suggestion for further studies:

The researcher would like to suggest that more research is carried out on the strength properties and application of lesser-used species (LUS) identified and be promoted and used by Small and Medium Scale building contractors in Ghana to help sustain the building construction industry in future.

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APPENDIX A

UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION - KUMASI

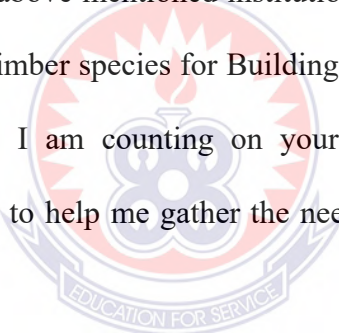
DEPARTMENT OF CONSTRUCTION AND WOOD TECHNOLOGY

MASTER OF TECHNOLOGY EDUCATION IN CONSTRUCTION TECHNOLOGY

QUESTIONNAIRE FOR BUILDING INDUSTRIES/PROFESSIONALS

Introduction:

I am a final year student of the above mentioned institution and I am conducting a research on the topic: “Trends in the usage of Timber species for Building Construction among Small and Medium Scale Contractors in Ghana”. I am counting on your expertise in the building industry by responding to this questionnaire to help me gather the needed information to make this research a success.



Please this research is purely for academic purpose and all information given would be handled as confidential as possible.

Thank you for the acceptance and assistance.

Instruction for completing this Questionnaire: Please kindly tick (✓) in the box provided where applicable to indicate your choice of response and also write briefly where applicable in the spaces provided.

SECTION A: DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

1. Name of Company:.....

Address of Company:.....

Contact of Respondent:

2. Gender: Male [] Female []

3. Position:

Supervisor [] Project Manager [] Structural Engineer []

Architect [] Quantity Surveyor [] Civil Engineer [] Other:

4. Level of Education: WASSCE [] HND [] BSc. [] MSc. [] PhD []

5. Years of working experience:

1 - 5 years [] 6 – 10 years [] 11– 19 years [] 20years and above []



SECTION B: TRENDS IN THE USAGE OF TIMBER SPECIES FOR BUILDING CONSTRUCTION

6. What timber species have you been using over the last ten (10) years? Please indicate them?

.....
.....

7. What timber species are currently being used by your company? Please indicate below.

.....

.....

8. Are the preferred species stated above still available?

(a) If yes, please indicate below.

.....

.....

(b) If no, what are the challenges for their unavailability? Please state below.

.....

.....

9. Kindly indicate timber species and the job used for in the table below. *For example Roofing members, Door/Window frames, Door/Window panels etc*

TIMBER SPECIES	USES

11. What are the factors that influence the choice of particular timber species for building construction?

Customer preference [] Strength of timber []

Availability of timber [] Appearance of timber []

Other(s) please specify below;

.....

.....



APPENDIX B

PICTURES OF SOME LOCAL TIMBER MARKETS IN GHANA



SOKOBAN WOOD VILLAGE:

The biggest local timber market in Kumasi, (Ghana).



AHWIAA TIMBER MARKET:

The second biggest timber market in Kumasi, Ghana.



A truck of timber being off-loaded at a local timber market.

Different timber species sawn into different sizes staked at local timber markets.



Wood
wood Esah and Dawoma



Building Materials, Wood
Cyber Board



CREDIT: (i) globest.com (ii) tropenbosghana.org (iii) iengineeringmall.com

Pictures of some other uses of timber in building construction:



(a) Wooden staircase



(b) Door panel with frame



(c) Timber for decking (floor) and props



(d) Scaffolds made of timber



(e) Office Cabinet



(f) Kitchen cabinet



(g) Wooden Door panels