UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

DESIGNING FOR STRENGTH AND AESTHETIC; EFFECT OF DOWEL DIMENSION ON THE STRENGTH OF RATTAN FURNITURE.

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M.TECH. ED. (WOOD TECHNOLOGY)

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BY

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DECLARATION

I Nelson Yram Kofi Amekah hereby declare that this thesis, with the exception quotation 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.

Candidate signature:……..Date: …….

NAME: NELSON YRAM KOFI AMEKAH

SUPERVISOR'S DECLARATION

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

Signature……Date …….

NAME: PROF. MARTIN AMOAH

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DEDICATION

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ABBREVIATION AND ACRONYMS

MDF	-	Medium Density Fiberboard
PB	-	Particle Board
FPRDI	-	Forest Product Research and Development Institute
NTFP	-	Non – Timber Forest Product
FC	-	Forest Commission
CSIR	-	Council for Scientific Research
ITTO	-	International Tropical Timber Organization
LUS	-	Lesser Used Species
NPD	-	New product Development
RMQD	-	Ranking Method Quality Development
FMEA	-	Failure Mode and Effective Analysis
INBAR	-	International Network for Bamboo and Rattan
MOE	-	Modulus Of Elasticity
MOR	-	Modulus Of Rapture
MC	-	Moisture Content
UF	-	Urea Formaldehyde

ABSTRACT

Although research on rattan care furniture joints has received significant attentions i.e. nailed, nailed and bound with rattan rops, screwed and screwed and bound, little research has been performed with respect to dowel connection, particularly in the area of rattan cane chair. Nine chairs from rattan with dowel joints were manufactured. Using questionnaire, the chairs were evaluated for aesthetic, functionality, environmentally friendliness, purchased intention durability and strength. The questionnaire was administered to 100 sandwich students from University of Education Winneba – Kumasi. Personal observations were also used in the data collection, photographs of the products were taken for more understanding of the manufacturing processes. The result showed that product aesthetic, functionality, environmentally friendliness and purchased intention supported the innovation of the rattan cane chair, whereas mixed result emerge from durability and strength of the chair. The most important drive of preference for the rattan cane chair was aesthetic followed by functionality, environmentally friendliness, purchase intention, durability and strength as the lowest. Recommendations were made to draw attention of rattan furniture industries in Ghana to improve on the use of rattan cane to help arrest the current situation of depending solely on our local wood resources in producing wooden artifacts. The study concluded that further research should be geared towards improving the design in the near future, the focus should be on durability and strength that could meet international standards to enhance trade.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The strength characteristics of furniture manufactured from wood and wood- based panel depends directly on the physical – mechanical properties of its structural materials and stiffness strength of employed connections. However, in some cases due to inappropriate design of the joints, failure occurs in furniture even below the ultimate load – carrying capacity of the connections and materials used (Maleki et al, 2012 Derikvand et al, 2014).

Podlena et al (2017) attempt to arrive at a product, which is not only aesthetic and functional but also sturdy and not over – invested materially draw the attention of designers to rigidity – strength problems of designed furniture. In wooden structures, joints are one of the most important parts of the structure; joints provide continuity to the members and the strength and stability to the structure. The structure and stiffness of joints used in wooden structures will determine the structures strength.

According to Eckelman (2004), wooden dowels are one type of fastener for joints in wood constructions. There are currently a wide range of types and sizes of wooden dowels available on the market. Their nominal dimensions are usually given in SI (metric) or customary (English) unit. To apply joints in structures, it is first necessary to understand their loads bearing behavior to select the correct material parameters.

Davland et al (2014), and Zhang and Eckelman (1993), ascertained that the diameter of the dowel and depth of penetration have a significant effect on the bending moment for tests under compression, for example with 19-mm plywood, the highest strength was achieved when increasing the dowel size from 6mm to 8mm. however, when the dowel size was increased to 10mm, there was a decrease in the bending moment. When multi

– pin dowel connection is used, it depends in addition to the diameter and depth of the dowels. Also on the number of dowels and their spacing (Derikvand and Ebrahimi 2015). Moreover, bending moment can also be derived during the testing of torsional strength (Zhang et al 2002b)

Dowels are also often subjected to shear stress in timber engineering (e.g beams) in two main stress. The first is a single shear dowel – type joint (Bocquet et al 2007; Milch et al 2017).

There are various joining techniques by which furniture structure can be constructed, while dowel joints are among popular ones, two – three and multi pin dowel joints are commonly used in the manufacturing process of furniture, dowel joints are best suited for small members in table and chairs and specifically for case – type furniture, bookshelves and kitchen cabinets made with wood – base panels such as medium – density fiber board (MDF), particle board (PB), plywood etc. given the widespread popularity of dowel joints in the furniture industry, several studies have been conducted so far to optimize the design performance of the dowel joint,(yerlikaya 2013).

Eckelman (2003), emphasized that joints are generally the weakest part of a piece of furniture, and they cause of failure. He also has reported that the strength and stiffness of joints used in furniture construction normally determine the furniture's strength and rigidity. Cost is a consideration of furniture assembly, dowel joints can be used instead of furniture joints, including mortise and tenon joints. Because of their low cost and favourable production characteristics dowel pins have traditionally been a favourite connector in the furniture industry. Dowel pins are also self – aligning and locate parts for further assembly without the use of jigs.

Ratnassingam et al (1997), stated that strength of dowel joints is lower than that of mortise – tenon joints, however, almost 80% of all mass produced furniture in the Asian region use the dowel joint.

The rational design of chairs to meet demanding service requirements dictates that the design of the joints and members used in construction of the chairs can be precisely determined as a function of the highest loads to be expected in service with respect to joints, this procedure requires that the moment capacity of the joints as determined by individual joint tests.

The numbers which construct the chair frame system are joined at the required points with different joint techniques. Chair frame should resist the destructive forces in time of usage strength of joints represents the entire system of chair frames. So the joints which are most critical parts of the chair frame should have enough strength. To develop a reliable system, it should be set properly the data of joint strength and the features of mechanical behavior properties and take concern to improve the strength (Kasal et al, 2015).

Bahlman 2011; Hrovatin et al, 2013 and Pantaleo et al 2013, demonstrated that dowel joints provide many advantages for manufactures. The top and bottom rails are always shorter by two widths of a bonded profile because they do not need material for the creation of joints, such as in the case for an opened Tenon and Mortise Joint, drilling dowels uses energy than milling and less waste is created. The production process is thus simplified and faster; due to the necessary profiles and holes for the dowels being formed by one machine. This increase manufacturing productivity and reduces production costs.

Santos et al(2009), Oudjene and Khelifa(2010), Resch and Kaliske(2010), Moreover, Zhang et al (2002a), reported about leteral shear strengths for horizontal and vertical rail directions for furniture applications.

Edge withdraws tests or face withdrawal tests can be summarized in the last group of testing methods. For example, beach dowel with diameters of 6mm, 8mm and 10mm were used in the control samples of particleboard and medium – density fiberboard (MDF). The highest withdrawal strength was observed using 6-mm dowels with particleboard, whereas the MDF, the highest strength was observed for 10-mm dowels. Kuvt et al (2009), this noted difference is explained by the board composition and their homogeneity of all of the above – mentioned test, this method aptly measures the shear stress of dowels in different material; hence this method was selected for the testing of various dowels in this investigation.

It is important for joints to be designed in a proper way so that they can carry loads safely in service conditions without excessive deformation or failure (Eckelman 1979). Fortunately, one of the main advantages of wood as structural materials is that structural elements can easily be connected with a wide range of fasteners joints may entirely consist of wood members. Joints are critical links between elements of a structure and provide structural rigidity.

Perhaps dowel joints are the most popular method of jointing members together in wood fram construction, for example cabinet or furniture making (Eckelman, 1971).

Modernized version of common joints developed over time to speed manufacturing or accommodate new materials. A dowel joints is by product of industry. They make quick work of journey by eliminating time – consuming fitting of joined elements and are alternatives that should find an appropriate place in every woodwork is repertoire.

A dowel is a solid cylindrical rod usually made of wood. Dowel rod is employed in numerous diverse applications. It is used as structural reinforcement in furniture and cabinet making. Dowel rod is often, cut into – short length before using (Noll T. 2002). The designs of construction have been carried out as a result of trials and error methods. Joints are generally the weakest part in the construction of furniture. Therefore joints design is the most important step of furniture production (Eckleman, 2003).

FPRDI (2001) emphasize that rattan is one of the most important non-timber forest products (NTFP) in the Philippines. It is in great demand for furniture and handcrafts for local and overseas markets. The country's exports of rattan furniture alone averaged US$119 million per year from 1994-1998.

Rattan is a climbing palm with unique physical and mechanical properties. It is light and has good strength properties but the main attribute of the material that influences product designs and quality, whether in round pole or split form, is its flexibility, round poles of rattan furniture and handicrafts.

The bending of rattan poles into the desired shape is traditionally done with a blowtorch. This process produces scorch or burn marks on the surface of the bent items and this consequently degrades products quality and value. The most efficient bending method involves plasticizing the stocks for a suitable period in a steaming chamber prior to bending to the required shape with the aid of appropriate bending jigs. After this the bent pieces are dried to the required moisture content in restrained mode before product is assembly.

Rattans are climbing palms exported for their flexible stems, the canes, which are extensively used in the furniture and handicraft industries. The rattan furniture is considered as a novelty with great demand in the world market. Rattans provide gainful employment to many people in rural and remote areas particularly the tribal people.

Rattan is perhaps the most extensively traded non-timber forest product (NTFP), the value in annual global trade being over US$7 billion (Sastry, 2002). About 95 million people one estimated to be involved in growing, harvesting, processing, trading, and using cane and products. Undoubtedly furniture is the most popular rattan product. Besides furniture, other products include carpet, walking sticks, umbrella handles, sporting goods, hats, ropes, cordage, matting, basketry, paneling and host of other utility products.

1.2 PROBLEM STATEMENT

For years wood has been the number one choice of raw material for the Ghanaian construction industry, and the furniture production in particular. In recent times, supply of wood in terms of species, quality and quantity to the domestic market has been erratic.

According to forestry commission (FC) report; council for scientific research (CSIR) (2009), lumber is obtained from three sources: bush cut, bush mill and saw mill. The dominate sources is bush cut representing about 76%. This is against the backdrop that it is criminal to produce the bush cut, should there be an implementation of the outright ban on the illegal chain saw operation which unarguable, is behind the dominance of the bush cut sources on the timber markets, acquisition of wood would be very difficult to come by.

The use of rattan as a substitute or alternative for wood is in ascendency in several rattan producing countries (Liese, 1999). There is the need for Ghanaian to follow suit. Cane and rattan is used all around the world, and can be used for weaving baskets, for hampers, chairs, beds, tables. (Gardenvisit, 2014).

It is anticipated that if the taste for rattan products increases and the manufacturing processes made very easy, the demand for timber (exploitation and depletion) will decline and therefore the supply for timber would also see a corresponding decrease, for the country to our forests at the socially ‘’optimal’’ level of timber exploitation and trade (i.e. sustainable timber management)

Ghana is constantly and consistently losing its high natural forest and subsequently most traditional tree species are getting depleted. It is high time to identify why Ghanaians are hesitant to patronize the furniture products from other locally natural obtained material other than wood. The main objective of the study is to ascertain the level of interest of Ghanaians in furniture products designed and manufactured from rattan other than wood as well as to create an innovative design solution for a simple rattan cane chair.

This study is to investigate the strength of dowel joints, aesthetic value, physical and mechanical properties of rattan as alternative engineering materials.

1.3 PURPOSE OF THE STUDY

The primary purpose of the study was to design and assess the strength of dowel dimensions in leg- and rail of rattan chair construction and utilization potential of rattan furniture.

OBJECTIVES

Specific objective were to;

- Assess the strength of dowel dimensions in leg- and –rail assess of rattan chair
- Assess the functionality and physical properties of the rattan chair.
- Determine the level of preference of people for rattan furniture on the market.

1.4 RESEARCH QUESTIONS

To what extent does the strength of dowel joint dimensions influence the durability of rattan furniture?

What are physical properties and functionality of rattan furniture?

What is the level of utilization of rattan among furniture products?

1.5 SIGNIFICANCE OF THE STUDY

Wood availability is the single most important consideration for timber industry in the world forest products research and development institute (FPRDI) and international tropical timber organization (ITTO 1997). However, the industry's survival is threatened because the amount of wood required annually cannot be met due to scarcity of timber (Adekunle et al.., 2013).

Manufacturers and end users have held onto over diminishing primary species, which has resulted in excessive pressure and over- exploitation of traditional timbers. Much attention is therefore needed to promote lesser use species (lus) that could substitute the declining level of the traditional species (Ayarkwa, 1998).

Timber selection for wooden products manufacture is based on information on its properties, which is often not available for several secondary timber species (Ayarkwa, 1998). Investigation into the properties, of rattan would enhance its utilization structural material, increase the wood raw material stock and contribute to minimize the pressure on the highly utilized primary timber, Erdil et al (2005), Likos et al.(2012) and Smardzewskiand Majewski (2013) asserted of furniture largely depends on its joints and the type of timber used for its parts.

In most cases, LUS recommended for furniture lack information on the best joints that must be employed to produce furniture with great strength. Addae – Mensah (1998),

Bavany et al;(2003) and joint selection is normally left to the discretion of manufacture whose choices may compromise the structural rigidity of the entire work pieces (tankut 2007). Thus, joints that ensure great strength of furniture and joinery products from rattan ought to be established to guide furniture designers in their choice. It was also important to identify the current challenges associated with utilization of NTFP by the furniture industry and to propose ways of solving them in order to ensure consistent supply of timber to the industry in future.

1.6 SCOPE OF THE STUDY

The study determined the strengths of dowel of various dimensions. It further investigated the level of usage of rattan in the operations of furniture manufactures and the anatomy of rattan including its fibre and vessel as well as its durability, moisture contect (mc), density, shrinkage and swelling characteristics, moduli of rapture and elasticity, compressive and shear strengths parallel to the grain.

1.7 LIMITATIONS

An obvious limitation of this study is its geographical delineation,

Lack of rattan pole steam-bending technology required considerable capital for equipment and skilled labor.

For this reason, presently the technology is only commonly used by the export oriented, medium to large-scale enterprises that mainly supply rattan furniture and handicrafts to export market.

Which involves plasticizing the stocks of rattan for a suitable period in a steaming chamber prior to bending to the required shape with the aid of appropriate bending jigs was not available.

Also lack of finance and sponsorship could not make it possible for the writer to go to source of some of the rattan growing area (collection point) for the selection of materials.

The small scale enterprise that mainly produce rattan furniture within the Greater Accra Region therefore was compelled the designer to use the traditional method of using blowtorch for bending the rattan poles.

Time schedule under the conditions was such that the writer had focused the study on few places in the Metropolis.

1.8 ORGANIZATION OF THE STUDY

This study consists of five chapters investigating the effect of dowel joints dimensions on the strength of rattan furniture. Here is an overview of the content of each presented chapter.

Chapter one introduces the problems, gives an overview about the study and describes the needs of using rattan with dowel joints. It also discusses the scope the study, the significance of the study and its objectives.

Chapter two contains the literature review which is the previous related works that has been done before. Moreover, it also present relevant information for the understanding the study more.

Chapter three: this chapter contains details of the selected methodology that were used in the manufacturing of chairs from rattan.

Chapter four presents the findings and discussions of the processed data collection from the laboratory test.

Chapter five provide a discussion of the main findings of the data obtained through data collection instruments.

And chapter six summarizes the key findings for the study, it also present the recommendation and future works to improve this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 THEORETICAL FRAMEWORK

The study in furniture designing has various objectives such as to develop new product, to improve manufacturing process, to improve present product and processes, to find extra benefit on present or reject product, to find technical data for main division in the organization, to analyze the competitor's product and to find and extend the knowledge which is the main reason of furniture research as well as this study (Youdhagarn, 2007)

Hovgaard and Hansen (2004), suggest that new product development, adoption of new or improve processing technologies, and business systems are three types of innovation in the forest products industry. New Product Development (NPD) is probably the most researched type of innovation. Benefit of successful NDP include achieving competitive advantages, increasing product value, and gaining more access to the market place (Bumgardner et al, 2001).

Domljan et al (2006), Horvat et al (2008) observed that, the world of furniture market is getting more complex than it was before. In order to measure consumer needs, preferences and habits, it is important to improve contemporary values of furniture. In recent years it is evident that the habits of buying and using furniture have been a changed. The fabrication of individual pieces of furniture is increasingly coming to the forefront. A personal contact is being established between the customer and the furniture, which is a relationship of one (product) to one (customer). In order to satisfy the individual demands, higher quality as well as higher price appeared as a necessity. In the competition that occurs on the market, when choosing furniture, preference is given to individuality and emotions (Domljan and Grbac, 2014).

Raport DTI (2005) established that there are various factors that influence customer decisions when buying furniture, price, quality reliability, etc. therefore, functionality and aesthetic functions determinative forms and fashionable style play a very important role in furniture design and production. Those parameters, usually connected with visual as parameters of the design, are measurable, as well as other designers, parameters appearing in the product, by using special designer's methods such as function analysis, questionnaire research, ranking method, quality development (RMQD) and failure mode and effective. Analysis (FMEA) (Antal, 2007, Laurel, 2003).

Jariya (2000) recommended that a good furniture design must answer to the main objective of effective creative design in various ways such as ease in use, ease in manufacturing and ease in distributing using these evaluation criterions:

- Good function and aesthetics
- Strength and durability
- Economy
- Appropriate structure
- Personality/identity
- Beauty causing positive
- Response by customers.

2.2 STAGES IN THE DESIGN PROCESS

According to Choodoungand Smutkup (2012) the following design process includes the following.

- Planning for design: Is the initial process of furniture design. The designer must identify customer group which leads to demand of the market, designer may plan for the product that already has its demand in the market then finalize the decision and conclude the expected design as well as plan the guideline (list) for the task;
- Production specification: Begins with specific feasibility study of related furniture in target customer group. The designer must obviously state about production technology level, and basic information preparation.
- Concept design: Is concept presentation of the furniture which comprised of concept generation based on basic information experienced, and skill of the designer, then will be concept selection and concept testing.
- Product Architecture; Is involving with various parts including design development, costing, prototype construction and prototype testing.
- Industrial Design: In real, furniture industrial design designer must start with a process in design revision. The designer and manufacture must verify the design then the designer will begin production drawing again specially for manufacturing. Thus, this process must concern about design for manufacture and assembly for efficiency in manufacturing process. In addition, for longer furniture's life the designer may apply robust design with the furniture works.
- Production: for production process, the designer should cooperate with manufacture as well as examine the product in every process with engineer (Youdhagarn 2007).

2.3 FACTORS INFLUENCING DESIGN OF FURNITURE

2.3.1 Ergonomics Principles

Morag (2003), observed that ergonomics is about "fit" the fit between people, the things they do, the object they use and the environment they work in sitting on a comfortable seat advances the comfort, health, well-being and safety of the person who uses the chair.

The thought of ergonomic is to bring comfort and well being to participates who will patronize the chair, a chair which is ergonomically designed helps to concentrate and work in a comfortable posture for long periods (Trevelyan and Legg, 2006). Ran (2009) mentioned that Ergonomically designed products enhances product comfort and easy use, also proposed that backward tilt of the seat surface of 20^0 to the horizontal to prevent buttocks sliding forward and a lumbar support of the back rest enclosed at 102^0 to the seat surface where applied in the design.

2.3.2 Anthropometrics in Design

Anthropometrics is the study of human body dimension that relates to the initial measure and sizes of a piece of furniture (Deros etal. 2009). Openshaw and Taylor (2006). In designing products, one has to note that users come in many sizes and shapes. The body measurements of the user population are very important as far as workstation design is concerned. This enhances conformability and health posture (Helander, 1997). Anthropometric data are used for proper design of workstation, equipment, and furniture (Mirmohanmmadi et al, 2011).

Ismaila et al. (2012) found that the human body measurement for a target population that is reliable is important in designing a product to suit the user. This may advance

the comfort, health, well-being and safety of the one who uses the furniture. (Pheasant 1998; Baqrroso et. al., 2005, Tunay and melemez, 2008).

2.3.3 Form of a Product

According to Choodoung (2012), form of a product refers to compactness; overall shape of the product must be unified and the exterior must be paralleled or systematically unparalleled. Therefore the best design for furniture is geometric form because of consistency in shape of the material finished in wood industry as well as ease to produce such shape with machine.

Simplicity: the design of wood products used in daily life should not look unpleasant. Therefore, it should be a shape that blends in with its surrounding environment, usually; the geometric form is a simple shape. Originality/identity. The product in designed to represent a unique shape.

2.3.4. Functionability

Antal (2007), explained that function can be expressed as the properties related to the use of a product. These properties include the relation between a product and a customer. One of the bases of purchasing motivation, the system of functions can be divided into:

Functionality (e.g. utility and practical function) and aesthetic function (e.g. visual sensation, emotions).

2.3.5 Aesthetics in Design

Karl (2007), explained that most users of an artifact will prefer a beauty artifact to an ugly artifact, even in highly functional domains such as scientific instruments.

Thus, beauty can be thought of as "just another attribute"; in a user's evaluation of preference, alongside durability, ease of use, cost and safety. In this respect, the aesthetic quality of an artifact is an important factor in providing a satisfying user experience, the prime motive for design.

Second, the aesthetic response to an artifact is usually the first response to the artifact. First impressions matter and overcoming an initial aesthetic repulsion is a substantial challenge for the designer but avoid in the first place.

Third, beauty may serve as a signal for unobservable attributes of quality, much as a brand does for products and services. In such cases, beauty itself is less important than what else the observer may infer from an exhibition of beauty.(http://creativecommons.org/licenses/by-nd/2.5/)

2.3.6 Rational Strength Design

Naturally, furniture has some features that required specific scientific consideration. However, the principles of structure mechanics can be applied as they applied to any other engineering structure.

Hindsley (1968), dealt with the design of chairs. He indicated that the first essential element in designing any framework is to consider what loads it may be called upon to bear so that the designer may make it adequately strong. He divided the loads on chairs onto three classes, functional, non-functional and dynamic.

Even though hinders made this load classification for chairs, it could be applied to any other furniture structure.

According to Eckelman (1988), in developing performance tests for furniture, the following procedure is typical; observe how the furniture is used in service, obtain

reasonable estimate of the load applied and their frequency of occurrence; based on the observations, develop a test method that simulates user service action.

During the course of its service life, furniture is subjected to respected normal load applications, along with occasional chance abusive loadings. While the furniture is relatively new and retain a high degree of its initial strength, it is able to resist these loads. As its strength decreases with time. However a point is reached when the magnitude of overload exceeds its residual strength and the furniture fails (Eckelman, 1988). The main purpose of reliability is to obtain information regarding failures, in particular, the tendency of the product/equipment to fail as well as the consequences of such failures. In the design and development of the products, the first prototype usually contains various design and engineering related deficiencies.

According to Benton and crow (1989), the reliability of a new design product or system could be very low, i.e. 15% to 50% of the mature design capacity.

2.4 RAW MATERIAL

2.4.1 Overview of global demand for ratten resources

Rattans are climbing plants that belong mainly to the genus *calamus* or other general of the sub-family *calcamiodeces* (Schutt et al 2002; siebert 2005). They can be found in the tropical regions of Asia, Africa and Australasia (Shaanker et al, 2004).

Rattan is one of the most important non-timber forest products (NTFP) in the Philippines. It is in great demand for furniture and handicrafts for local and overseas market.

Rattan has unique physical and mechanical properties. It is light and has good strength properties but the main attribute of the material that influences product designs and quality, whether in round pole a split form is its flexibility. Round poles can be bent

into various forms and shapers for the structural and decorating-components of rattan furniture and handicrafts (INBAR, 2001).

Humans have used rattan for their livelihoods and subsistence for many centuries. Although rattan is confined mainly to south East Asia, the material has found its way to many other parts of the world throughout history (UNIDO, 1983). Almost all rattan is collected from natural forest. In recent years, uncontrolled harvesting and deforestation have exhausted the desired species in many rattan –processing countries in Asia. Yet only a small proportion of the approximately 600 species of rattan are used for commercial purpose. There is potential to develop some of the currently underutilized and lesser known species.

Additional benefits may occur from intention in the sector to systematize resource use, management, marketing and processing IFAD (1991) Manokoran, 1990; Wan Razali, Dransfield and Manokaran, 1992). Genetic conservation of rattan resources for sustainable supply of the material could involved:

2.4.2 Cultivation

Resources for sustainable supple of the material could involved; According to Manokaton (1985), this approach could be applicable only for elites species. Almost invariably the genetic base is narrow because seedlings for planting would have come from a limited number of mother plants with no criteria applied in seed collection.

2.4.3 Seed banks or tissue-cultured

Some exchange of seeds had been taken place in the last few years between countries such as Malaysia, China, Indonesia, India and Thailand (Mori et al, 1985). The seeds or the plants raised were expected to be planted in the respective rattan gardens in order

to help redistribute genetic materials to preserve diversity. It was noted that rattan seeds were recalcitrant as the seed storage viability was very low, frame 7 to 15 years.

Moei et al, (19985) explained that the conservation of the system through the establishment of national reserves is a means of conserving the vigor and variability of the wild germ plasm, rattans with increasing economic value will have to be widely available for purpose of selection and breeding.

2.4.4 Promoting less known species

"There is the need for botanical surveys to discover unknown rattans of high quality form regions where the flora is less known" (Dransfield, 1985), such species need to be introduced into cultivation and the use of these canes promoted. At the same time, good quality species form one area need to be introduced into cultivation in other areas so as to prompt their usage.

2.5 RAW MATERIAL SUPPLY

2.5.1 Rattan

Rattan is extracted mainly from forest reserves, cleared of spines, leaves etc., and bundled for sale in urban markets in Accra, Kumasi, Takoradi and Asamankese. It can also be supplied directly by some processors in these areas. Collected poles may also be sold in rural markets for commercial processing and household use. Collectors based in rural areas may possess some of the rattan for sale and or used some of the rattan for their household needs. Middlemen and few collectors may export rattan to market centres in La Cote D'lvoire, Togo and Nigeria for better prices. Traders from some of these countries in the West Africa Sub-region may purchase rattan directly from collection areas, or from the urban markets for sale in their countries (Oteng- Anoako

& ObiriDarko, 2009). In the Accra Metropolis, the study area, it was discovered that apart from Western Region, some of the raw materials were also obtained from Kubease Forest. Abofour and Obuasi.

2.5.2 Categories of rattan Collectors.

Two categories of rattan collectors are in urban and rural areas were identified. The urban collectors from the majority of collectors interviewed. They may be based in rural or urban areas, but collect raw rattan purposely for sale and use in urban areas such as Accra, Kumasi and Takoradi. Rural collectors on the other hand, were solely rural-based, collecting raw rattan for sale to middlemen and processors, or for use within the rural areas (Belcher, 1995).

Both categories of collectors could operate as individuals and or in a collection term. The average number of people in a collection team was five, ranging from two to fifteen people. The term was referred to as "Gang' among collectors. A gang may be made up of individuals responsible for financing their own collection operations with respect to payment of royalties, permit fees, food and transport, etc. but who pool raw rattan collected together in bulk to facilitate transportation to centres for processing or sale (Oteng-Amoako & Obiri Darko, 2009). Alternatively, a gang could consist of a leader (referred to as "master") and his subordinates (known as "boys"). The master finances all expenses incurred in the collection process (payment of royalty fee, food and transport and others) while the boys do the actual rattan collection/harvesting from the forest. The boys are remunerated by the master from proceeds realized after the sale of the harvested rattan.

Falconer (1994) explained further that processing of the rattan at both rural and urban levels is largely on a small-scale basis. The same entrepreneur does both the primary

and secondary processing manually. Furniture, shopping and laundry basket, serving trays and other handicrafts are the major project from urban processors while carrier and storage baskets are the main products at the rural areas. The urban products are sold mainly to urban consumers consisting of locals, expatriates and tourists. A small quantity may be exported to Europe. At the rural level, local carriers and storage baskets may be sold on domestic, urban and rural markets. Some are also exported to markets in coffee and cocoa growing areas in nearby cote D'lvoire.

2.6 HARVESTING RATTAN

TRDA (2010), noted that the knowledge required for collecting and cultivating rattan has traditionally been passed on from generation to generation. Villagers usually travel in a group of 3 to 5 people to the forest. Rattan collection is simple; the gatherer needs a machete for cutting the rattan and removing the sheath, plus the strength to pull it down from the treetops. Tools used in the process include a hook-like knife tied to the end of a long straight cave of piece of bamboo to isolate climbing rattan and tug on them until they fall.

2.6.1 Impacts of rattan harvests

The increasing international demand, overexploitation is becoming a serious threat to rattan population (ITTO et. al., 2007); Sunderland et al., 2001; FAO 2007; Siebert 2004). Siebert (2004), explained that the current harvest rates are already exceeding the growth and yield of the rattan populations.

2.6.2 Processing raw rattan

From the forest, only the bare canes are carried out to be processed, they are usually cut into smaller pieces to ease transportation out of the forest. Small diameter canes are dried in the sun and sulphur, while larger ones are boiled in oil (often a mixture of diesel oil and palm oil) to remove excess moisture and natural gums. This process also prevents wood-boring beetles from attacking the canes.

2.6.3 Rattan-properties and uses

Rattan can be found in diameters between 3mm to 20 cm (Dransfield et. al., 2002), and are divided into small and large diameter canes. Both are used by locals for everyday commodities, but this study focuses mainly on the large diameter species *calamuszollingeri*, because it is one of the commercially most important species (Siebert 2004).

Rattan is used for many things. It is widely used for making furniture, household items, baskets, and even bridges (Siebert, 2009). Certain rattan species are edible and others can be used as medicine (Siebert, 2004). In summary, rattans are a very valuable, non-timber forest products for everyday life of the local residents.

As a trailer and climber, rattan needs tress to reach up into the canopy where light conditions are better than on the ground (Shaanker et. al., 2004). The scaly rattan that is referred to as a cane, can reach a length of 100 to 200 metres and has many long and pointy thrones and spines which allows it to conquer its climbing habitat (Shaanker et. al., 2004). Since rattan plants are dieocious, ie. Either male or female and only flower after they have reached a length of 30 metres (Siebert 2004). Under intense harvesting pressure they can only regenerate vegetatively to the distraction of their habitant (Shaanker et. al., 2004).

2.6.4 Properties and Qualities

Rattan is strong durable and lightweight. It is often confused with bamboo, however although they might seem similar, there are some important differences. Rattan stems are solid unlike bamboo canes, which means it is easier to manipulate into different shapes. This strong core makes it extremely hard to break and is a good choice for making hardworking home wares such as garden furniture, rattan is the fastest growing tropical wood, typically taking around 5-7 years restore its growth before it is ready to be harvested again, which makes it great sustainable option. (http://www-urbanara.co.uk, 2016).

2.6.5 Properties of Wood Influencing Their Prospective Uses

In spite the versatility of wood, Likoset. al., (2012) and Tankut (2007) explained that timber with specific properties are required for specific applications for example, Discovery communications (2013), observe that since 1900 furniture has been manufactured from *J. Nigra, Quercusspp, E. cylindricum, Acer Saccharum and M. excels*, due to their beauty , strength, durability and workability.

Forest Products Research and Development Institute (FPRDI) and International Tropical Timber Organization (ITTO), (1997). Studies on specific properties of wood are therefore important for ascertaining timbers utilization potential. (Tankut 2007; discovery communications 2013).

Strong (2013) observed that the biological and mechanical properties of wood mostly influence its selection for certain applications. Therefore in order to predict the full range of uses of wood.

2.7 FACTORS INFLUENCING ACCEPTANCE OF ASANFINA TIMBER SPECIES BY END USES

Asanfina is yellow-white to pale brown or pinkish brown, it medium in density, suitable for decorative furniture, joinery and for good constructional timber (Attah and Piston 2003) they observed that it is easy to slice and peels Asanfina upon pre-heating of the log, gluing and nail holding properties and finishing gives very good result, saws fairly but with severe blunting effect on saws when dried. Logs should be extracted rapidly from the forest and /or chemically treated to avoid stain.

It has medium but variable compression crushing strength (479 kg/cm^2) of moisture movement, the bending strength is (1, 192 kgcm^2), modulus of elasticity (112m, 090 kg/cm) and a density of 560 kg/m3.

2.8 BIOLOGICAL PROPERTIES INFLUENCING THE USE OF WOOD

2.8.1. Anatomical properties'

Major cells, that make up tropical hardwoods, are vessel, fibres and parachyma. These cells may be hollow, elongated or spindle - shapenered (McGraw- Hill 2002). Vessels are comparatively large cells with large cavities and open ends that could sap up a plant. Fibres rather have small cavities relatively thick all walls and are the main elements that give strength to wood (Izekor and Fuwape, 2011). Ocloo and Liang (2003) explained that the strength, density, dimensional stability and many other properties, which determines the use of wood basically depend on fibre, vessel and parachyma characteristics such as wall thickness, diameter, length, lumen width and proprietors. Rowell and Winandy (2005) observed that wood density increases as the proportion of cells with think wall increases.

They explained that most high density woods issue more thick walled fibres in relation to vessels and panachyma and subsequently have great bending, compressive and shear strengths. They also turned to be dimensionally stable shrinkage and swelling less. These timbers are good for flooring, furniture, building and bridge construction. Rowell and Winandy (2005) mentioned that in furniture construction, it is important to select wood with narrow vessels in order to minimize excessive moisture absorption, which results in swelling and shrinkage of furniture products. Wood deposits also have great influence on the uses of timber.

2.8.2 Durability

Wood product deterioration is a challenge to consumers. Meanwhile as natural polymer, is prone to bio - degradation by bacteria, fungi and insects (Khatib, 2009). Termits, carpenter bees, ants and powder - post beetles are the major insect pesters to wooden structure (Abood, 2008). Usually the durability of wood is widely correlated with the amount of cellubolytic materials it loses from attacks by bio-degraders (Arango et al. 2006; Ashaduzzaman et al; 2011, Asamoah et al; 2011).

When less bimass is removed wood marginally loses weight and becomes more resistant to bio-degradation (Ashaduzzaman et al; 2011). In order to ensure increased service - life of manufactured products, while minimizing maintenance costs and protecting the environment from harmful effect of preservative chemicals against bio - deterioration (Ashaduzzaman et al. 2011).

In order to ensure increased serviced - life of manufactured products, costs and protecting the environment from harmful effect of preservative chemicals against bio-deterioration Venmalar and Nagaveni, 2005) naturally - durable timbers are highly recommended (Scorttish Wood Ltd; 2000).

Ibach (2013) explained that wood durability and different natural ability to resist insect and fungal decay; timber utilization must be based on the level of resistance to bio - deterioration.

In order to successfully determine the uses of asanfine species, the durability of its sapwood and heartwood was determines in this study using visual assessment, which evaluates the durability of timber from signs of attack on organism in the field. (Ashaduzzaman et al 2011).

2.9 MECHANICAL AND PHYSICAL PROPERTIES INFLUENCING THE USE OF WOOD.

2.9.1 Mechanical Properties.

Mechanical properties of wood are its ability to resist forces that tend to deform it (Smardzewski, 2015). They determine how loaded wood can bear without fracture or undue distortion (Callister and Rethwish, 2012). Wooden structures are subjected to varying forces during their life span, predominantly, compression, bending and shear (Ali, 2011). These forces affect wood in different ways; for instance while compressing forces tend to shorten wood fibers (Adolzadeh et al; 2015). Shear stress causes on section of a piece of wood to slide along the other section in a direction often longitudinal to the grain (Yuksel et. al., 2014). Shear stress normally results when one side of a piece of wood is subjected to tension forces and then other compression (Abdolzadeh et al; 2015).

Engineers choose wood for flooring, building bridge and furniture construction based on much stress and timber materials will be able to withstand without failure.

Lima et al; (2014), mentioned that in predicating the use of wood, its mechanical properties such as modulus of elasticity (MOE), compressive and shear strength parallel to the grained to be ascertained (Green, 2007).

Studies on mechanical properties such as MOR, MOE, and Compressive and shear strength parallel to the grain to timber would thus help to assign timber to their right uses. (Lima et. al; 2014).

2.9.2 Physical properties

The physical properties of timbers are the quantities characteristic of wood and behaviour to external influences other than applied force (Winandy 1994). The physical properties is a of great concern to the timber industry include density, moisture content (MC) and swelling and shrinkage characteristic (Ali 2011).

2.9.3 Density

Wood density is defined by the amount of cell wall material, moisture and proportion of void space created by fibre and vessels cavities (Pitman 1999).

It influences other wood properties such as strength, dimensional stability, durability and treatability. (Gryc and Horacek 2007) and subsequently identifies timber for a particular uses.

Hernandez (2007), observed that wood strength greatly depended on its density. Lower density species were suitable for non -load bearing applications like internal trim and ceiling construction due to their low strengths.

Ali (2011) recommended medium (400 kg/m^3) to high (1100 kg/m^3) density wood for furniture's production. Humar et. al., (2008) also found that higher density species were more durable than their lower density counterparts. They explained that high density

timbers were important materials for fencing, mine props, railway sleepers; floor bearers and joists.

2.9.3 Swelling and shrinkage Characteristics

Antwi - Boasiako and Boadu (2013) explained that wood is hydroscopic and undergoes dimensional changes when its moisture varies below or above the fibre saturation point (FSP). These changes can lead to reduction in wood strength, tightening and fracture of joints, splits, and change of cross - sectional shapes of wooden products, (Kollamn and cote 1986). Since movement of wood in service cannot be entirely prevented, it is important to select wood that shrinks or well less for structures. The age - long use of traditional species for furniture, window and door frame and decking stem from their properties including dimensional stability (Lermmens 2008). Therefore, knowledge on the MC, density as well as swelling and shrinkage characteristics of timbers would enhance their utilization

2.10 FURNITURE PRODUCTION

Furniture construction is one of the oldest jobs in the manufacturing sub –sector of many countries (Yang et al. 2012). Until the industrial revolution where materials such as aluminum. Steel, plastic and glass were used, furniture was conventionally made of wood (Asomani, 2009). The introduction of automated standardization in design and construction techniques and the use of composite materials have brought some advancement to the furniture industry. (International Tropical Timber Organization, 2015). Tankut (2007), asserted that not all wood species are suitable for furniture making and the biological physical and mechanical properties of timber should be taken into account before their selection.

Strong (2013), also explained that fasteners influence the overall strength of furniture and should be chosen based on the kind of product and the level of strength required.

2.10.1 Rattan furniture

The furniture industry is the main consumer of raw rattan materials. Rattan is bent, woven and tied to make chair, beds, table and cabinets for the world market as well as for domestic usage. Rattan furniture has been provided since classical time. The furniture is stylish and very popular in many countries.

Although most village in many raw material producing countries may take rattan for granted, the furniture buyers in reach countries imported the raw materials and manufactured their own furniture but nowadays raw material producing countries such as Indonesia and Malaysia have developed their own manufacturing powers and can gain more form the value of a finish goods. (Trade research and development agency 2010).

2.10.2 Fastness available for furniture production

Atar et al, (2009) explained that furniture making requires bringing together pieces of wood with the help of fasteners, McDonald (2013) noted that fasteners strengthen furniture and also help attach hardware to furniture parts.

Fasteners employed for wood work furniture include nails, bolts, dowels, hingers, screws, joints and adhesives (Kureli and Altinoik, 2011).

Yuksel et al (2014), observed that nails and screws were the most common type of attaching wood members in light –frame structures, while bolts were used for heavy members such as the beam to the posts. Glued joints are also recommended for the construction of quality chairs and tables (Asomani 2009).

In most furniture firms in Ghana, glued joints are the most common fasteners used for wooden furniture construction because they are economical and impact great strength (Asomani 2009). McDonald (2013) explained that since the overall integrity of wooden furniture depends on how its components are held together, a careful analysis of the strengths of these fasteners is required prior to their selection.

2.10.3 Joints

Koch et. al., (2013) noted that joints are needed to put wood pieces together in furniture frame construction they play a major role in the structured behaviour of joinery products. (Tankut and Tankut 2011). Several kinds are available for wood work include dowel, dado, rabate, lap, tongue and groove, mitre butt, dovetail and mortise-tenon (Jesberger, 2007).

According to Zwerger (2012) each type of joint is appropriate for specific uses and should be employed depending on the kind of product, its desired strength and easy of construction. For instance, dowel are recommended for joining chairs rail to post, frame and boards at right angles to each other. Dado also used in making books shelves to hold them in position.

2.10.4 Dowel Joints

The wooden dowel rod used in woodworking applications is commonly cut into dowel pins, which are used to reinforce joints and support shelves and other components in cabinet and furniture making. Some woodworkers make their own dowel pines while others purchase precut dowel pins that are typically available in assorted lengths and diameters (Noll 2002).

Dadzie al., (2014) ascertained that the diameters of the dowel and depth of penetration have a significant effect on the bending moment for tests under compression. For example with 19-mm plywood, the highest strength was achieved when increasing the dowel size from 6mm to 8mm. However, when the dowel size was increase to 10mm, there was a decrease in the bending moment (Dadzie et. al., 2014). When multi-pin dowel connection is used, it addition to the diameter and depth of the dowels also on the member of dowels and their spacing (Derikvand and Ebrahimi, 2014).

A well-made dowel joint is as strong as mortise and tenon joint if cost is a consideration in the assembly of the work.

Some researches have been carried out on joints of configuration (Zhang & Eckelman 1993). Although, doweled joints are vastly used in furniture and cabinet frame, in iron, these are a little information about its withdrawal and shear strength. The studies is to obtain initial information concerning the withdrawal and shear strengths of dowel joint to understanding effective parameters on the strengths.

2.11 FACTORS AFFECTING THE STRENGTH OF FURNITURE JOINTS

Haviarovaet. al., (2013) observed that the wood strength properties and moisture content affect its joint strength. Erdil et al (2005), explained that greater joint strength is often associated with greater wood shear strength.

According to Antwi-Boasiako and Boadu (2013), fluctuations in wood moisture content cause internal stress in glue lines and subsequently decreases joint strength. Tankut. (2007) noted that when wood was conditioned at a relative humidity (RN) of 85%, joint strength reduced by 15%. Duport (1963) found 7% - 9% wood moisture content (mc) appropriate for strong joints. Therefore, timbers with great strength properties and low MC may be more appropriate for the construction of wooden products with Yang and

Li (1986) further mentioned that joints design and type of adhesive also affect strength. In their study on mortise-tenon joints using two adhesives, Haviavovaet. al., (2013) observed that joints constructed with polyvinyl acetate (PVA) were stronger than those produced using polyurethane (PU).

Ahun. et. al. (2010) bending moment capacity under diagonal compression for joints, glued with PVA compared to cynoacrelate. Erdilet. al., (2005) noted that PVA was better than UF and resorcinol, Phenol adhesive in an experiment to determine the effect of wood species, adhesives, rail width, tenon depth and length on bending strength and flexibility of some wood joints. They concluded that different adhesives would influence joint strength differently. Haviarova et al., (2013) mentioned that manufacturers must carefully take into account the influence of joint design and adhesives on the length of furniture joints during their construction.

2.11.1 Adhesive

Mahu't (1995) and the U.S Development of Agriculture (2011) defined adhesive as materials used for sticking, or adhering, one surface to another. Yukselet. al., (2014) explained that manufacture often prefer making joints without adhesive because it reduces shipping coast and enables furniture to be exported in the knock-down condition for assemblage on site. However, adhesive add great strength and rigidity to furniture when they are used (Haviarova et. al., 2013).

There are two groups of adhesive that could be used for joinery, natural and synthetic (Atar et. al., 2009). The natural adhesive are made from hides, bones milk and other part of animals and plants. Such as cassava and soybean. This group of adhesive is hardly used in recent time because they stain wood, have poor resistance to moisture and heat and could best be applied when hot. Synthetic adhesives are of two basic types:

thermosetting and thermoplastic. PVA, Polyvinyl alcohol (PVA), Polyacrylates polyester acrylics, acrylic solvent cement, cyanoacrylates (Superglue) and silicone resins are examples of the thermoplastic type.

Thermoplastic adhesives harden on cooling but soften and flow upon heating (Vick, 1999). They are easy to apply, durable against bio-deteriorating organisms, odorless and nonflammable, they develop very good bond between wood pieces within 15 min or application under room temperature (Atar et. al., 2009).

However, it is very expensive and not resistant to heat Ataret. al., (2009) recommend PVA for indoor furniture, they cautioned against its usage in permanently stressed joints. Thermosetting adhesives required longer time for curing under room temperature (Mahu't 1995). However, they do not soften on reheating once cured. They are resistant to moisture and other chemicals and have better gap-filling ability and good adhesion to wood (Frihart, 2005). Resonrcinol, Phemol-resorcinol, epoxy, phenol and Urea formaldehyde are examples of thermosetting glue.

Asomani (2009), noted that most thermosetting adhesives contain formaldehyde and catalyst that controls the speed for curing adhesives should be chosen based on their costs, moisture resistant, heat sensitivity, flexibility and ease of application. In Ghana, most furniture production companies employ, Fevicol SH synthesis adhesive, which is thermosetting due to their availability, great bonding strength, impact and fire resistance, quick setting time and non staining properties (Asomani 2009).

2.12 SUMMARY

The review has indicated that dowel joint is one of the popular joints used in furniture work, particularly in chair construction. However, no evidence was identify through

literature about utilization of dowel joint for rattan furniture and the ability to perform in service.

In order to draw meaningful conclusion on the appropriateness of dowel joint for rattan furniture empirical research need to be conducted. Again, the literature has explained the potential role the use of rattan could play as substitute for wood in ensuring sustainable supply of wood in future and also research into the properties of several of these lesser used rattan species in the forest.

CHAPTER THREE

METHODOLOGY

3.1 Overview

This chapter seeks to provide and outline the parameters used in selecting the samples and methods used to gather data for the study. They are discussed under the following headings. Research design, population, study area, sampling, primary and secondary data practical based research method, data collection process, data collection instrument, validation of instruments, data presentation and analysis and the general procedure in executing the work.

3.2 The Study Area

The study was conducted in selected communities in the Accra metropolis, the capital of greater Accra Region and also the capital of Ghana as well as University of Education, Winneba – Kumasi.

The greater Accra which consist of six sub-metros is approximately 200 square kilometers with total population of four million, three hundred and fifty eight thousand two hundred and sixty-three (4,358,263) representing 17.98% of Ghana population (Ghana statistical service 2010).

As Ghana largest city, Accra is cultural and tourist hub, sporting and wide range of nightclubs, restaurants and hotels. The central business district of Accra contains the city's main banks and departments stores, the cocoa marketing board headquarters (dealing with cocoa, Ghana's chief export) and is known as the ministries, where Ghana's government administration is concentrated. Economic activities in Accra include the financial and agricultural sectors. Atlantic fishing and the manufacture of processed food. Lumber, plywood, textile, clothing and chemicals. The city hosts the

University of Ghana and other higher institutions, training colleges, technical institutions and numerous first and second cycle schools.

3.3 Population for the Study

"Population as a concept in research methods refers to every individual who fits the criterion (broad or narrow) that the research has laid out for research participant's (Saumur and Given, 2008). The population is homogenous. All furniture manufactures, wood construction technology students in the Accra metropolis constitute the target population. However the target population cannot be reached within the time frame for the project. Therefore an accessible population was selected based on easy availability to the researcher. Rattan furniture manufactures in Accra cantonment and all year two wood construction technology students of sacred heart technical institute respectively were selected as the accessible population. Also sandwich students at University of Education Winneba, Kumasi during the period of the research, the total number of student involved in the study were (100) hundred.

3.4 Research Design

The researcher employed qualitative and quantitative approaches of research to carry out the study. Action, descriptive and quesi-experimental research methods were used. Qualitative research is concerned with collecting and analyzing information in as many forms, chiefly non-numeric, as possible. It tends to focus on exploring, in as much detail as possible, smaller numbers of instances or examples which are seen as being interesting or illuminating, and aims to achieve depth rather than "breadth" (Baxter, Hughes and Tight, 2006).

Leedey and Ormored (2006) also assert that, qualitative research encompasses several approaches to research that are, in some respects, quite different from one another. Yet all qualitative approaches have two things in common. Firstly, they focus on phenomena that occur in nature settings that are "in the real world" and second they study those phenomena in all their complexity.

3.4.1 Descriptive Research

Descriptive study, according to Hendrick et al (1993) as cited in Gray (2004) is providing a picture of a phenomenon as it naturally occurs. This may be purely descriptive or a normative study comparing the data against some standard. Leedy Ormrod (2005) conduct that descriptive research "involves either identifying the characteristics of an observed phenomenon or exploring possible correlations among two or more phenomena. In every case, descriptive research examines a situation as it is.

3.4.2 Quasi-Experiment

According to Shuttlewort (2008), quasi-experiment is useful for measuring social variables and in generating results for general trends. Quasi-experimental design is often integrated with individual case studies; the figures and the results produced often reinforce the findings in a case study given room for some sort of statistical analysis to take place. Grimshaw, Campbell, Eccles and steen (2000) also wrote that "quasi-experimental studies often are conducted when there are practical and ethnical barriers to conducting randomized controlled trails"

3.4.3 Action Research

According to Blaxter, Hugher and Tight (2006), action research lends itself to the direct involvement and collaboration of those who it is designed to benefit. This is participatory case for participation action research, which is not designed for undertakers by research "experts" along but in partnership with people who are involved in the issues that the research is addressing.

Gray (2004) also asserts that, within this approach there are varied methodologies, each width their own priorities and modes of enquiry (although there are as many overlaps and similarities between the approaches as there are distinctions). All approaches however have at least three common features.

- Research subjects are themselves researchers or involved in a democratic partnership with a researcher.
- Research is seen as an agent of change
- Data are generated from the direct experiences of research participants. A mode of action research that takes this latter point particularly and seriously is participatory action research.

Somekh (2008) holds the view that the outcomes of action research are both practical and theoretical; the knowledge it generates has a direct and ongoing impact on changing practice for participations and on a wider audience through its publications". In the study, the quasi-experiment was therefore found to be very useful for the processing of the rattan into rattan furniture and the description method was used in recording, analyzing, synthesizing and interpreting the processes and procedures used in accomplishing the research and useful for gathering data from the participants on their experiences after working with the processed rattan poles.

3.4.4 Sampling

According to Morgan (2008) "sampling" is the process of choosing actual data sources from a large set of possibilities" He also defines "the sample size as the number of data source that are actually selected from the total population" The researcher used the purposive sampling techniques to draw the sample size for this study. Purposive sampling is a technique of handpicking supposedly typical or instructing cases (Blaxter, Hughter & Tight 2006).

Eight students were drawn purposively from the year two wood construction Technology students of Sacred Heart Technical Institute-Jamestown-Accra based on their ability and previous performance in practical work.

Each student was assign to perform a specific task under the supervision of the researcher.

Three rattan furniture producers at cantonments in Accra also availed themselves for the project, one of the rattan furniture manufactures did all purchases of all the rattan poles and the others did the bending of the rattan poles under the researcher's supervision.

3.4.5 Primary and Secondary Data

Primary data were collected through focus groups discussion, interview, and direct observation at the workshop of the rattan furniture procedures and students.

The secondary data comprised the entire literary material sought, cited and used from books, articles, thesis, internet sources, journals and others that were related to the study.

3.4.7 Practical-Based Research Method

Practical-based research is a form of research that aims to advance knowledge partly by means of practice. This type of research is an original investigation undertaken in order to gain knowledge and understanding. It includes the invention of ideas, images, performances and artifacts includes design, where these lead to new or substantially improved insights in the field of practice, moreover, practice-based research is also a research where some of the resulting knowledge is embodied in the artifact. Whilst the significance and context of that knowledge is described in words a full understanding of it commonly is obtained with reference to the artifact itself (Candy, 2010).

The research was conducted in rattan furniture in woodwork workshop of sacred heart Technical Institute. The production processes and invention, and idea explorations of the rattan furniture samples were executed solely.

3.5 Data Collection Instruments

Leedy and Ormrod (2005) assert that qualitative researchers often use multiple forms of data such as observations, interviews, objects, within documents, audiovisual materials, and electronic documents in any single study. Qualitative studies, with the exception of content analyses rely heavily on observations, interviews or both as a source of data. Therefore, data for this thesis were collected through observation, semi-structured interview, and questionnaire.

3.5.1 Observation

Observation involves the systematic viewing of people's actions and the recording, analysis and interpretation of their behaviour (Gray 2004).

Blaxter, Hughes and Tight (2006) also assert that "the observation method involves the researcher in watching, recording and analyzing events of interest".

Leedy and Ormrod hold the view that; observation is a qualitative study are intentionally unstructured and free-flowing. The researcher shifts focus from one thing to another as new and potentially significant objects and events present themselves. The primary advantage of conducting observations in this manner is flexibility; the researcher can take advantage of unforeseen data sources as they surface.

In this study, the process of bending rattan poles into shapes and weaving processes of were observed.

3.4. 9 Semi-Structured Interview

"The semi-structured interview is a qualitative data collection strategy in which the researcher asks series of predetermined but open-ended question".

According to Gray (2004), in the semi - structured interview, additional questions which were not anticipated at the beginning of the interview may be taken as new issues arise. Responses can be documented by note-taking or tape –recording the interview. The semi –structured allows for probing of views and opinions where it is desirable for respondents to expatriate on their answers. In this study, the semi structured interview was sued to gather data form rattan furniture manufactures in cantonment –Accra.

3.5 Questionnaires

The study also employed the use of questionnaire. One hundred questionnaire made up of twenty four questionnaire item were set and administered to selected sandwich students of University of Education Winneba Kumasi Campus. The questions were on aesthetic, functionality, strength and durability of the product.

The questionnaire has closed - end questions and statement with appropriate optimal answers and responses for the respondents to select from. The close - ended questions

and statements were to ensure efficiency and specific in responses/. In the construction of the questionnaire the questions and statement were categorized and ambiguous questions ort statements were avoided. The questionnaire was constructed information in a way to elicit the required from the respondents for the study.

The respondents were made to provide the responses by ticking their best optimal answers provided for the various questions and statements. See Appendix for a sample of the questionnaires.

3.6 Validation of Instruments

To ensure that the variables yield the desired result, the questionnaire were structured and submitted to my supervisors for vetting before finally administering them.

With regards to the reliability of information. The questionnaire was designed such that consistency in measurement was assured each time that it was used under similar conditions. Moreover, the questionnaire was such that they could be used to effectively solicit the views of all the respondents who operated within the geographic space in question.

3.7 Data Collection Process

Questionnaire were designed and distributed to the sampled population for the evaluation of the product.

The validity of information was critically considered, thus, is the questionnaire used for the study was designed to measure what it was intended for. Moreover, data was gathered from the right sources, that is, rattan furniture manufacturers of small and medium - sized enterprise in Accra- Cantonment.

To ensure high recovery rate, the questionnaire were personally delivered to the respondents for their opinions. This was done on a face-to-face basis. The respondents were made to submit the questionnaire within thirty minutes. The students involved in the construction were observed during and after the construction of the furniture.

3.8 Data Presentation and Analysis

The data collected were assembled, analyzed and interpreted to derive the findings, conclusion, and recommendation as stated in chapter four.

In the preparation of the data, accuracy was ensured and data entry errors were revealed and corrected. Activities that were followed in preparing the data included editing, coding the data entering.

Editing of the raw data was done to detect errors and omissions for correction. This ensured that data become accurate and consistent with respect to the information demanded form respondents.

Coding was used to ensure categorization of data. This was done because the statistical software used for data analysis worked more efficiently in numerical mode, coding rules which included exhaustiveness and mutual exclusively were followed.

Statistics package for social scientists (SPSS) and Microsoft Excel were used to analyze the data and presented in figures and tables.

3.9 Tools, Equipment and Material used

In this study, hand and machine operated tools and equipment employed in woodworking and rattan furniture were used for the project. These include:

- **Tools used**

Tape measure, straight edge, tenon saw, hacksaw, mallet firmer chisel,. Screwdriver, rasp, try square drilling bits, ratchet brace pinces, smoothing plane, oil stone, sash clamp, hammer and spockshave.

- **Machines used**

Surface planner, circular saw thicknesser, dimension saw, spindle moulder. Band saw, air compressor and spraying gun.

- **Equipment**

Jigs template, setting out rod.

- **Materials**

Rattan poles, Asanfina, plywood, foam, fabric (covering material), tack nail, sandpaper, white glue, contact glue, vanish, sanding sealer and thinner.

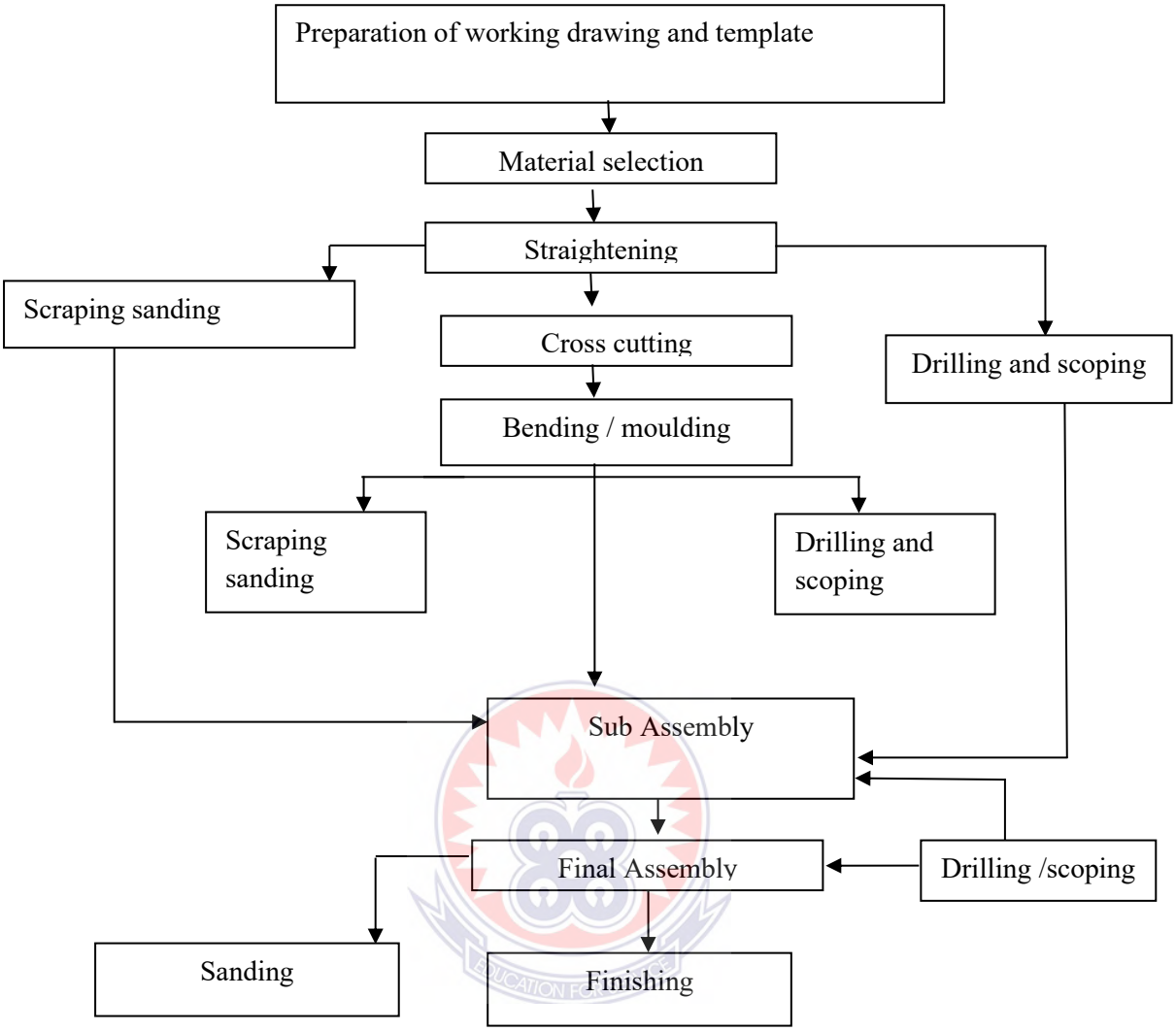
Table 3.1 Dowel dimensions used

Length (mm)	ØDowel (mm)			
	8mm	10mm	12mm	Total
50	1	1	1	3
70	1	1	1	3
90	1	1	1	3
Total				9

Source: Researcher's Field Data

3.10 General Work Procedure and Processes

The study basically employed procedure and process as described in Table 3.2 the chart below and photos of the process.



Source: Constructed from INBAR report from international Network for Bamboo and Rattan.

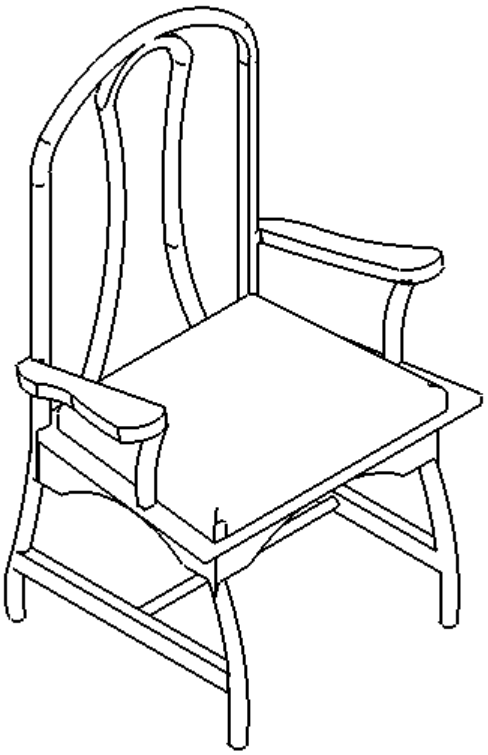


Figure 3.1 Isometric view of the ratten chair

Source: Research's own design

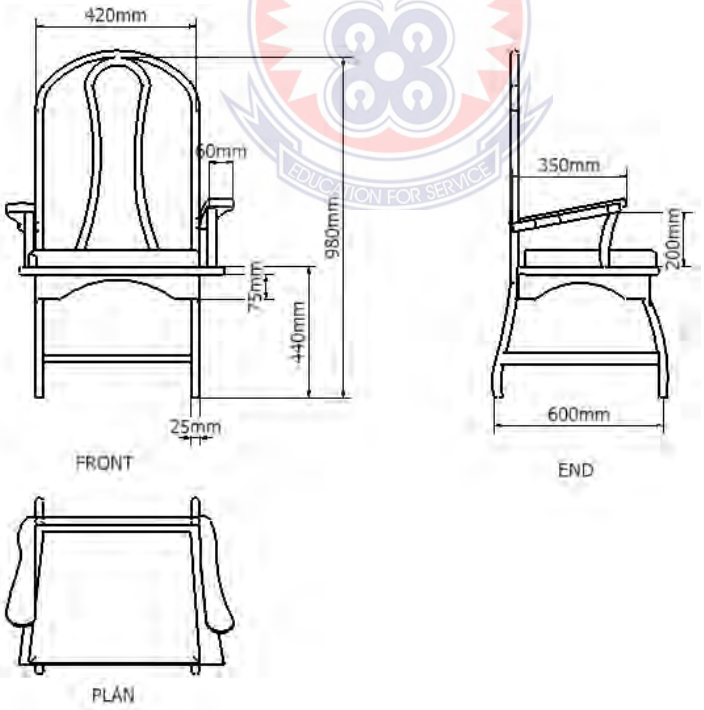


Figure 3.2 orthographic projection (working drawing)

Source: Researcher's Design

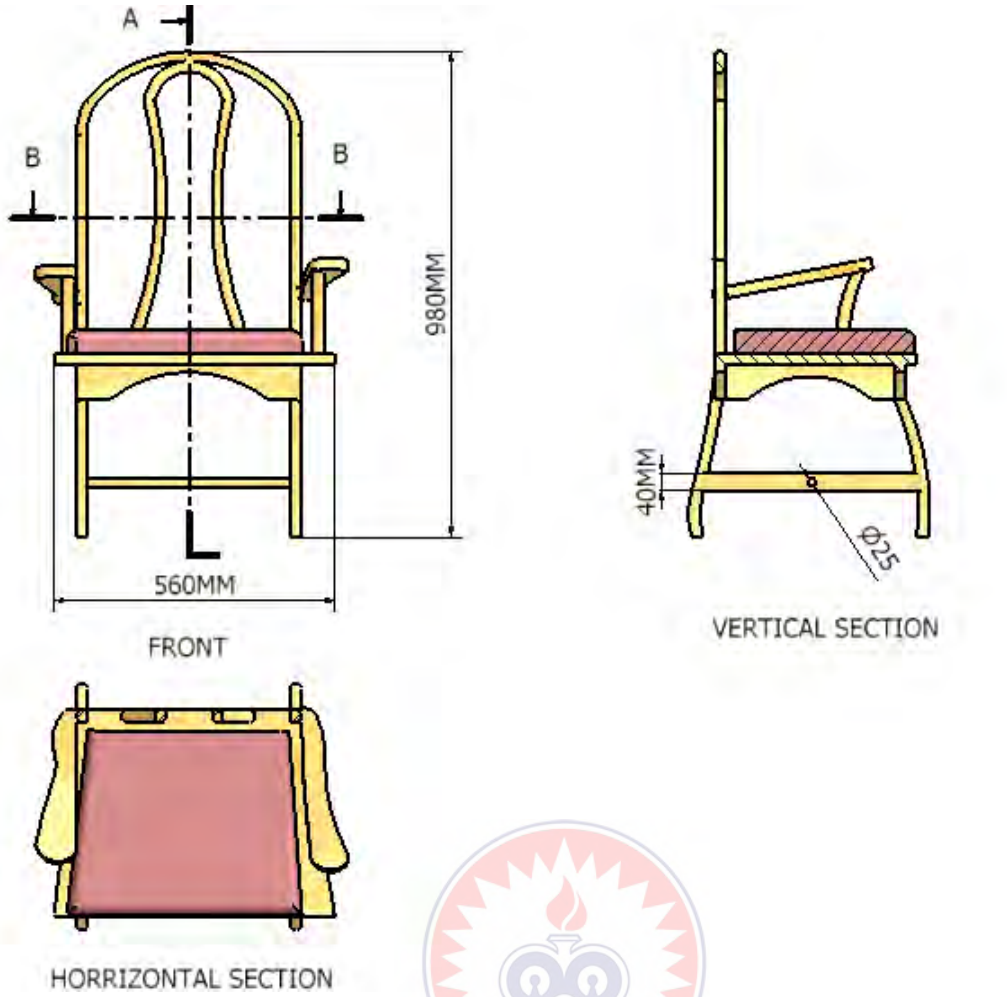


Figure 3.3 Sectional Drawings

Source: Researcher's Design

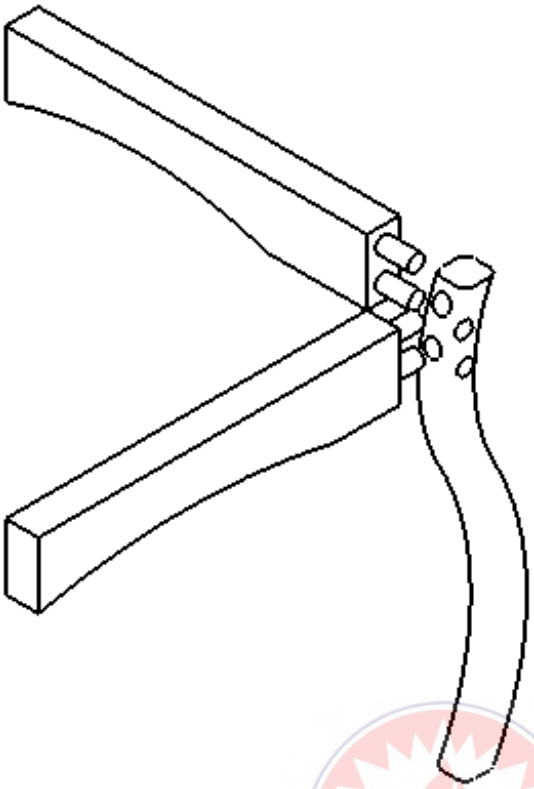


Figure 3.4 Exploded view showing joint dateils

Source: (Mark & Nelson, 2018)

3.10.1 Rattan selection

The process began with selection of materials. The selection was done by one of the sampled participate in the study at Cantomato-Accra.

3.10.2 Straightening the rattan poles

The rattan poles were bent out of shapes a little bit due to their inherent properties and because the rattan were stored vertically. The bent rattan poles were straighten manually. This was done to ease the process in other to make higher quality furniture.

- **Measuring, marking out and crosscutting**

The straightened rattan poles were measured and cut to the desired lengths using pencil for the making so that it can be easily erased. The shaped members were marked on the setting out board and also using jigs. Hack saw was used to cut the poles.

The other components made of wood (asanfina) were also cut with their end scoped to fit the rattan poles.

The machines used includes circular saw, surface planner, thicknesses, band saw and spindle moulder.

Figure 3.5 Marking out on the workshop rod.

Source: Researcher's Construction

Figure 3.6 Measuring and Marking out an ratten components

Source: Researcher's Own Construction

- **Bending or moulding**

Before bending into the desired shapes, parts of the rattan poles that needs to be bent were pre heated to soften the fibers and to ease the bending by using blowtorch.

Jigs were used to aid in procuring the chair legs, back rest and arm rest supports to the desire shapes.

- **Drilling**

The chair rails and legs were drilled with a series of holes for inserting the dowels to be joined together. Shaped members were sanded after drilling in a bench-vice to hold the shaped members in position before a hand rill was used to create series of the dowel holes. For the straight moulded components, drilling was done manually using a hand drill before the frames were assembled.

Figure 3.7 Drilling the end of side rails.

Source: Researcher's Construction

Figure 3.8 Drilling the edge of back rail

Source: Researcher's Construction

- **Assembly**

The rattan furniture components were assembled together to form the frame structures. Dowels were used to join the components. Assembling was done in two stages of sub-assembled to form the frame structure such as front legs, back legs, arm seat.

The additional components include leg bracers, seat slates and back slates. The assembling work was done on a workshop bench equipment with various jigs and other parts (components made of wood) to ease in clamping, stopping and arranging the furniture component before fastening take place.

Figure 3.9 Dowel joint between leg and rails of rattan chair
Source: Researcher's Construction

Figure 3.10 Measuring and squaring legs of ratten chair
Source: Researcher's Construction

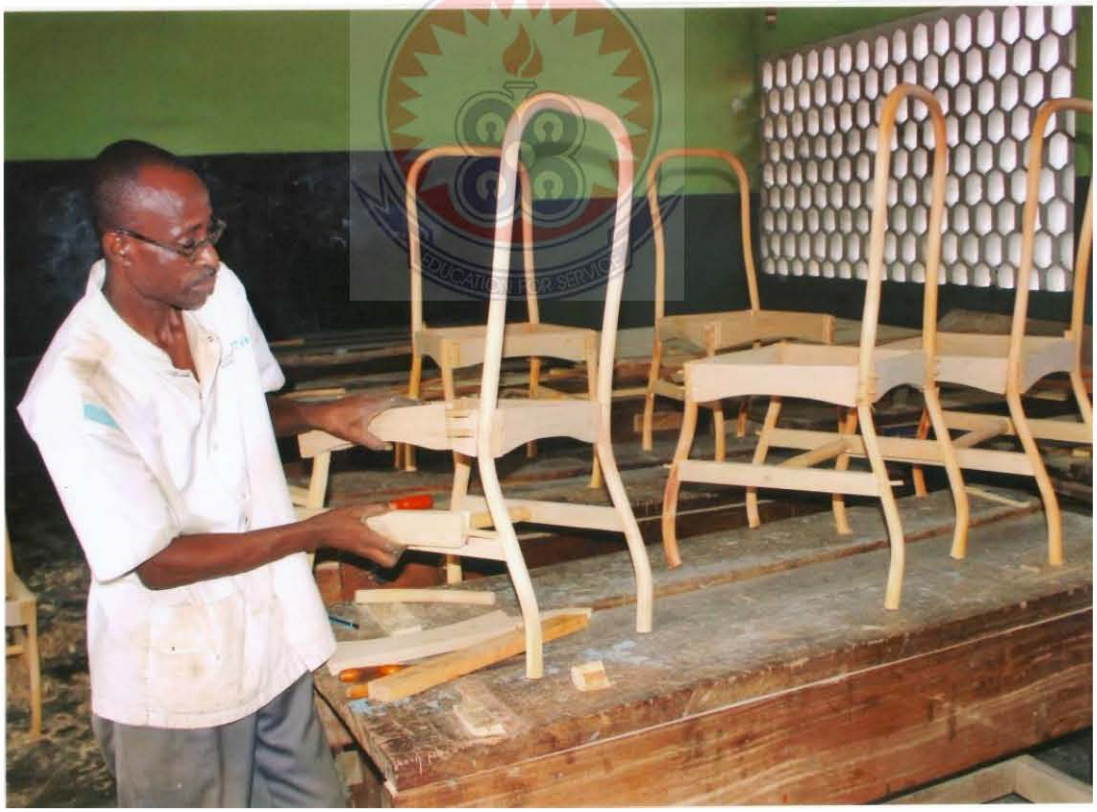


Figure 3.11 Assembling of the components in furniture
Source: Researcher's Construction

- **Scraping and sanding**

Scraping and sanding was used to smooth the surfaces of the components. The sanding work was done at various times during the workflow, after assembling and during the finishing process.

After bending, sanding was done to smoothen the rough rattan surface to remove burn marks caused by the blowtorch. Scraping was done using a hand scraper to remover excessive putty (the paste applied on it to fill holes and gaps in the rattan frame).

A grit size of 80, 100 and 120 sandpaper were used for sanding before finishing process. During the finishing process, grit sizes of 360 was used. The sanding was done manually.

- **Finishing**

Finishing was another important stage to ensure the final quality of furniture, spray guns powered by compresses air was used for spraying the furniture.

Figure 3.12 Ratten furniture product is sprayed in front of the workshop

Source: Researcher's Construction

CHAPTER FOUR

RESULTS AND FINDINGS

4.1 Overview

This chapter discusses the data analysis and findings for the study. The questionnaire used in this retrospective study was carefully analyzed to ensure that the data gathered was presented clearly with aid of Tables, percentages, mean and standard deviation where possible.

The questionnaire comprised three sections with a total of 47 structured closed ended questions that were developed to ensure regour and objectivity of data.

The first section presents the demographic information on sandwich students of the university of Education Winneba Kumasi respondents. The second section presents the findings on the quality of the chair made from rattan cane in respect of its durability, aesthetics, functionability, strength, environmentally friendliness and purchase intention. The third section contains the results of the overall evaluation of the chair.

4.2. Response Rate

All the 100 questionnaire that were administered were properly filled and returned hence representing response rate of 100% which was excellently adequate for the study.

4.3. Gender

The respondents with the highest proportion were male with 61% while female had a proportion of 39% as shown in Table 4.1 below.

The percentage shows that the male respondents were much higher than the female respondents.

Table 4.1 Background Characteristics of respondents

Gender	**Frequency**	**Percentage**
Male	61	61%
Female	39	39%
Total	100	100%
Age Group	**Frequency**	**Percentage**
20-25	2	2%
26-30	37	37%
31-35	25	25%
36-40	14	14%
41-45	9	9%
46-50	13	13%
Total	100	100%
Level of Education	**Frequency**	**Percentage**
Technician Part I, II, III.	11	11%
HND	32	32%
Bachelor	31	31%
Masters	7	7%
Other/ Diploma / Advanced	19	19%
Total	100	100%

Source: Researcher's Field Data

4.4. Age of Respondents

The respondents with the highest proportion was that of aged 27 with 13 respondents (13%) was followed by aged 28 and 32 with 10 respondents (10%) respectively.

The findings are as presented in table 4.4 while aged 43, 46 and 48 respectively were the least respondents (1%) each.

This implies that majority of the sandwich students of the University of Education Winneba, Kumasi were young people between aged 25 and 32 who are still in search of a higher academic qualification.

4.5 Education Level

The majority of the respondents were HND holders with 32.0% while those who had Bachelor Degree were 31.0%. In addition 19.0% of the respondents had attended Diploma/Advanced courses. Technician part I, II, III holders were ranked 4th with 11 respondents (11.0%). The minority of the respondents were master's Degree holders with 7% and non-held PHD as shown in table 4.0 below.

The level to which the respondents were educated implied that individual had the needed knowledge and ability to compere the aspects being study. It aided in evaluating the performance of the chair under study.

Table 4.2 Strength Rating

Attributes	N	SA	A	N	D	SD	M	SD
This chair is light in weight	100	79	20	1	-	-	1.22	0.440
This chair van endure stress	100	21	34	29	16	-	2.40	0.995
I like the structure of this chair	100	30	62	6	2	-	1.80	0.636
This chair is very strong	100	20	53	17	10	-	2.17	0.865
This chair is stable	100	29	59	9	4	-	1.89	0.723
This chair can support maximum load of human being	100	24	33	19	20	4	2.47	1.176
This chair has a good mechanical strength	100	28	41	21	10	-	2.13	0.939
This chair is easier to machine	100	22	50	20	8	-	2.14	0.853

Scores Interpretation **SA = Strongly Agree (1)** **A = Agree (2)** **N = Neither (3) Agree Nor Disagree (3)** **D = Disagree (4)** **SD = Strongly Disagree (5)**

Source: Researcher's Field Data

The respondents were asked to respond to some statements on the strength of the chair under study. The findings reveal that most of the students agreed that the variables and the variables with the lowest mean was on, this chair can support maximum load of human being (2.47). The respondents were asked if this chair is light in weight had the highest mean (1.22) as well as the highest standard deviation (0.446) to this question, while this chair can support maximum load of human being had the lowest variations in their responses in this questions. The results are shows in Table 4.2 above.

Table 4.3 Durability Rating

Attributes	N	SA	A	N	D	SD	M	SD
This chair is structurally sound	100	38	59	1	1	-	1.68	0.649
This chair can withstand pressure	100	19	61	12	5	-	2.12	0.879
This chair will last longer	100	29	49	14	8	-	2.01	0.870
This chair is solid in construction	100	39	47	11	2	-	1.79	0.795
The chair will withstand all weather conditions	100	26	26	30	16	-	2.42	1.103
This chair is dimensionally stable	100	30	63	5	2	-	1.79	0.624
This chair has fewer deflects	100	21	50	18	10	-	2.20	0.921

Scores Interpretation **SA = Strongly Agree (1)** **A = Agree (2)** **N = Neither (3) Agree Nor Disagree (3)** **D = Disagree (4)** **SD = Strongly Disagree (5)**

Source: Researcher's Field Data

The respondents were asked to respond whether the chair under study is Durable. Using the five point liker scale, the finding revealed that the variables with the lowest mean was on the chair will withstand all weather condition had the lowest mean (2.42). The respondents when asked if this chair is structurally sound had the highest standard deviation (0.624) indicating that the respondents had highest variable in their responses to this question, while the chair will withstand all weather conditions had the lowest Standard deviation (1.103) indication that the respondents had the minimal variables in their responses in this question. The results are shown in table 4.3 above.

Table 4.4 Functionality Rating

Attributes	N	SA	A	N	D	SD	M	SD
This chair can be used in the dining room	100	60	37	3	-	-	1.42	0.555
I will feel impressed by using this chair	100	39	59	1	1	-	1.64	0.560
This chair is a sophisticated brand	100	22	39	26	12	1	2.31	0.982
This chair would make me feel good	100	40	52	7	1	-	1.69	0.647
This chair will make me comfortable	100	36	57	3	4	-	1.75	0.702
This chair is fit for the purpose for which it was made	100	38	48	11	2	1	1.80	0.791
This chair can serve dual purpose	100	24	36	14	24	2	2.44	0.157
This chair is easy to handle	100	56	39	3	1	1	1.52	0.703

Scores Interpretation **SA = Strongly Agree (1)** **A = Agree (2)** **N = Neither (3) Agree Nor Disagree (3)** **D = Disagree (4)** **SD = Strongly Disagree (5)**

Source: Researcher's Field Data

The respondents were asked to respond to some statements on functionability of the chair under study the findings are represented in table 4.4. The study found out that few of the respondents agreed with the variables and the variables with the lowest mean was on, this chair can serve dual purpose (2.44). this chair can be used in the dining room had the highest mean (1.43) as well as the highest standard deviation (0.555) indicating that the respondents had highest variations in their responses to this question while this chair can serve dual purpose had the lowest standard deviation (1.157) indicating that the respondents had the minimal variations in their responses in this question.

Table 4.5 Aesthetics Rating

Attributes	N	SA	A	N	D	SD	M	SD
I like the colour of this chair	100	70	22	5	2	1	1.42	0.768
I like the grains of this chair	100	55	39	5	-	1	1.53	0.688
I like the size of this chair	100	60	34	3	2	1	1.50	0.745
I like the shape of this chair	100	63	32	4	1	-	1.43	0.624
This chair is attractive	100	73	25	2	-	-	1.29	0.498
I like the texture of this chair	100	55	41	3	1	-	1.50	0.611

Scores Interpretation **SA = Strongly Agree (1)** **A = Agree (2)** **N = Neither (3) Agree Nor Disagree (3)** **D = Disagree (4)** **SD = Strongly Disagree (5)**

Source: Researcher's Field Data

The respondents were asked to respond to some statements on the Aesthetic nature of the chair under study, the findings are represented in Table 4.5. According to the findings, I like the grain of this chair had the lowest mean (1.53) while this chair is attractive had the highest mean (1.29) as well as the highest standard deviation (0.498) implying that the respondents had highest variations in their responses to this question and I like the colour of the chair had the lowest standard deviation variation in their responses in this question. Hence minimal in their response.

Table 4.6 Environmentally Friendliness Rating

Attributes	N	SA	A	N	D	SD	M	SD
This chair is environmentally safe	100	39	52	8	-	1	1.72	0.697
This chair is environmentally friendly	100	35	54	8	3	-	1.79	0.715
By patronizing this chair I will contribute to the conservation of the forest	100	53	42	2	3	-	1.55	0.687
This chair is new in the environment	100	45	33	10	10	2	1.95	1.065
This chair can contribute to reducing forest depletion	100	58	25	8	9	-	1.68	0.963

Scores Interpretation **SA = Strongly Agree (1)** **A = Agree (2)** **N = Neither (3) Agree Nor Disagree (3)** **D = Disagree (4)** **SD = Strongly Disagree (5)**

Source: Researcher's Field Data

In this section, respondents were required to respond to some statements on the environmentally friendliness of the chair under study. The result for this section revealed that the variable with the lowest mean was on this chair is new in the environment (1.95) as well as the lowest standard deviation (1.065). On the other hand, the respondents when asked if by patronizing this chair I will contribute to the conservation of the environment had the highest standard deviation (0.687) implying that the respondents had highest variations in their responses to this question while this chair is new in the environment had the lowest variations in their responses in this question. The results are shown in Table 4.6

Table 4.7 Purchase Intention Rating

Attributes	N	SA	A	N	D	SD	M	SD
I will purchase this chair	100	54	41	3	2	-	1.53	0.658
I am willing to buy this chair	100	48	43	7	2	-	1.63	0.706
I will recommend this chair to my family	100	48	44	4	3	1	1.65	0.708
This chair is my first choice	100	52	30	9	8	1	1.76	0.986

Scores Interpretation **SA = Strongly Agree (1)** **A = Agree (2)** **N = Neither (3) Agree Nor Disagree (3)** **D = Disagree (4)** **SD = Strongly Disagree (5)**

Source: Researcher's Field Data

The respondents were asked to respond to some statements on purchase intention of the chair under study. The findings are represented in Table 4.7. The study found out that few of the respondents agreed with the variables and the variable with the highest mean was on this chair is my first choice (1.76) while, I will purchase this chair had the highest mean (1.53) as well the highest standard deviation (0.658) indicating that the respondents had highest variation in their responses to this question while, this chair is my first choice had the highest standard deviation (0.956) indicating that the respondents had the highest variations in their responses in this question.

Table 4.8 Overall Rating Overall

Attributes	N	E	VG	G	F	P	M	SD
Durability	100	29	34	36	1	-	2.09	0.830
Functionality	100	40	46	11	3	-	1..77	0.763
Aesthetic	100	64	27	9	-	-	1.45	0.657
Strength	100	22	38	34	6	-	2.24	0.866
Environmentally Friendliness	100	36	44	18	2	-	1.86	0.779
Purchase Intention	100	33	45	19	3	-	1.92	0.800

Scores Interpretation: **E = Excellent (1)** **V.G = Very Good (2)**

G = Good (3) **F = Fair (4)** **P = Poor (5)**

Source: Researcher's Field Data

In this section respondents were required to respond to the overall assessment of the chair under study. The result revealed that the variables with the lowest mean was on the strength of the chair (2.24) as well as the lowest standard deviation (0.866) indicating that the respondents had the minimal variations in their responses while the aesthetic of the chair had the highest mean (1.45) as well as the highest standard deviation (0.657) indicating the highest variation in their responses to this question.

CHAPTER FIVE

DISCUSSION

5.1. Overview

This chapter reflects on the main findings of the research in terms of its contributions to the key issues of the rattan furniture. The strength and aesthetics value of the chair are very important aspect of the contribution to knowledge because they are original contribution in methodological approach, and so they shall be the focus of attention in this chapter.

5.2. The first objective was to assess the strength of dowel dimensions in leg-and-rail of rattan furniture (chair).

5.2.1. STRENGTH

The strength rating of the rattan chair; According to the findings from the Table 4:2, deduced that the respondents are in agreement with all the outlined attributes, even though not strongly agree. The mean scores of the strength attribute ranges from 1.22 to 2.47. The result suggest that the respondents have strong and positive attitudes towards the strength of the chair. The result on the strength of the chair were similar to the study by Yerlikage (2013) who sated that several studies have been conducted so far to optimize the design performance of a dowel joint, and again reported that dowel joints are best suited for small members in table and chair. The result also confirmed a study conducted on wooden chair by Eckelman (2003) who stated that 2 dowel pins and mortise and tenon joints are commonly used to join a seat rial to back rail post in a chair. This implies that the strength of a chair depends on the design /dimensions of its parts and the kind of material employed. It is expected that the apparent high level of awareness of the strength of the rattan furniture (chair), would drive manufactures and

customers to generate interest in the material that could bring relief on the ever-increasing use of wood furniture production.

5.2.2. DURABILITY

Considering the durability rating of the chair under study, the mean value of the attribute increases consistently ranges from 1.68 to 2.42 as indicated in Table 4.2. The characteristics of the chair as indicated by the respondent suggest to be a suitable material for furniture manufacturing. The finding showed that rattan has potential for further development as material in furniture design and manufacturing. The responses suggest that the general perception of rattan is weak a furniture material is negative. Thus rattan is not a good material for furniture making is negligible. The result of current study on the rattan chair is similar to the findings by Venmalar and Nagaveni (2005) whose findings revealed that, naturally durable timbers are highly recommended for the wood industry increase in service-life of manufactured products. Again Meire (2014) also observed that wood used in structural application, should be dimensionally stable and possess superior mechanical properties that can withstand great stress.

The findings clearly indicated that rattan is a suitable material for furniture manufacturing and will be accepted in the consumer market.

5.3. The second objective was to assess functionality and physical properties of the rattan furniture (chair).

5.3.1 FUNCTIONALITY

The functionality rating of the rattan furniture (chair); The findings showed that perceived usability was high for the chair as rated in Table 4.3. The rating of the functionality of the chair remained consistent. The mean value were from 1.42 to 2.44.

Analysis of the rating showed that a product can only exist as long as it fulfills the user's needs. Just like every product, every furniture is created to solve a problem, every furniture is different and all of them create their own design frame work according to their most critical tasks by Nielsen (2012). The vital thing is to make these tasks accessible and notable for users. This current result provide further confirmation of the positive influence of aesthetics on perceived usability observed in previous work by Hassenzah (2013) who conclude that because the main thing is a feeling and the human psychology plays an important role on the concept, it is very difficult to design and predict even though a product is designed perfectly which provides all the needs of users, all experiences can be collapsed with a single negative bug, comment or a moment. In Conclusion, the root of experience is feelings and emotions what users see when they look at the product, what they feel while using it, what they remember after using, what comments they make about the product. All these, constitute the concept of user experience.

5.3.2. AESTHETICS

The aesthetics rating of the rattan chair; it is important to note that the result in this study is based on the manufactured rattan chair. The result clearly demonstrates that the manipulation of the parts was successful since the aesthetics features of the chair were rated very high with regard to their perceived attractiveness. The mean value of the attributes of the chair were from 1.29 to 1.53 Table 4.5. The findings provide further

confirmation on perceived aesthetics observed in previous work by Norman (2004) who stated that the purpose of every design is creating a solution that effectively solves a problem. Everything has been developed to make us perform more effectively in the world. But there is another point as well, beyond functionality of a design, aesthetics attractiveness and beauty. This notion is not supported by Miller (2005) who states that some designs just look attractive but nothing aesthetics has always been significant. A good looking design plays a critical role in scales of the product when people have chosen among products doing the same thing. Spite of the contrary group, as many researches proved that it is impossible not to see the role of aesthetics in our life. However the usability of a product is essential, beauty is mostly the first reason for users to front a product. It is the moving force which make us learn the things we actually are not interested or buy the things we actually do not use.

Attractive by beauty – this is human nature by Yerlikage (2013) whose reason is that things created positive feelings; these feelings move people toward the beautiful one over other options. The most important advantage provided by beauty is increasing motivation and effectiveness. It is a reason of preference between similar products. It can be thought as a door which pulls users inside. After crossing that door it is functionality which keeps users in system, so after all aesthetics is an advantage, a plus and profit for the product. This implies that good design is the most important way to differentiate ourselves from our competitors.

5.4. The third objective was to determine the level of preference of people of rattan product in the market.

5.4.1. Environmentally Friendliness

The environmentally friendliness ratting of rattan furniture (chair); the result suggests that the respondents have strong and positive attitudes towards environmentally friendliness of rattan furniture. The mean value of the attributes ranges from 1.55 to 1.95 Table 4.5. The findings showed that rattan has potential of contributing to the conservation of the forest. Rattan furniture manufacturing does not impose threat to the environment as significant as wooden furniture manufacturing. Nevertheless, one major problem that needs to be solved is the high wastage of rattan raw material especially rattan poles, which often become a burden to the environment through open burning and illegal dumping. The result of the findings is similar to the studies conducted on environmentally friendliness of rattan furniture by International Network of Bamboo and rattan (INBAR 1996). The environmental friendliness of rattan to the furniture industry finds expression in the word of Pickering (2017) says that the good news is that as far as naturally – sourced materials are concerned; rattan is one of the safest from an environmental point of view. He further stated that, rattan its self is easily renewable and the environment is almost negligible. The general opinion was that rattan should be sourced of alternative material that can contribute to reducing the forest depletion.

5.4.2. Purchase Intention

The purchase intention rating of the rattan furniture (chair); According to the findings from the Table 4.7, purchase intentions correlated positively with all attributes with the perception that rattan furniture patronage will decrease deforestation. The rest of the variables were relevant to the perceived preference for rattan furniture, overall all the attributes correlated positively; mean values of attributes rating were from 1.53 to 1.76.

This suggests that not a single dimension can explain customer perceived preference and purchase intentions for rattan furniture. One of the major challenges facing the world today is how to use natural resources without compromising the quality and sustenance of the environment. The need to promote to carbon resources - efficient and "green" product has generated a plethora of discussions in the literature (UNEP 2011). Reported that a practical implication of this finding producers and marketers of rattan furniture can take advantage of the multidimensional nature of perceived preference and purchase intention constructions to develop information, rich advertising and promotional packaging that meet the expectations of diverse consumers by (Tiovonen, 2011); As a contribution to the literature, this study has demonstrated that indeed social value does have a significant effect on consumers purchase decisions, more furniture producers and marketers can increase the level of patronage of rattan furniture by highlighting the social status enhancement potential of the product.

5.5 OVERALL RATTING

The overall ratting of the rattan furniture (chair); First, the reliability of the survey is tested and seen that each component of six factors (Aesthetics, Functionality, Environmentally Friendliness, Purchase Intention, Durability and Strength). The difference in mean values (1.45 to 2.45) this can be seen to the in Table 5.8.

Aesthetics and functionality are related to their factors and are significant. It was expected that the value of aesthetics (mean 1.45) would be as important as functionality (mean 1.77). The result also supported the study which proved that the chair aesthetics are highly rated as functionality and strength rated the lowest (mean 2.24) with user opinions by Eckelman (2004) says besides the strong relation between these two factors (aesthetics and functionality) tells that they support each other, so it can be concluded

that these two variables aesthetics and functionality, need to be combined and given the same importance to users. The findings also suggest that functionality is enough to sell a product by Norman (2004). A poor visual design can disaffect users easily and they never learn and the inside functionality and system or interaction design by Garrett (2001) contrary, a beautiful designs motivates people to learn and understand the system easier and it brings a well functionality as well as purchase decision.

As Rodriguez (2012) says "When you take technology and mix with something innovative". Aesthetics and functionality together is a true combination of a good design which users desire to experience.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1. BACKGROUND

This chapter presents summaries of the findings from the study and draws conclusion. It further gives recommendations that could improve the rattan furniture, sustainable production and supply of rattan in commercial quantities to raise enough revenue to compliment that of timber.

6.2 SUMMARY

This section gives a presentation of the summary of the findings which has been conducted in line with the study objectives. The study sought to design and assess the strength of dowel dimensions in leg-and-rail of rattan chair to assess the functionability and physical properties of the rattan chair and to determine the level of preference of people for rattan products on the market.

A descriptive research approach was taken and the information obtained used to better describe the characteristics associated with the target population and to estimate the proportion of a population demonstrating the characteristics, the target population for this research therefore composed of the students of University of Education Winneba, Kumasi.

Qualitative data collected was analyzed by the use of descriptive statistics in statistical package of SPSS and excel. This was presented in percentages, means, standard deviations, frequencies and frequency tables.

The review has indicated that dowel joint is one of the popular joints used in furniture works, particularly in chair construction. However no evidence was identified through

literature about utilization of dowel joint for rattan furniture; its combination with wood (Asafina) and the ability to performed in service.

In order to draw meaningful conclusion on the appropriateness of dowel joint of rattan furniture, empirical research needs to be conducted. Again the literature has explained the potential role the use of rattan could play as a substitute for wood in ensuring sustainable supply of wood in furniture and also research into the properties of several of these lesser used rattan species in the forest.

Although the findings of this study suggest strong preferences for material factors such as the sustainability of material supplies and environmental concerns should be considered in developing new designs.

The positive perception of rattan suggested in this study does not conflict with sustainability and environmental issues, due to rattan's relatively high sustainability.

6.3 CONCLUSION

- The most important conclusion that can be drawn from this study is that furniture manufacturers select material for furniture-making based on their strength, durability and aesthetic, due to reduced furniture maintenance and replacement cost of their products, thus, with decreasing quantities of the convensional timbers many of the alternatively naturally available material (non-timber or forest product) with comparable strength, beauty, durability (rattan) could be substitute to ensure regular wood supply.
- There is the evidence that the people appreciate the negative impact of wooden furniture manufacturing on the environment. This has led to pressure on the demand, for and exploitation and depletion in the natural high forest.

- The furniture industry's ability to meet future demand for wood products is unsustainable, which requires adequate efforts for the promotion and utilization of the rattan as substitute to wood. Rattan is a fast growing non-timber for material with great potential, its utilization would ensure sustainable supply of wood for furniture manufacturing.
- Reliable information on the physical properties have been provided which will enhance its utilization to expand the raw material stock and contribute to solving the wood demand and supply imbalances.
- This work has added to the global debate on promotion of alternatively naturally available materials for furniture production (rattan) as one of the best and sustainable strategies for the reduction of over dependence on the endangered traditional timbers.

6.4 Recommendations

- To increase the level of utilization of non – timber forest product (rattan) and also to ensure consistent wood supply for the furniture industry, adequate information about their abundance, properties and uses must be made available to furniture manufactures.
- As a dwindling supply of preferred naturally – durable timber, requires the promotion of non – timber forest product with excellent properties as their substitutes, rattan could be a good alternative to widen the raw material base for the timber industry.
- Quality can be used as a strategy in promoting customers' awareness of product quality increases as competition intensifies continuous quality improvement will be followed by a decrease in costs. Declining in costs is partly due to the

decreasing quality of scrap, rework as well as consumers' increased confidence in the quality of products.

- Quality control in it's entirely constitutes an effective system to incorporate efforts to development, maintenance, and improvement of various products.
- Rattan would need thorough drying before utilizing it for any furniture work in order to minimize the challenges associated with high moisture content, hence it's splitting.
- Due to the hardness of rattan poles, extensive sanding would also improve rattan surface quality for application of finishes.
- Working chairs designed with double legs would likely resist any bending forces better and ensure greater strength of furniture than one leg.
- To ensure greater strength of furniture products, rattan species and joint (dowel dimension) design used in the construction must be carefully selected as joint design and rattan type affects the strength performance of joint.
- Further studies should be conducted on the mechanical properties of the rattan furniture (chair) with dowel dimensions which will enhance its utilization and processing.

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APPENDICES

UNIVERSITY OF EDUCATION WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

DEPARTMENT OF CONSTRUCTION AND WOOD TECHNOLOGY

QUESTIONNAIRE

This questionnaire seeks to solicit views from students of the University of Education Winneba, Kumasi on the topic*: **Designing for Strength and Aesthetic: Effect of dowel dimension on the strength of rattan furniture.***

The piece of work is purely for academic work in partial fulfilment of the award of the Master of Technology Education Degree.

You are kindly requested to provide responses to the questions to enable the researcher contribute knowledge in the field of study.

All information given shall be treated as confidential and besides your anonymity is guaranteed.

Thank you for your co-operation

SECTION I

Please respond by ticking the appropriate responses below.

Gender: 1. male [ ] 2. Female [ ]

Your Age please ……..years

Your highest educational Level

Technician Part I, II, III [ ]

HND [ ]

Bachelor [ ]

Masters [ ]

PHD [ ]

Others please specify……

SECTION II

This chair was made from rattan cane. The quality of this chair is being evaluated in respect of its durability, aesthetics, functionability, strength, environmentally friendliness and purchase intention. Please indicate the extent to which you agree or disagree with the following statements. The ratings are 'strongly agree', 'agree', 'neither agree nor disagree', 'disagree' and 'strongly disagree'.

No	DURABILITY	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
1	This chair is structurally sound					
2	This chair can withstand pressure					
3	This chair will last longer					
4	This chair is solid in construction					
5	The chair will withstand all weather conditions					
6	This chair is dimensionally stable					
7	This chair has fewer defects					

No	FUNCTIONALITY	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
8	This chair can be used in the dining room					
9	I will feel impressed by using this chair					
10	This chair is a sophisticated brand					
11	This chair would make me feel good					
12	This chair will make me comfortable					
13	This chair is fit for the purpose for which it was made					
14	This chair can serve dual purpose					
15	This chair is easy to handle					
	AESTHETICS					
16	I like the colour of this chair					
17	I like the grains of this chair					
18	I like the size of this chair					
19	I like the shape of this chair					
20	This chair is attractive					
21	I like the texture of this chair					

	STRENGTH					
22	This chair is light in weight					
23	This chair can endure stress					
24	I like the structure of this chair					
25	This chair is very strong					
26	This chair is stable					
27	This chair can support maximum load of any human being					
28	This chair has a good mechanical strength					
29	This chair is easier to machine.					
	ENVIRONMENTALLY FRIENDLINESS					
30	This chair is environmentally safe					
31	This chair is environmentally friendly					
32	By patronizing this chair I will contribute to the conservation of the forest.					
33	This chair is new in the environment.					
34	This chair can contribute to reducing forest depletion					

No		Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
	PURCHASE INTENTION					
35	I will purchase this chair.					
36	I am willing to buy this chair.					
37	I will recommend this chair to my family.					
38	This chair is my first choice.					

Please select an option by ticking (√) in the right column box.

SECTION III

Overall how do you asses this chair

		Excellent	**Very good**	**Good**	**Fair**	**Poor**
i.	**Durability**					
ii.	**Functionality**					
iii.	**Aesthetic**					
iv.	**Strength**					
v.	**Environmentally friendliness**					
vi.	**Purchase intention**					