RESOLVING ENVIRONMENTAL CONDITIONS REQUIREMENT FOR ARCHIVAL STORAGE AND HUMAN COMFORT: STUDY OF PUBLIC RECORDS AND ARCHIVES ADMINISTRATION DEPARTMENT (PRAAD), ACCRA.

by

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CERTIFICATION PAGE

I, hereby declare that this submission is my own work towards the Master of Architecture and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT.

Archives are facilities that provide a proper environment for the purpose of storing records and materials that require permanent protection for historic and lifetime storage, upkeep and preservation (*Acker et al., 2010).* This research presents the findings of a case study of the Public Records and Archives Administration Department (PRAAD) of Ghana that seeks to balance the environmental needs of both its archival collections and occupants of the facility. The aim of this study is to provide a wider view and understanding of the archives' internal environmental performance in relation to its users and collections. This research identified the internal environmental conditions in the archives and examines how the internal environmental conditions in the archives affected collections. The research further identified the effects of the internal environmental conditions in the archives on the users and the coping strategies adopted by users of the archives to feel comfortable.

With the aid of physical data collection, user opinions and health complaints, the indoor environmental performance of the repository and search room was analysed. Data was collected on the search room and repository's air temperature, relative humidity and lighting levels. In addition, the occupants' perception of the indoor environment and health complaints were solicited. The design of the facility and its maintenance and operational schedules were investigated.

Air temperature, relative humidity and lighting levels were significant problems in both the search room and repository. The repository had operated for 12 year without mechanical control due to lack of electricity to operate the mechanical equipment. Also, a great deal of neglect and lack of understanding, how important it is to maintain a strict environmental performance guideline for archives. 75% of the

respondents expressed discomfort with the archival space. The general heath complains was high.

Focus was placed on improving the overall local indoor environment for both archival collections and human comfort. This study provides some insight into how architects, preservationist, conservators and environmental engineers can collaborate to design more environmentally sound archive space.

DEDICATION

This report is dedicated to the Lord for giving me the strength to research and finally draft this paper.

Dedication of this report also goes to my father, Mr. Vincent Yaw Asabere, my dear mother Miss. Elizabeth Frimpong and my brothers and sisters for their enormous support. This is to say thank you for your toil, sweat and prayers for me.

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CHAPTER ONE

INTRODUCTION

1.1 Background

Archives are facilities that provide a proper environment for the purpose of storing records and materials that require permanent protection for historic and lifetime storage, upkeep and preservation (*Acker et al., 2010)*. Due to this, archival buildings are designed to be high performance buildings whose systems must operate at very high levels with no tolerance for failure. The often irreplaceable nature of the materials to be permanently stored and preserved in these buildings requires a life cycle analysis and approach to their design, construction and management, with extensive redundancy in their building systems (*Chang et al., 2008)*.

Archives by their design should be able to accommodate all the loads of the materials to be stored, the sensitive environmental needs of the different collections to be permanently stored and preserved; the functional efficiency, safety, security and comfort of the visiting public and operating personnel; and the protection of the archival materials from fire, water and man-made threats (*Acker et al., 2010)*. Also, an archive should have a safe and secured working environment for the staff and visitors and above all provide a healthy environment for both users and collections to be stored. This is especially so, since different temperature and humidity requirements are needed for the storage of different materials and human comfort in the archival reading rooms and offices. The lighting levels, especially the day lighting for the employee and visitors amenity should also not be harmful for the archival materials since ultraviolet (U.V.) light would harm archival collections and adversely affect the sensitive indoor environmental conditions (*Francis et al., 1998)*.

Worker satisfaction, health and comfort in a high performance building as the archives are of paramount concern since, the facility is ran and managed by humans who can easily manipulate the environmental systems to the detriment of the building and its collections to suit their comfort (*Acker et al., 2010)*. In order to prevent this manipulation of indoor environmental conditions, strategies such as increased fresh air ventilation, specification of non-toxic and low polluting materials and systems and controlling indoor air quality such that it does not affect the integrity of the collections to be stored should be taken care of during the design stage. Furthermore workers and visitors' ergonomics and safety should be properly taken care of with regard to frequency of need to access certain archival materials and storage methods used.

1.2 Research Problem

The design, construction and operation of archival environments, unlike conventional buildings require the most stringent of indoor environmental conditions for the preservation of their collections (*Chang et al., 2008)*. But these collections are managed by the staff of the archives for historic and lifetime upkeep and preservation so that it can be accessed by its visitors. Thus, in the designers attempt to provide these stringent indoor environmental conditions for the storage of collections, the needs and comfort conditions of the staff and visitors should be integrated.

It is also good to note that the basic mission for all archival buildings is to protect their collections permanently and to provide safety and comfort for their occupants (*Francis et al., 1998)*. This goal cannot be achieved without a wider understanding of the building's performance, particularly the interface between the building and its

users, that is, the building's ability to adapt and satisfy both collections and human working conditions.

Although an archival building may have been designed with the best of intentions, the actual conditions of the indoor environmental performance may not be suited for both collections and users (*Chang et al., 2008)*. This environmental performance may even further be compromised over time, if the appropriate team of specialists with the knowledge of environmental conservation and needs are not involved in its operation (*Francis et al., 1998)*. As a result, what may be considered good conservation practice for one may be detrimental to the other that is, between different collections, and between collections and users.

Archives are high performance buildings that operate at zero tolerance for failure due the need to protect the collections within it (*Acker et al., 2010)*. Also the different temperature and humidity requirements for different collections vary greatly from the comfort and health conditions needed by the users of the archives (*Francis et al., 1998)*. This results in an internal conflict between the users and the collections as to the required internal environmental conditions to allow comfort for users and conservatory environment for collections.

The Public Records and Archives Administration Department (PRAAD), Accra was created in 1946 when it used to be called the National Archives (*Akotia, 1994*). It has an overall responsibility of all archival collections in Ghana. The building it currently operates from is the only of purposely built archives in the country, constructed in 1961 and became operational in 1962. Since then PRAAD has seen very little infrastructural improvement apart from the new records store which was built to enable it perform its new function of managing the whole life-cycle of records in the

country. Due to the fact that the environmental performance of buildings are compromised over time, the offices of PRAAD, in Accra was chosen for the study to assess the building's ability to properly provide the needed conservation environment for collections and a healthy environment for the users to operate within.

This project was initiated as part of a guide for the designing of a proposed PRAAD, for Sunyani, in the Brong Ahafo Region of Ghana. Also the study was carried out to understand the interface between the conservatory environment for the archival collections and environmental conditions for human comfort by monitoring the indoor environmental condition on both collections and humans.

1.3 Research Aim

The aim of this study is to provide a wider view and understanding of the archives' internal environmental performance in relation to its users and collections.

1.4 Research Questions

The research will seek to answer the following question, in order to effectively address the research aim:

i. What are the internal environmental conditions in the archives?

ii. How do the internal environment conditions affect collections?

iii. How do the internal environment conditions affect users?

iv. How do users and collections co-exist?

1.5 Research Objectives

The objectives of this research will be:

i. Identify the internal environmental conditions in the archives

ii. To examine how the internal environmental conditions in the archives affected collections

iii. To identify the effects of the internal environmental conditions in the archives on the users

iv. To identify the coping strategies adopted by users of the archives.

1.6 Research Justification

Archival buildings with their often sensitive collections and contents come with various internal environmental condition requirements, but the management of the collections are done by people who also require a different environmental conditions. The management and design of such buildings need to be better understood in the context of the interrelation between the users and the collection so as to prevent damage that can be caused to valuable and often irreplaceable assets whilst maintaining a healthy working environment for the users (*Francis et al., 1998)*.

In the context of this particular research, the significance of internal environmental conditions of an archive is considered both in relation to the preservation of archival collections and user comfort.

1.7 Scope of Research

Due to time constraints, the onsite research was limited to one week; focus was placed on the archival store and reading area. The archival store was chosen because it housed majority of the collections. The archival store is an enclosed area separated from the reading area but share the same indoor conditions as the rest of the building.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Favourable environmental conditions within an archive will have a profound effect on the life expectancy of every record in the collection *(Carlin, 2002)*. Factors within the environment that affect an archival collection include: relative humidity and temperature, light, pollutants and biological attack. Deterioration of the collection can be reduced by controlling these factors. Deterioration of archival collection is inevitable, but controlling and measuring the indoor environment can significantly reduce deterioration and therefore add to the safekeeping of the collection (*Francis et al., 1998, Acker et al., 2010)*.

The archival environment is, first of all, designed to moderate extremes in relative humidity and temperature, but also to provide a reasonable tolerable temperature for the staff and visitors, the human comfort zone (*Acker et al., 2010)*.

2.1.1 What is an Archive?

An archive is a collection of documents such as letters, official papers, photographs, audio visuals or recorded material, kept for their historical interest *(Schmidt, 2011)*. This collection includes historical records, or the physical place they are located. The record kept in an archive consists of items that have been selected for permanent or long-term preservation on grounds of enduring cultural, Historical or evidentiary value (*Acker et al., 2010)*. Archives may be collected by an individual or an organization. An archive is also a repository where records are stored.

2.1.2 Types of Archives

There are many varieties of archives and the types of materials they collect differ as well.

College and university archives: Archives that preserve materials relating to a specific academic institution. Such archives may also contain a special collections division. College and university archives exist first to serve their parent institutions and alumni, and then to serve the public. For example, University of Ghana, Legon Archives.

Corporate archives: Archival departments within a company or corporation that manage and preserve the records of that business entity. These repositories exist to serve the needs of company staff members and to advance business goals. Corporate archives allow varying degrees of public access to their materials depending on the company's policies and archival staff availability. For example, The Ghana Broadcasting Corporation archives, New Times Corporation archives.

Government archives: They are repositories that collect materials relating to local, state, or national government entities. For example, The Ghana National Museum, The Public Records and Archives Administration Department.

Historical societies: They are organizations that seek to preserve and promote interest in the history of a region, a historical period, nongovernment organizations, or a subject. The collections of historical societies typically focus on a state or a community, and may be in charge of maintaining some governmental records as

well. For example, The Ghana Monument Board, United Nations Educational Scientific and Cultural Organization.

Museums and archives: They share the goal of preserving items of historical significance, but museums tend to have a greater emphasis on exhibiting those items, and maintaining diverse collections of artefacts or artwork rather than books and papers. Any of the types of repositories mentioned in this list may incorporate a museum, or museums may be stand-alone institutions. Likewise, stand-alone museums may contain libraries and/or archives. For example, The Ghana National Museum, The Public Records and Archives Administration Department.

Religious archives: They are archives relating to the traditions or institutions of a major religion or belief, denominations within a faith, or individual places of worship. The materials stored in these repositories may be available to the public, or may exist solely to serve members of the faith or the institution by which they were created. For example, The Methodist Church of Ghana Archives, Ghana Baptist Church Archives.

Special collections: They are institutions containing materials from individuals, families, and organizations deemed to have some significant historical value. Topics collected in special collections vary widely, and these include medicine, law, literature, fine art, and technology. Often, a special collections repository will be a department within a library, holding the library's rarest or most valuable original manuscripts, books, antics and/or collections of local history for neighbouring communities.

2.1.3 History of PRAAD

Ghana realised the need for archival and records management services in the mid 1940's. In 1946 the Gold Coast secretariat operated the archive depository which ultimately became the country's Public Records and Archives Administration Department (PRAAD). Prior to that, the PRAAD was the National Archives of Ghana which was a successor to the depository established in 1946 *(www.praad.gov.gh)*.

Five years after its establishment it was still a small department, but its programmes were forward-looking and practical. It was opened to researchers initially on a 50 year rule after older records of the colonial government were transferred to the archives. In an attempt to expand its records, the foundation of Special Collection was formed in 1951, to collaborate and copy from private archives all relevant information about personalities who contributed to the life and policies of Ghana.

(National Archives Annual Report, 1951)

Also with the expansion of the Civil Service in the mid 1950's, there was a corresponding increase in the activities of government and this lead to the loss of control over records registries *(Akotia, 1994)*. The early post-independence era was embraced with government efforts to develop the socio economic situation in the country. These efforts lead to the generation of large volumes of records and the reformation and splitting up of ministries which made it difficult to manage records. The registries which are places where active records of Ghana government are kept just like all other commonwealth countries quickly lost control of these records. Due to the nature of government business it is very important to have an effective registry so that necessary information can be readily available when needed.

A round the same time the Ghana National Archives in its bid to improve its services introduced the photographic reproduction service and opened seven regional offices across the country. These were Kumasi, Koforidua, Cape Coast, Sekondi, Ho, Temale and Sunyani in that order. In 1961 a new and permanent office was built for the National Archives and was officially opened in 1962 *(www.praad.gov.gh)*. But the management of the registry services grew worst in the 1960's and 70's as the colonial management system became inappropriate for the post independence era and the quality of files deteriorate over the years. Ephemeral and policy papers were mixed together as the space became overcrowded waiting for the time when the documents would be destroyed or sent to the National Archives *(Akotia, 1994)*.

These situations lead to the steady loss and inefficiency in the public agencies due to the inability to plan and evaluate. Exacerbating these problems were the wasted expenditure on storage of useless papers, the loss of valuable information and time when searching for information.

The National Archives had been entrusted by law with the care and custody of public records but without the necessary support in training and logistics required. Even worse there was no clearly defined responsibility for the management of active records. Under the Archive law the National Archives had no responsibility for the management of active records, but only for a right of inspection. This made it impossible to apply and enforce an orderly disposition plan since the records depository mechanism had broken *(Akotia, 1994)*.

Also the management of registries (the responsibility for active records) had never been seriously considered. Thus there was no agency to advise on proper filing methods and to provide expertise in a range of records management actives. The

National Archives, whose function had been limited to access and presentation of archives in its custody had been operating without a coherent management system.

External difficulties compounded the problems of government records. Primarily there was a lack of interest by the political class. This was due to the fact that they lacked the understanding of the immerse contributions a properly functional archives and records service provided to nation building. Some of these contributions are governmental efficiency, accountability, human rights, supporting national economy, social and intellectual development through its preservation of documents of the past needed for governmental works. For these reasons, government record systems have been identified as part of the non-economic sector providing the easy way out for fiscal authorities to accord low priority in training and appropriations *(Akotia, 1994)*.

Confronted with these challenges the National Archive was involved in records and information management review programme under the government's economic management support project in the early 1990's *(Akotia, 1994)*. This led to the National Archives being changed in 1997 to PRAAD, which was given the responsibility for the management of current and semi-current government records including their old responsibilities making it a national records service provider. It was also given the responsibility under law to train personnel's in the public sector to handle and manage records *(www.praad.gov.gh)*.

Unfortunately despite these efforts of government to improve records management in the country, PRAAD has seen very little infrastructural improvement apart from the new records store which was built to enable it perform its new function of managing the whole life-cycle of records in the country. Due to the fact that environmental performance of buildings are compromised over time, the PRAAD, Accra was chosen for the study to test the buildings ability to properly provide conservation

level environment for collections and a healthy environment for the users to operate within.

2.2 Archives Environment

The two types of environment in an archives are the macro and micro environment.

2.2. 1 Macro-Environment

The environment in a records repository is not uniform; it is a spectrum of environments *(Thomson, 2001)*. The macro-environment, which may be defined as the general space in a building, contains a distribution of micro environments. The temperature and relative humidity vary between limits, and these limits are different for each sub-element of an installation. The limits depend on infiltration, how well the building is insulated, the kind of heating system, whether the building is air conditioned, the capacity of the air conditioning system, the efficiency of air handling system, accuracy of control devices, etc *(Thomson, 2001, ASHRAE, 2003 and Michalski, 2000)*.

A macro environment has pockets of space that may not be as well regulated as the main space. Because of a distribution of values of temperature and relative humidity for each building, it is necessary to have enough general data on the performance of the HVAC (heating, ventilation and air conditioning) system to be able to set reasonable limits *(Craddock, 1992)*.

A well constructed facility with an excellent HVAC system and competent technical oversight can be maintained at +/- 1°F and +/-2% relative humidity, but this is the

most that can be expected of today's building construction and air conditioning technology *(Thomson, 2001, ASHRAE, 2003, Craddock, 1992)*.

2.2.2 Microenvironment

Microenvironment is the pockets of environmental conditions inside the repository such as the conditions inside a records storage box. Each microenvironment in a records repository responds at a different rate to change in temperature and relative humidity in the microenvironment *(Thomson, 2001, Craddock, 1992)*. A microenvironment can also be created by controlling the climate in one area of archives at optimum conditions.

The number of situations in an archive can be infinite, depending on the size of the size of the records unit which can range from one sheet of paper to a shelf packed with books *(Thomson, 2001)*. An isolated sheet of paper will respond very quickly to changes in temperature and relative humidity as opposed to a book when there is a sudden change in the macro-environment.

The archives may possess an existing appropriate microclimate in some part of the building where a particular set of stable environment conditions exist. A cooler and lower relative humidity area, for instance, could be used for the storing of photographic collections *(Craddock, 1992)*. In order to ascertain the suitability of the various microclimates for the storage of various collections, a regular monitoring is necessary for a period of some months.

2.3 Environmental Control

2.3. 1 Temperature and Relative Humidity

The collections in archives require a special temperature and relative humidity to reduce the deterioration rate of the collection *(Shahani, 1990 and Hansen et al., 1992)*. Temperature and relative humidity are interrelated because when temperature increases, relative humidity will decrease and vice versa *(Michalski, 2000)*.

Incorrect temperature and relative humidity can cause significant deterioration to collections. Decay reactions such as the breakdown of cellulose in paper constitute chemical reaction. The rate of these reactions is affected by temperature and humidity levels *(Thomson, 2001, Craddock, 1992)*. Warm, damp conditions provide more energy and so increase the speed of decay. The rate of change for many chemical reactions is doubled for each increase in temperature of 10°F. Archival materials are hygroscopic, readily absorbing and releasing moisture *(Michalski, 2000)*. They respond to diurnal and seasonal changes in temperature and relative humidity by expanding and contracting. Dimensional changes accelerate deterioration and lead to such visible physical damage as cockling paper, flaking ink, warped covers on books, and cracked emulsion on photographs *(Michalski, 2000, Thomson, 2001)*. Physical damage can be caused by human activity such as poor handling or packing; vulnerability to this type of damage is increased in hot dry conditions *(Wilson, 1995)*. Biological damage is caused by organisms such as mould or insects, and is much more common when conditions are damp and warm. It is worth noting that mild changes in temperature and relative humidity appear to be buffered by certain types of storage enclosures and by books being packed closely together *(Tétreault, 1999)*.

Although temperature and relative humidity are interrelated, for archives humidity control is a great deal more important than control of temperature *(Wilson, 1995)*. Materials expand when either the temperature or the relative humidity rises, but for moisture-absorbent, organic materials, the expansion due to a rise in temperature is small compared to the change in size due to a rise in relative humidity. One has to keep in mind that the relative humidity is determined by the absolute humidity (the total amount of moisture present) in combination with the temperature *(Michalski, 2000, Thomson, 2001)*.

2.3.1.1 Specifications for Temperature and Relative Humidity

Archival materials absorb and release moisture when the surrounding air becomes damp or dry in an effort to achieve equilibrium with it. With each gain or release of moisture, the materials change in dimensions, not enough for the casual observer to see, but enough to cause damage when two different materials are bonded together and try to expand or contract different amounts *(Michalski, 2000, Thomson, 2001)*. Practical consequences of not stabilizing relative humidity are a shorter collection service life and more costly collection maintenance (*Thomson, 2001)*.

At one extreme, materials that are too dry (less than 30% relative humidity) desiccate and become brittle; at the other, materials that are too damp (greater than 70% relative humidity) encourage mould growth; consequently 35-65% relative humidity is recommended as the maximum acceptable range for any archival collection *(Thomson, 2001, ASHRAE, 2003 and Michalski, 2000)*. However, to minimize damage from expanding and shrinking layers, archival materials need to be kept as close as possible to constant relative humidity. For collections of mixed media, a design specification of 40% relative humidity and a maximum of 5% fluctuation (i.e.,

35-45% relative humidity including fluctuation) around the clock *(ASHRAE, 2003 and Michalski, 2000)* is an acceptable compromise among different ideal conditions for different media. This specification applies to both permanent and special mixed media collections, in repositories and in reading environments, where maximizing collection service life is a major goal.

Heat on the other hand degrades all organic materials, including paper, photographic film and prints, and analogue and digital media *(ASHRAE, 2003 and Michalski, 2000)*. More heat speeds up the chemical reactions responsible for degradation of materials, shortening their service lives. So colder is better, down to reasonable tolerance limits for staff and patrons who need to work in the stacks. For permanent collections, where book stacks and user spaces often are combined, the low end of the human comfort zone (68-72°F, including fluctuation) is recommended as the range *(Thomson, 2001, ASHRAE, 2003 and Michalski, 2000)*.

Special and local history collections should be separated from staff work and reading areas, enabling the temperature in the collection storage area to be reduced to as close to 60°F as possible to maximize the service life of the collections *(Thomson, 2001)*. A range of 60-65°F (including fluctuation) is recommended for closed stacks for three reasons:

i. most HVAC systems use "chillers" technology because it is relatively easy to service, but cannot maintain 40% relative humidity at temperatures much below 65°F;

ii. moisture condensation on the surface of books is avoided when they are removed from the colder storage area to the warmer reading environment; and

iii. 60°F appears to approach the limit of staff tolerance of differences in temperature between the book stack and reading room work environments. *(Michalski, 2000)*

Thus for storage and operation of archives for the safety and comfort of staff and visitors, the values in Table 2.1 are suggested.

Table 2.1:Suggested values for temperature and relative humidity *(Thomson, 2001, ASHRAE, 2003 and Michalski, 2000)*

	Temperature (°F)	Relative humidity (%)
Combined stack and user areas	70 (maximum)	30-50
Stack areas where people are excluded except for access and retrieval	65 (maximum)	30-50
Optimum preservation stacks	35-65	30-50
Maximum daily fluctuation	+/-2	+/-3
Maximum monthly drift	3	3

2.3.1.2 Temperature and Relative Humidity in Relation to Handling of Paper Based Records.

The suggested temperature values for records repositories have always been based on the minimum comfort levels for humans rather than the stability of records *(Craddock, 1992)*. Historically, a relative humidity of 50%, or higher, has been recommended for the storage of records, because paper is more flexible at 50% relative humidity than at lower values of relative humidity *(Thomson, 2001, ASHRAE, 2003 and Michalski, 2000)*. This is based on the fact that the folding endurance of paper is two to three time greater at 50% relative humidity than at 25% *(Crook et al., 1962)*. Although paper may be folded during use, especially in

archives, it normally is not folded under tension as it is in a folding endurance tester. It is worth noting that paper-based records are twice as stable at 25% relative humidity as at 50% relative humidity *(Graminski et al., 1979)*. However, at 25% relative humidity and below leather and parchment may suffer irreversible loss of moisture and flexibility for a long period of time *(Shahani, 1990 and Hansen et al., 1992)*.

Paper base-records come with various protective covers consisting of paperboard cover with cloth, heavy paper, leather, parchment or some combination of materials. Because of this various parts of the paper based records such as books react differently to changes in relative humidity and temperature *(Thomson, 2001)*. For example, the inside covers of a book respond more slowly to changes in relative humidity than the covers, thus resulting in warping.

2.3.1.3 Effect of Temperature and Relative Humidity on Mould Growth

Mould propagates by disseminating large numbers of spores, which become airborne, travel to new locations, and (under the right conditions) germinate *(Tétreault, 1999)*. They excrete enzymes that allow them to digest organic materials such as paper and book bindings, altering and weakening those materials. In addition, many moulds contain coloured substances that can stain paper, cloth, or leather. It is also important to realize that mould can be dangerous to people and in some cases can pose a major health hazard *(Wilson, 1999)*.

It has been reported by Wilson el al., 1984, that mould growth occurs from a little below freezing to somewhere above 55°C (131°F) and at a relative humidity of 70%, or above. As a general thumps rule, the higher the relative the more readily mould grows. If the relative humidity is over 70% for an extended period of time, mould

growth is almost inevitable *(Tétreault, 1999, Wilson, 1999)*. It is, however, important to remember that, it is possible for some species of mould to grow at lower relative humidity as well. It is worth noting that the 70% relative humidity value should not be the macro-environment condition, as microenvironments usually strays away from the control value of the macro-environment. For this reason, it would be safer not to exceed a 55% relative humidity value for the macro-environment *(Tétreault, 1999, Wilson, 1999)*.

Mould spores, either active or dormant, exist everywhere, making it impossible to create an atmosphere free of spores *(Nittérus, 2000)*. They exist in every room, on every object in the collection, and on every person entering and leaving the collection area. The only wholly dependable control strategy is to keep the relative humidity and temperature moderate so the spores remain dormant *(Nittérus, 2000)*.

2.3.1.4 Controlling Temperature and Relative Humidity

The control of temperature and relative humidity in archives is about maintaining optimum values for temperature and relative humidity and maintaining a stable environment, minimising fluctuations within its internal environment.

Most HVAC systems are designed to control the temperature of internal spaces to the specified temperature with the expectation that a stable relative humidity would follow *(ASHRAE, 2003)*. This is mostly effective because relative humidity is dependent upon temperature and is destabilised by relatively small changes in temperature. This is so because the percentage of relative humidity is "relative" to the amount of moisture, air can hold at any given temperature *(Thomson, 2001, Michalski, 2000)*. Thus as, the temperature goes up, the amount of moisture the air can hold rises with it; as the temperature goes down, the amount of moisture the air

can hold is reduced. Consequently, in a closed environment, as the archives with a given amount of moisture in the air (a book stack, for example), if the temperature goes up, the relative humidity goes down because the capacity of the air to hold moisture has increased *(Michalski, 2000)*. Conversely, if the temperature in the book stack goes down, the relative humidity rises.

Although HVAC seem to provide a perfect solution to maintain a specific indoor climate, they have their own setbacks:

i. HVAC systems are designed for human comfort since people are more sensitive to temperature than to relative humidity. On the other hand archival collections are more sensitive for relative humidity than to temperature. Thus in an archives a variation in temperature is usually preferable to a prolonged swing in humidity. Conventional HVAC systems treat temperature as the primary goal and humidity as supplementary. Therefore the system is produced to serve a different goal than what it is used for in archives.

ii. HVAC systems require a lot of maintenance and failure of the system is quite unacceptable for the archives. Once the system fails, the climatic shock for the archival collections would be dramatic.

iii. Duct and pipes from control systems carrying water or steam over and in collection areas always present the possibility of leaks. An all-air system is usually therefore preferred even though it is very expensive.

iv. To retrofit such a system is expensive and often results in damage to archival collections.

v. Some HVAC systems in archives are not properly adjusted leads to waste of money and energy.

The difficulty with control of relative humidity when using HVAC systems can be overcome by introducing a humistatically controlled heating system *(Thomson, 2001, ASHRAE, 2003)* which is controlled by a humidistat rather than a thermostat, and respond to the relative humidity. Also a humidifier and dehumidifier can be introduced to work together with the HVAC system to vary the relative humidity without changing the temperature *(Thomson, 2001, ASHRAE, 2003, Michalski, 2000)*.

It is also worth noting that good storage systems and the features of the building can be used to control temperature and relative humidity.

2.3.2 Light

Deterioration caused by light is both physical and chemical *(Thomson, 2001, Michalski, 2000)*. Light can cause surface deterioration on all organic materials, reducing their service lives. Ultraviolet (UV), infrared, and visible light all cause degradation of outer surfaces, so each source of light damage needs to be addressed and controlled *(Wilson, 1999)*. Damage is directly proportional to exposure (i.e., intensity × time); more exposure results in more damage. Thus as much as possible, people should be located in areas with natural light and archival collections in areas with artificial light, in order to better control collection exposure to light *(Thomson, 2001)*.

The spectrum of radiation from light sources can be divided into ultraviolet radiation (shorter wavelengths, 100-400 nm), light or visible radiation (400-780 nm) and infrared radiation (longer wavelengths, 780 nm – 1 mm) *(Thomson, 2001)* as shown in figure 2.1.

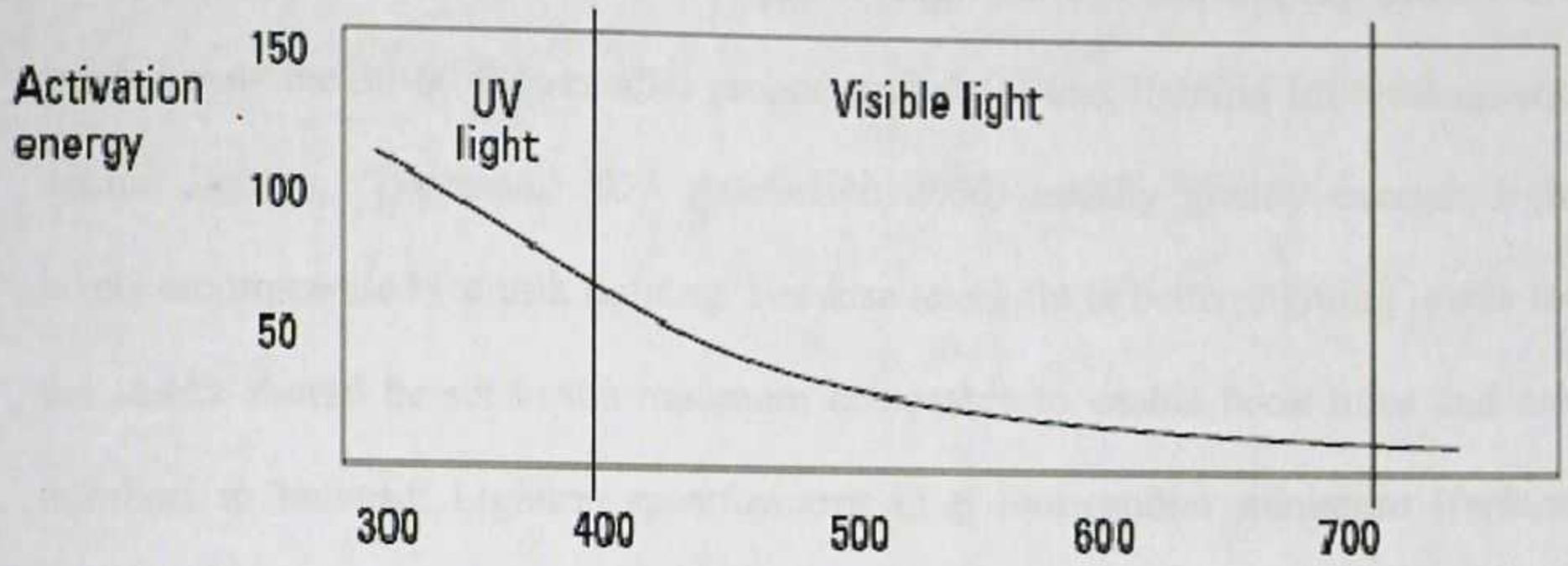

Figure 2.1 Graph of light wavelength against activation energy *(Thomson, 2001)*

Visible light is that part of the spectrum of radiation which we can see. All wavelengths of light cause significant damage to collections. The damage caused by ultraviolet light, shorter wavelengths, is most damaging because it attacks collections with more energy than light with longer wavelengths *(Michalski, 2000)*. This energy is more likely to meet or exceed the required activation energy for most collections and thus start an unwanted chemical reaction. Infrared radiation, longer wavelengths, produces heat which tends to accelerate all chemical processes. The process of light deterioration is cumulative and irreversible *(Thomson, 2001)*.

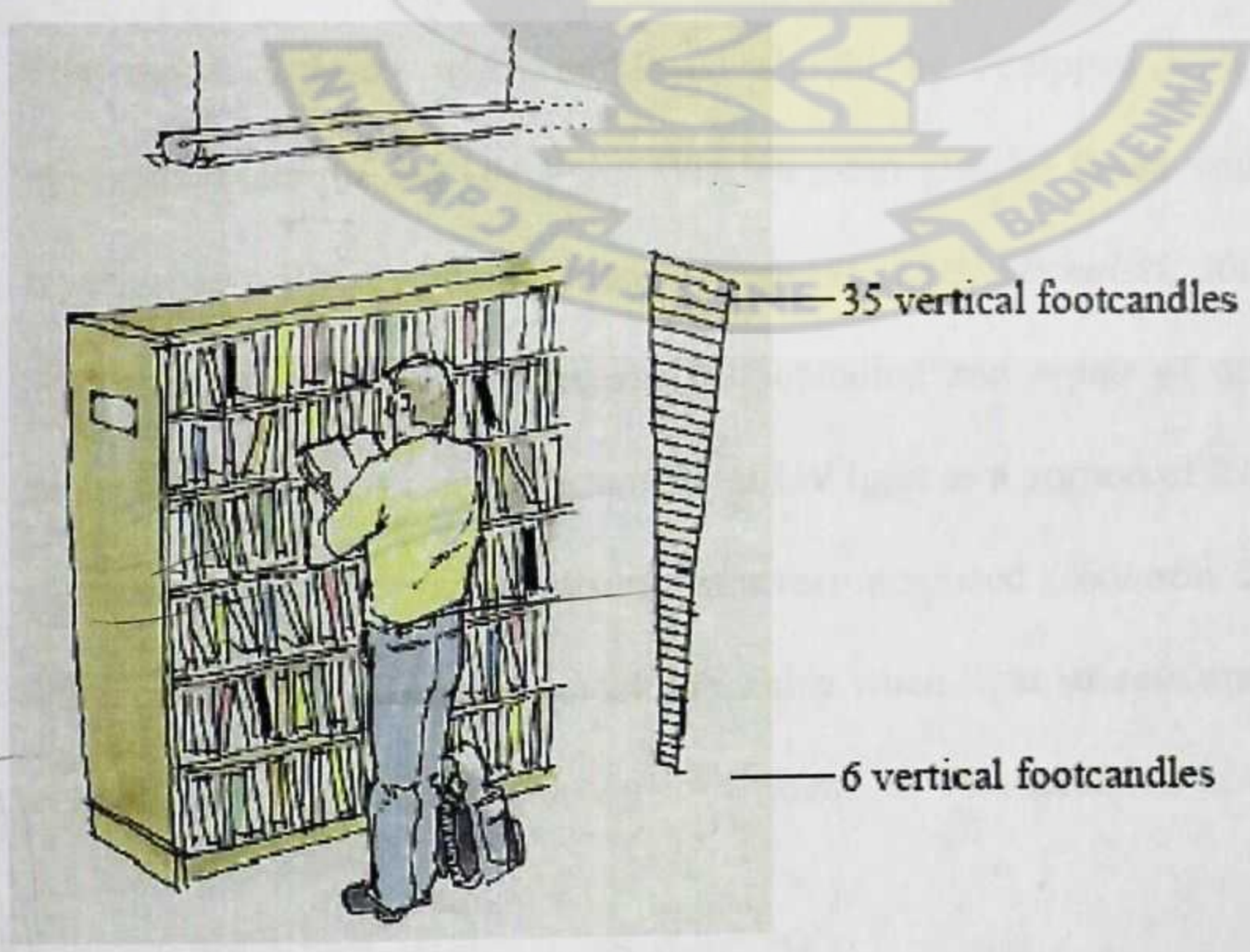

Figure 2.2 Ideal vertical foot-candle distributions at book stack *(Thomson, 2001)*

Visible light levels recommended for preservation storage and display usually are much below the 30-60 foot-candles recommended for task lighting for reading, and natural lighting *(Thomson, 2001, Michalski, 2000)* usually greatly exceeds light levels recommended for task lighting. Because less light is better, lighting levels for the stacks should be set to the minimum acceptable to enable book titles and call numbers to be read. Lighting specifications of 6 foot-candles minimum (farthest from source) and 35 foot-candles maximum (closest to source) *(Thomson, 2001)* are recommended for stacks as shown in figure 2.2. As such lighting types and configurations that can reduce the maximum light levels will pay off in reduced deterioration.

Natural and fluorescent light contain ultraviolet (UV) rays, which are damaging to collections *(Wilson, 1999)*. General collections in areas with natural light should be arranged such that, shelve are set perpendicular to and away from windows whenever possible to avoid direct sunlight incident on spines of books*(Thomson, 2001)*. Repositories should have no natural lighting; artificial lighting should be equipped with staff-operated local switches so lights can be employed as needed rather than left on continuously or for extended periods when not needed for staff work.

Fluorescent lighting when employed should be equipped with UV shields to eliminate much of the UV light. Windows can also be tinted with a UV filtering layer, or retrofitted with UV filters *(Thomson, 2001, Michalski, 2000)*. Both actions will substantially reduce expenses for rebinding and repair of otherwise exposed collections. Also limiting the intensity of UV light as a portion of total light exposure to a maximum of 75 microwatts/lumen is recommended *(Thomson, 2001)*.

Infrared radiation damage is most noticeable when light sources are close enough to collections to heat them, causing local damage. This situation is evident in older,

over-crowded stacks with collection materials stored high on the shelves near incandescent stack lighting *(Thomson, 2001)*. A more common situation in modern archives occurs in display areas that use hot, high intensity lighting. The lighting can heat up objects even at a distance from them; when lighting is mounted in cases, it raises the temperature of the case environment.

Most collections receive more exposure to light when on display than at any other time during their service lives. Display lighting that is left on during all open hours (if not around the clock) cumulates very high levels of exposure and light damage. In a bit to limit deterioration, visible lighting levels of 5-15 foot-candles is recommended for display of paper-based collections *(Thomson, 2001,Michalski, 2000)*, a level often lower than surrounding ambient lighting.

As an alternative, exhibits can be housed in a separate space with low levels of ambient lighting or to raise exhibit lighting to at least ambient lighting levels, whilst making sure the lights are turned off when not needed, and to limit the length of time collections are allowed to remain on display.

2.3.3 Air Pollutants

The effect of pollutants on the indoor environment is just as destroying as exposure to high lighting levels. Its effect on the indoor environment is also cumulative *(Tétreault, 1999)*.

Airborne contaminants occur in the form of gases and particulates which have seriously jeopardising effects on the preservation of archival collections. Sulphur dioxide, nitrogen dioxide and ozone are the primary sources of gaseous pollutants identified in the deterioration of archival collections *(Tétreault, 1999)*. Other

pollutants have also been identified including many volatile organic compounds (VOCs) such as acetic acid, formaldehyde, etc. *(Tétreault, 1999)*.

Particulate pollutants are mostly introduced into archives from external sources such as roads, industrial sites, building works, etc. For this reason, a sensible precaution is to locate fresh air intake to the HVAC system well away from loading docks, car parks or other areas where exhaust of vehicles and other petroleum-powered equipment can introduce unwanted pollutants. Also gaseous pollutants may be generated inside the archives as products of material decay, by wooden shelving or certain types of paints *(Tétreault, 1999, Thomson, 2001,Michalski, 2000)*.

One the main sources of cellulose deterioration are photo-oxidation which is accelerated in the presence of sulphur dioxide, nitrogen dioxide and high relative humidity levels *(Michalski, 2000)*.

Filtration systems were often recommended for the control of gaseous pollutants but recent research have revealed that molecules in gaseous pollutants are too small to be trapped by any filtration system and must be removed from the air through a chemical reaction with another substance *(Tétreault, 1999, Thomson, 2001,Michalski, 2000)*. Despite this, some degree of control can be achieved by simply dealing with the known sources: remove poor quality paper storage enclosures, seal untreated wood, make sure that paints have cured before bringing in collections into that space; set up the photocopier in separate well ventilated area, etc.

Particulate pollutants are also a major source of concern to collections since, they are generally abrasive and acidic, and can be highly reactive chemically *(Tétreault, 1999, Thomson, 2001)*. Most particulates are removed by air intake filters and this depends on the porosity of the filters. Even though electrostatic filters are very

effective in reducing particulate pollution, because these air cleaners produce ozone, a powerful oxidant which accelerates deterioration in many organic materials such as cellulose and it is therefore not recommended *(ASHRAE, 2003)*.

2.3.4 Monitoring Indoor Environment

An environmental monitoring system is very relevant to help understand the various microenvironments within the indoor environment *(ASHRAE, 2003, Thomson, 2001)*. This monitoring would have to be carried out independent of the HVAC monitoring systems that might exist within the archives. This is because the system monitoring normally relies on sensors built into the supply or return ducts and this does not give the correct environmental conditions of the archival collections (*Thomson, 2001)*. The collections normally absorb and releases moisture to the surrounding air to achieve relative humidity equilibrium, while the supply air ducts reports to the monitors only the conditions of the air delivered through the system instead of the micro conditions of the collections (*Thomson, 2001)*. Similarly, sensors positioned in the return air duct measure only the conditions of the return air, which differs remarkably from the micro environmental conditions of the collections within their storage containers.

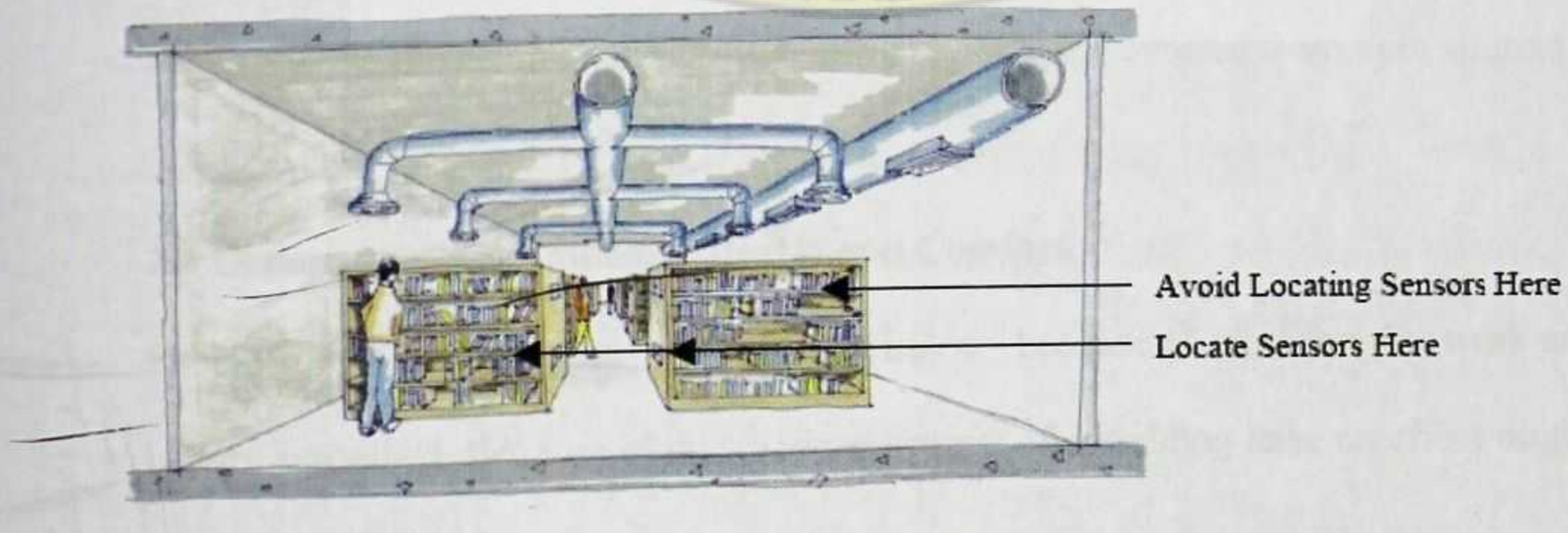

Figure 2.3 Positioning of sensors in archives *(Thomson, 2001)*

For this reason the system thermostat and humidistat should be located in the collections spaces away from the air duct as much as possible (*Thomson, 2001)* as shown in figure 2.3. Even when these sensors are well positioned, independent sensors should be placed within the collections containers to better understand the microclimate within the archives and as such apply the proper corrective measure. In addition, these sensors serve as a double check, just in case any of the system sensors malfunctions or fail *(Thomson, 2001, ASHRAE, 2003, Michalski, 2000)*.

Also because maintenance engineers are mostly concerned about the performance, HVAC systems as opposed to the life of collections, it is important for environmental monitoring by the archival staff to correct this potential conflict *(Thomson, 2001, Michalski, 2000)*.

These monitoring are done by specialised instruments. Hygrothermograph or dataloggers are used for the monitoring of temperature and relative humidity. The hygrothermograph are placed at points where they are needed and it constantly and continuously read and records both temperature and relative humidity to a chart, making these data readily available. The dataloggers on the other hand periodically measures and stores these conditions as electronic data that is downloaded at certain periods. Visible and ultraviolet light unlike temperature and relative humidity is not recorded continuously but is spot-checked with a metre and corrective actions taken till new lighting equipments are introduced. The lux metre is used to monitor light levels and the ultraviolet metre for ultraviolet light being emitted from light sources.

2.4 Occupants Environmental Health and Comfort

People spend a vast majority of their time indoor, because of our lifestyle (work and leisure activities). Because of this, various aspects of a building have an effect on the

comfort and health of its occupants. Ulrich (2004), demonstrated this by showing how design characteristics, like better ventilation, layout and light reduces stress and fatigue in patients and staff and their overall improvement in health. This together with other research works proved that the conditions in a building affect the health and comfort of its users.

Studies have also proven that inadequate heating or cooling and ventilation system result in adverse health effects, including respiratory illness, asthma, infectious diseases, injuries and even mental health disorders (*Ulrich ,2004, Edwards, 1999, Kaplan, 1995)*. Thus, maintaining good indoor climate improves the health of its occupants. This cannot be achieved without fully understanding user satisfaction within the building, its space and indoor climate. As such for archives where human co-exist with archival collections, understanding user satisfaction becomes paramount.

2.4.1 Environmental Psychology in Archives

In the 1990's, the term "Sick Building Syndrome" (SBS) was used to describe the condition where occupants of certain buildings experienced mental and physical diseases as a result of occupying a particular building *(Edwards, 1999)*. Studies by various psychologist indicated that these buildings had separated their users from natural elements. This separation of users from natural elements is common concept in archives due to the need to create an isolated indoor environmental condition for the preservation of the collection. This intends ends up affecting the staff and visitors of the archives. This concept is contrary to Kaplan's *(Kaplan, 1995)*, attention restoration theory (ART) which states that natural settings provide an easy

fascination that can help people recover from mental fatigue caused by the effortful attention often required at work.

Studies by Kou and Sullivan *(Kou, Sullivan, 2001)*, have shown that the presence of vegetation in public housing reduced levels of aggressiveness and crime. Furthermore, the hypothesis about the restorative function of natural environment have been tested in many empirical studies, with an example being Ulrich *(Ulrich et al., 2004)* study of patients who looked out on trees and nature from their windows recovering quicker than those with restricted view. As such, since archives are designed to have solid walls with little and restricted windows, it is more likely staff would suffer psychologically. For this reason, the ability of natural elements to function as natural tranquillizers *(Berg et al., 1998)* would be very beneficial to archival staff.

Recent studies have lead to similar results, strengthen the assumption that natural environment have positive influence on psychology and mental health. Also students in day lit classroom where happier than those in minimal day lit classroom *(Heschong et al., 2002)*. For this reason staff and visitors of archives may have their emotional well being affected due to the low lighting level required for its collections and operations.

2.4.2 Environmental Health in Archives

The use of synthetic materials, solvents and mechanical systems of indoor environmental control of archives comes with their own threat to health and personal well being of it staff and visitors. The term "Sick building Syndrome" (SBS) is used to describe situations in which building occupants experience acute health and comfort effects that appear to be linked to time spent in a building but no specific

illness or cause can be identified *(Boxer, 1990)*. These complain may be localised to a particular room or widespread throughout the building. Poor thermal, visual and aural comfort conditions, presence of gaseous pollutants, microbiological contaminants, dust and fibre are generally the combining factors that lead to sick building syndrome. This condition is exacerbated when user of building lack the ability to perceive natural conditions and are unable to control the internal environmental conditions.

Also "Building Related Illness" (BRI) is used when symptoms of diagnosable illness are identified and can be directly attributed to air-born building environments. Both sick building syndrome and building related illness are associated with acute or immediate health problems.

According to the World Health Organisation committee, in 1983, up to 30 percent of new and remodelled buildings worldwide were subject to excessive complaints related to indoor air quality (IAQ) *(World Health Organisation, 1983)*. This was as a result of poor building design or occupants activities, building use and inconsistent maintenance. It is important to note that the complaints may have resulted from other causes as, illness contracted outside the building, acute sensitivity, job related stress or dissatisfaction and other psychological factors. This notwithstanding, various studies have shown that symptoms may be caused or exacerbated by indoor air quality problems *(Galea et al., 2005)*. The quality of the internal environment is affected by both internal and external pollutants. The internal pollutants are produced by the building materials and collections and external pollutants being, smoke from cars and dust from outside.

Since psychological factors affect sick building syndrome, it has been observed that sealed air conditioned buildings are more prone to complaints of sick building

syndrome than buildings ventilated and lit by natural means *(Hedge et al., 1996)*. This implies that staff and visitors of archives are at risk of sick building syndrome complaints, since most archives operate in sealed air condition building with artificial controlled light.

It important to note that it was recorded in the 1970's office buildings which were designed like archives with deep planned and relatively small windows resulted in increased health problems (*Ulrich ,2004, Edwards, 1999, Kaplan, 1995, Hedge et al., 1996)*. Also since archives are highly sealed to control unwanted air filtration, it tends to reduce ventilation rate, leading to toxicity levels in the building becoming critical to users.

2.5 Factors Influencing Indoor Environment of Archives

The indoor environment of archives is the result of a great variety of both positive and negative number of factors as shown in figure 2.4. The following lists show the complexity of this system and the many influences on the indoor environment making it difficult to predict it behaviour and to interpret abnormalities in measurements.

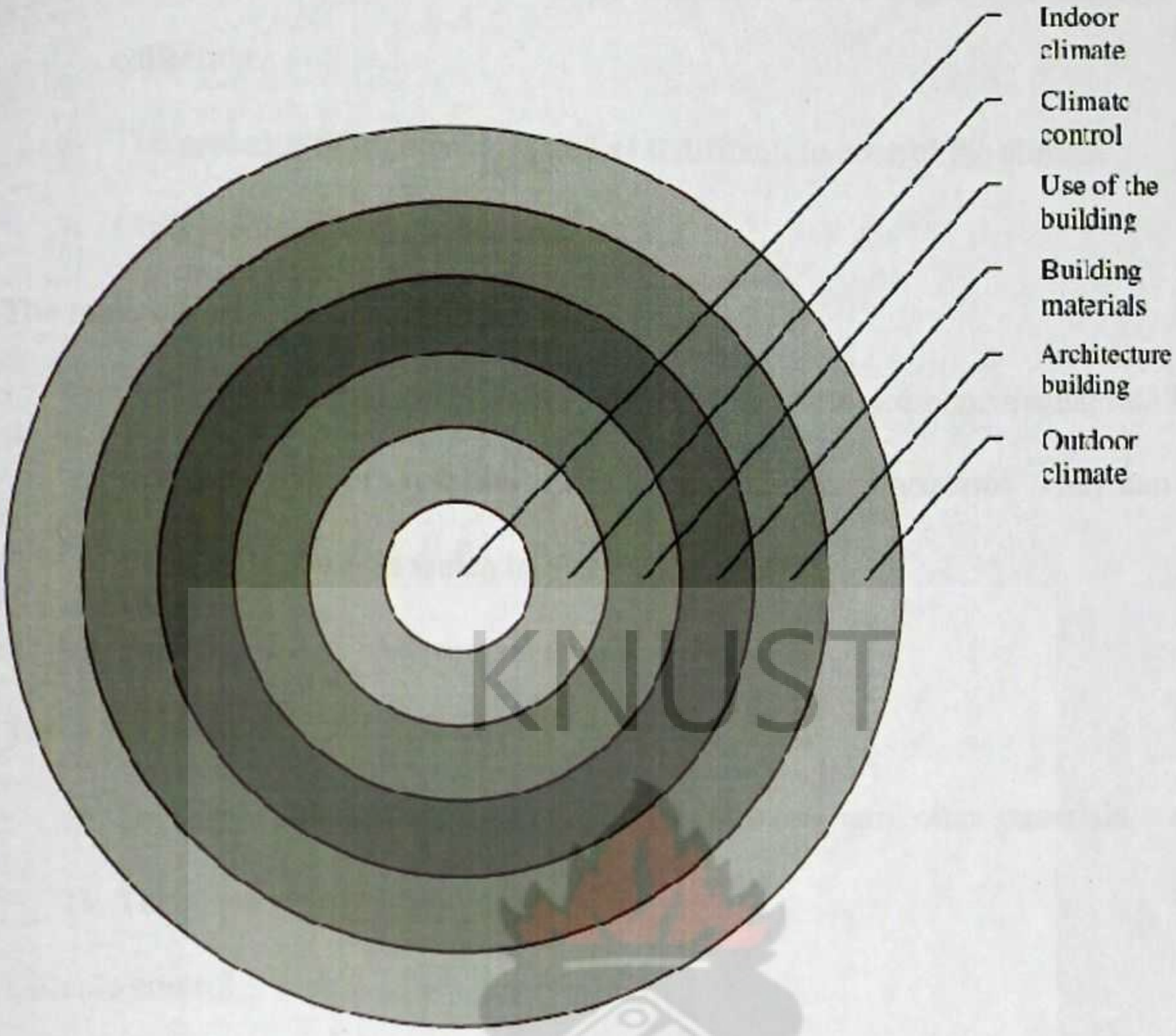

Figure 2.4 Factors influencing the indoor environment of archives

The following list shows the factors influencing the indoor environment of archives.

Outside the archives

1. The location of the building. Two extreme zones can be defined: the Humid Zone (continual mould problem) and the Arid Zone (too dry).
2. Building orientation: sun, wind, rain.

Inside the archives

3. Temperature and relative humidity; they are interrelated: warm air can contain more water vapour, so when cold air is heated, the relative humidity decreases and vice versa.

The architecture of the archives

4. The shape of the building.

5. Glass surfaces make insulation difficult. Natural light can damage the collection.

6. The presence of high ceilings makes it difficult to control the climate.

7. Open traffic patterns inside and outside

The materials used for the archives

8. Inorganic materials like glass, metal and concrete are poor insulators. They give only a slight protection from outdoor climatic variations. They can also create cold surfaces which increase condensation.

9. The presence of buffering materials.

The collection

10. Some exhibit materials may give off gas that can harm other materials.

11. The presence of buffering materials.

Climate control

12. The presence of a HVAC system.

13. Good air circulation.

Relative humidity control in a closed case

14. The presence of closed cases or cocoons.

Maintenance

15. Maintenance of the humidifying equipment.

16. Maintenance of dataloggers: regular calibration.

17. Maintenance of the building.

Monitoring and reporting

18. The presence of dataloggers: the temperature and relative humidity need to be recorded in order to be able to respond accordingly.

19. The proper positioning of the equipment is of importance for the results of the measurements.
20. The readings from the measuring devices need to be assessed.
21. Skills and knowledge of the personnel.
22. The readings need to be filed with all relevant information.

The use of the building

23. All doors between more or less controlled zones in the building must be closed most of the time.
24. Control knobs and removable parts on equipment in the room must be made secure from interference.
25. If receptions and parties are taking place in the building, the equipment should be designed to handle these special circumstances.
26. The amount of visitors.

Funding

27. How much funding is available to provide the building with the proper equipment to control the climate?

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This study provides a wider view and understanding of archives internal environmental conditions in relation to its users comfort and the ability to preserve archival collections. This study utilised both the quantitative research method of experimental analysis and qualitative research methods in the form of questionnaire and observations to explain this relationship. The quantitative method was used to collect actual measurement of the environmental variables so that these measurements could be compared to the standard to check if the indoor environment was suitable for the archival collection. Also these measurements were checked with the acceptable human comfort levels. The qualitative method was used to elicit information from the staff and visitors about their health history, comfort levels and their perceptions.

Because the onsite research was limited to one week, focus was placed on the archival repository and reading area. The repository was chosen because it housed a majority of the archives. The reading areas because it abuts the repository and it is suppose to have the same environmental conditions. This chapter elaborates on the approaches, sampling methods, data collection methods and analysis and finally the code of ethics which guided the research procedure.

3.2 Research Approach

The case study approach was used in this research since it allowed for a systematic gathering of information for better understanding of a situation (Berg, 2004), in it real life context (Yin, 2003). The descriptive case study approach was specifically used, because it provided, in-depth investigation and holistic description of the archival indoor environment through the use of multiple sources of evidence (Yin, 2003).

3.3 Sample and Sampling Technique

Since the research is being conducted on the staff of the Public Records and Archives Administration Department, Accra the sample population is already known. Purposive sampling was used since the research was restricted to the repository and the archival reading area. All the eight (8) staff who worked in the repository and the readings room during the one week study period was used as the working sample group. This is because the most stringent of indoor environmental conditions in the archive occurs at the repository and reading room.

3.4 Method of Data Collection

The study was based on questionnaire administered to both staff of the repository and reading room. Temperature, relative humidity and light levels inside the repository and reading room were collected to provide a view of the indoor conditions. Also observation was carried out as part of the visual inspection of the building's environmental control system.

The source of information as such can be categorised into primary and secondary sources of data collection.

3.4.1 Primary Source of Data

Information for the study was gathered through personal observation of the Public Records and Archives Administration Department's environmental control system, questionnaire administered to staff and visitors, photography, measured drawings and sketches relevant to the study.

3.4.1.1 Questionnaire

In order to qualitatively and quantitatively assess different indoor environment factors influencing human comfort levels and preservation of collection. The survey questionnaire was based on a comprehensive questionnaire to acquire information on three interrelated subjects: indoor environmental conditions, human comfort and preservation of collections.

Questionnaires were administered to all eight (8) staff in the search room and repository over study period. To improve responds rate, consent was acquired from the Public Records and Archives Administration. The questionnaire sought answers regarding environmental control, health history and perception of indoor environment and comfort levels.

3.4.1.2 Observation

Observation was carried out as part of the visual inspection of the building's environmental control systems. Furthermore, the state of the building materials and architectural design on the archives were visually inspected.

3.4.1.3 Photographs, Sketches and Drawings

Photographs were taken to aid with the description of various elements and also to reinforce the data collected. Schematic sketches and measured drawings were drawn to shown the relationship between spaces and the position of dataloggers in the building.

3.4.1.4 Monitored Environmental Data

Indoor temperature and relative humidity were monitored using dataloggers for a period of one week. The accuracy of the respective sensors is given in Table 3.1.

Table 3.1 Accuracy of sensors *(Computer Corporation HOBO)*

Sensor	Range	Error
Air temperature	-20 to 70°C	+/- 0.4 °C
Relative humidity	5 to 95%	+/-3%

3.4.2 Secondary Sources

In order to understand the relationship between archival indoor environmental conditions, collections and user comfort, the study commenced with an extensive literature search and review in order to obtain data for a wider understanding of archival environment. The main subject areas for the search were:

- Effects of temperature on building, collections and human comfort
- Effects of relative humidity on building, collections and human comfort
- Mould and pest

- Influence of particulate and gaseous pollutants on the deterioration of different materials and human comfort
- Human interaction
- National and international standard on storage/preservation policies

The methods employed to achieve this were:

i. Reference from library include books, journals, reports and other literature works

ii. Internet

3.4.2.1 Library

Journal, books, reports, encyclopaedias and dictionaries were obtained from the Kwame Nkrumah University of Science and Technology (KNUST) main library, College of Architecture and Planning, KNUST library and Department of Architecture, KNUST library were used as resource materials for the research paper. These have been documented under the bibliography.

3.4.2.2 Internet

Information was gathered from the internet to supplement and compliment information from the library and other sources.

3.5 Data Analysis

Morse and Field (1995) explained that data collected from a study should be labelled in set of themes. Applying this concept, the themes were analysed using graphs and diagrams. Schematic sketches and measured drawings were used to indicate the

position and relation between the dataloggers and the collections. Graphs and schematic diagrams were processed using Microsoft Excel and AutoCAD applications respectively.

3.5 Limitations

Some of the limitations to this research paper were:

i. Limited time available for study.

ii. Limited literature at libraries.

iii. Some important books could not be assessed since they had to be bought over the internet.

3.6 Ethical Issues

The following ethic considerations were used to conduct the research

- Permission was sought from the Public Records and Archives Administration Department and to grant access into the study domain.
- Participants were not forced, coerced or influenced by any means to participate in the research since this can influence responses or cloud judgement. Participation was absolutely voluntary.
- The researcher assured participants that findings/responses and results will be treated with absolute confidentially and for that matter their identity will not be disclosed under any condition.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

The relationship between the internal environmental conditions of archives in relation to its users comfort and the ability to preserve archival collections is investigated using both the quantitative research method of experimental analysis and qualitative research methods in the form of questionnaire and observations. The findings as presented in this chapter are obtained in line with the aims and objectives of the research. This chapter begins with a brief look at the history of PRAAD and proceeds to present and discuss data gathered with respect to the internal archival environment and it ability to protect records and provide human comfort.

4.2 Respondents Profile

The target respondents were the staff who worked in the search room and repositories. They were purposely selected since the internal environmental conditions of these spaces are the most stringent in all archives. As such, this staffs experience the greater part of the internal environmental conflict between the internal environmental needs of humans and requirements for archival records.

All the staffs in who worked in the repository and search room were administered questionnaires which they filled and returned within a period of five minutes. Thus a 100% responds was achieved. The total number of staffs who worked in the

repository and search room was eight (8). Also the search room and repository head was interviewed.

4.2.1 Respondents Demographic Characteristics

The gender and age profiles of respondents are as follows;

A) Gender

7 (87.5%) of respondents were males whiles the remaining 1 (12.5%) was a female. The chart below shows the gender ratio of respondents.

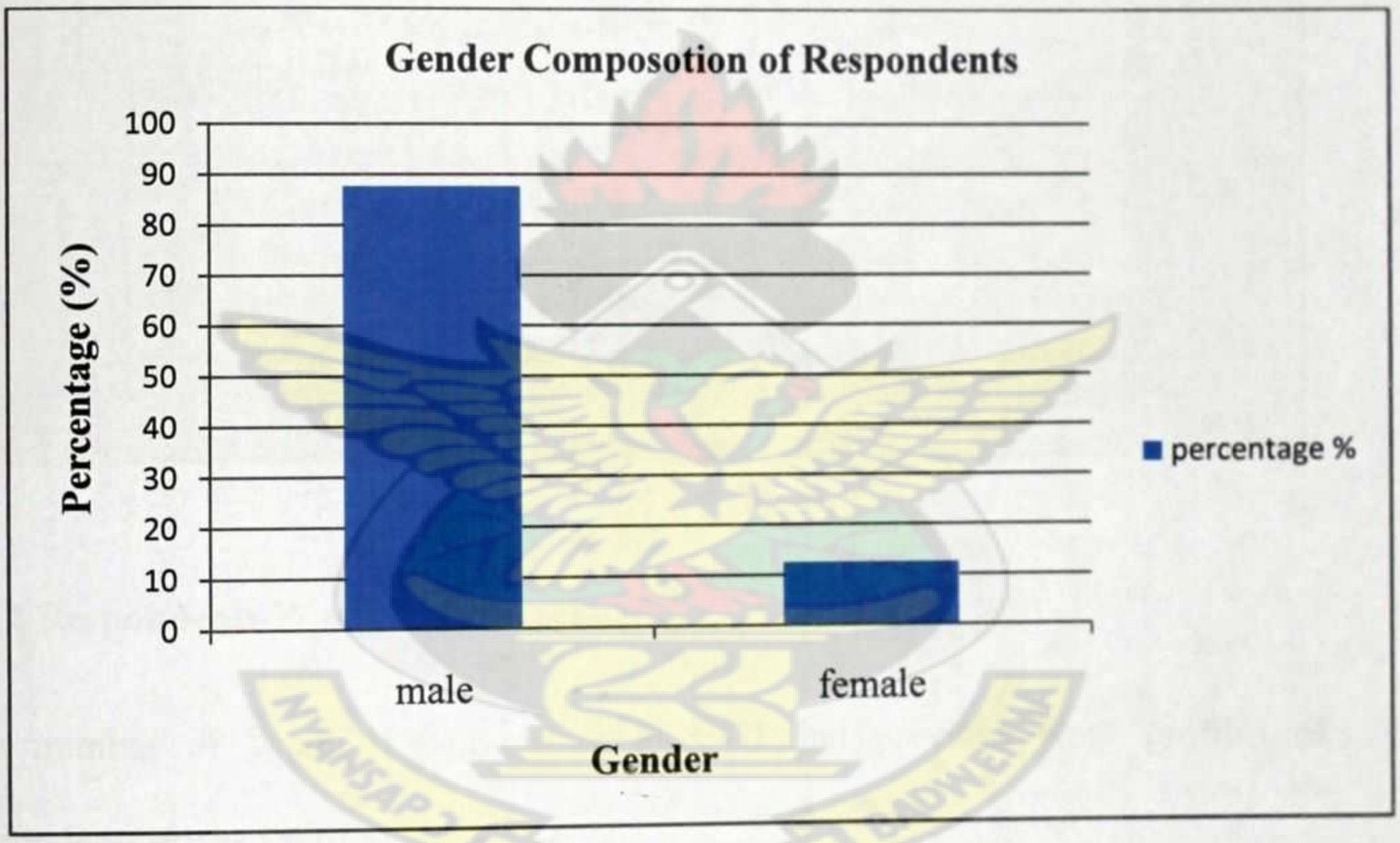

Fig. 4.1 Bar chart showing the gender composition of respondents to questionnaire

(Source: Author, 2011)

B) Age

Out of the respondents, 2 (25%) were between the ages of 25-29 years, 1 (12.5%) within 30-34 years and 2 (25%) are between 35-39 years. Also 2 (25%) have their ages ranging from 40-44 years and 1 (12.5%) fall within 55-59 years. None

of the respondents was above 60 years since their retirement age is 60 years. The table below shows the age distribution of respondents.

Table 4.1 Age distribution of respondents *(Source: Author, 2011)*

Age range (yrs)	Frequency	Percentage (%)
20-24	0	0
25-29	2	25
30-34	1	12.5
35-39	2	25
40-44	2	25
45-49	0	0
50-54	0	0
55-59	1	12.5
60 and above	0	0

4.2.2 Respondents Work History

The number of years of working at PRAAD and previous work profiles of respondents are as follows;

A) Number of years at PRAAD

Out of the respondents surveyed, 3 (37.5%) having been working here for the past 2 years, 2 (25%) within 3-5 years and 2 (25%) within 6-8 years. Lastly, one (1) of the respondents forming 25% of the surveyed population has been working there for more than 30 years as shown in table 4.2.

Table 4.2 Working experience distribution of respondents at PRAAD *(Source: Author, 2011)*

Years of working at PRAAD (yrs)	Frequency	Percentage (%)
0-2	3	37.5
3-5	2	25
6-8	2	25
9-11	0	0
12-14	0	0
15-17	0	0
18-20	0	0
21-23	0	0
24-26	0	0
27-29	0	0
30-32	1	12.5
33-35	0	0
36-38	0	0
39+	0	0

A) Other employment details

From the survey it was realised that all the respondents have had no prior employment exposure anywhere before working at the PRAAD.

4.3 Data Sourcing and Analysis Procedure

Over a 5 days period, from 16th May, 2011 to 20th May, 2011, environmental variables within the search room and repository of the Accra PRAAD, was measured and monitored. These spaces were selected because they present the best interaction between the archival records and humans. The repository was chosen because it housed majority of the collections. The repository is an enclosed area separated from the search room but is suppose to share the same indoor conditions.

Air temperature, relative humidity and light intensity were measured at the search room and repository. Two Onset Computer Corporation HOBO U12-012 data loggers were used to measure and monitor these variables. It was placed 1200mm above the floor level in the search room and 600mm above the floor level in the repository. Figure 4.2 and figure 4.3 shows the floor plan of the test area indicating the position of the data loggers.

The data gathered from the data loggers were processed with Microsoft (MS) Excel. Greenline software was used to launch and download the data from the data loggers. Hoboware pro software was used to screen the values and exported to MS Excel. In MS Excel, the text files were screened and built together in daily tables. In addition, formulae sheets were generated to produce mean daily values and output values were graphed and analysed.

Interviews were conducted with the staff to collect information on facility usage and maintenance. Observations were carried out as part of the visual inspection of the buildings environmental control system.

Finally, questionnaires were administered to the staff in the search room and repository to solicit their opinions on the comfort levels these spaces with a closer

look at the environmental conditions. The questionnaire further probed into their medical history.

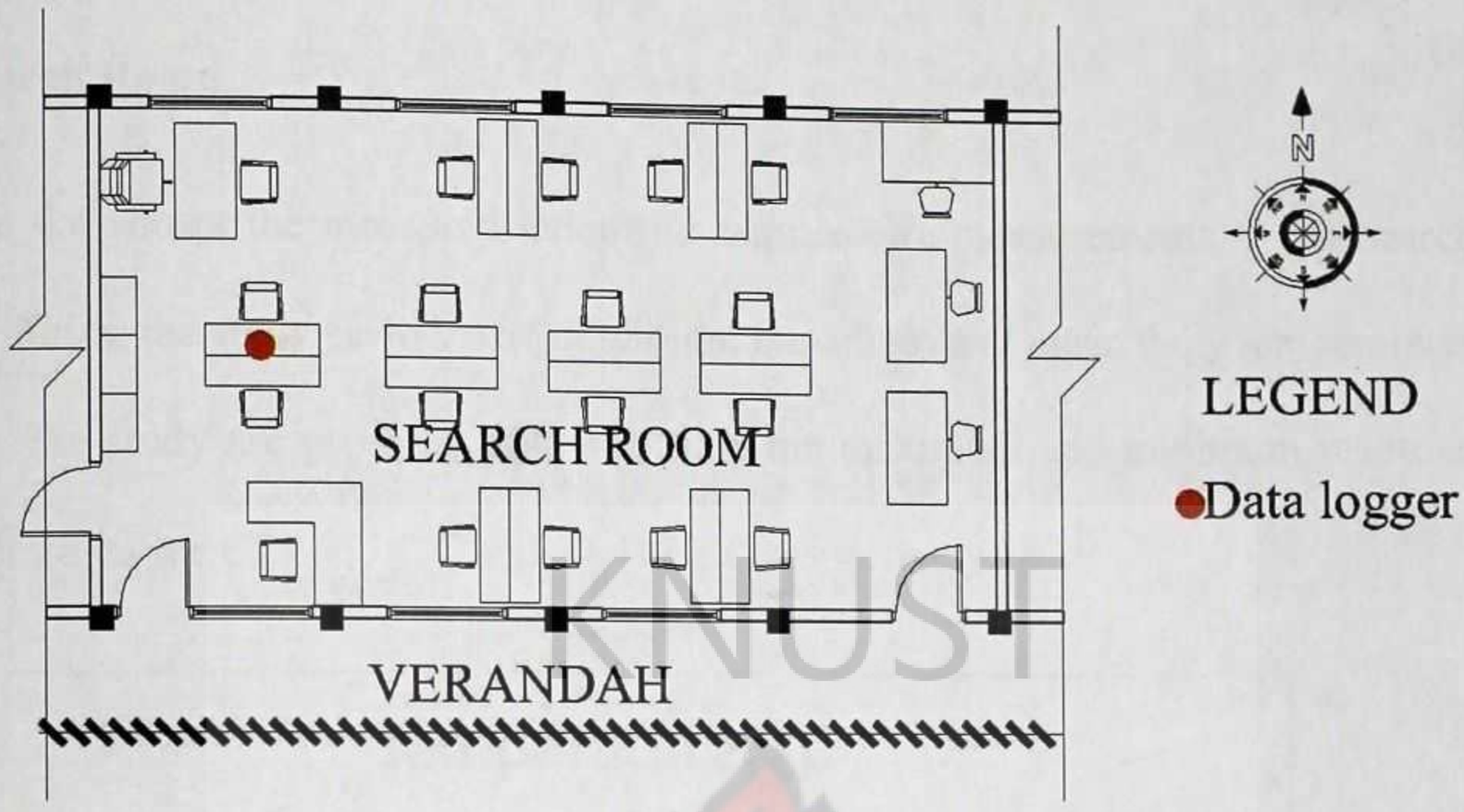

Fig. 4.2 Floor plan of search room indicating the position of the data logger.

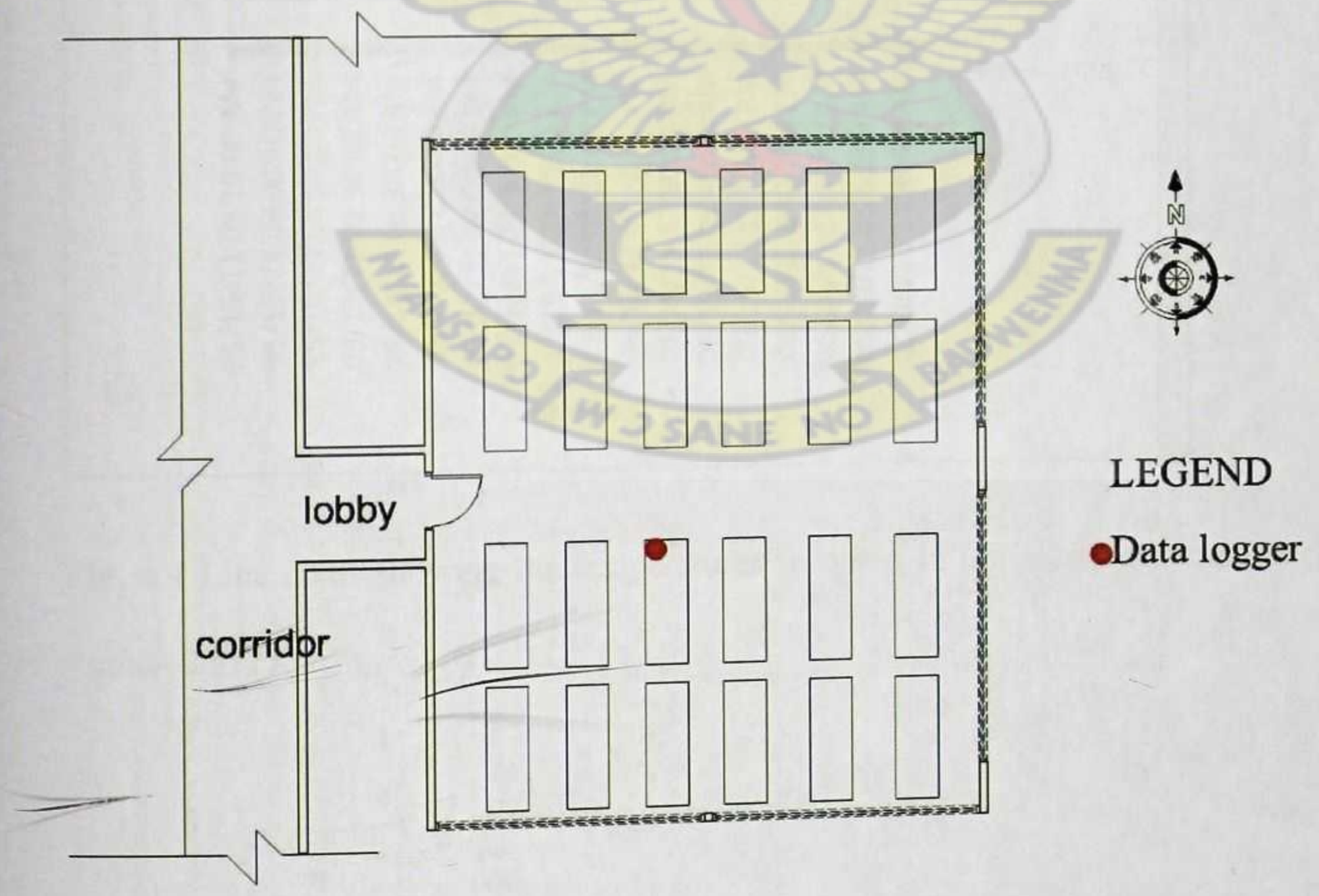

Fig. 4.3 Floor plan of repository indicating the position of the data logger.

4.4 Results

4.4.1 Measured Internal Air Temperature

A. Search Room

Figure 4.4 shows the measured indoor air temperature measurements in the search room during the study period. The minimum, maximum and mean daily temperatures during the study are given in table 4.3. Also the maximum and minimum recorded temperatures were 29.655 □C and 22.417 □C respectively.

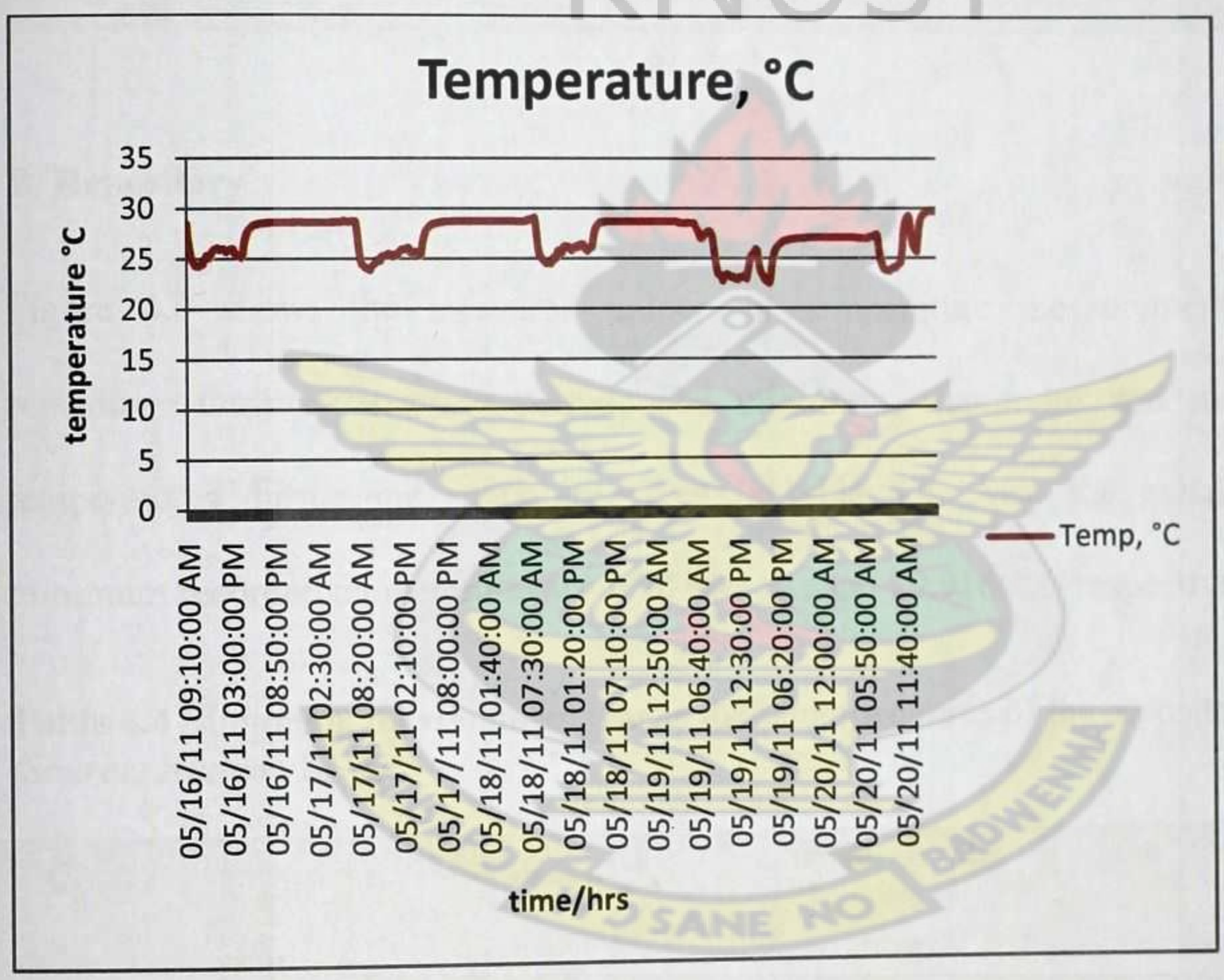

Fig. 4.4 Line chart showing the temperatures recorded in the search room *(Source: Author, 2011)*

Table 4.3 Minimum, maximum and mean daily temperatures of the search room
(Source: Author, 2011)

Day	Minimum daily Temperature, °C	Maximum daily Temperature, °C	Mean daily Temperature, °C
16/05/2011	24.195	28.568	26.806
17/05/2011	23.809	28.692	27.244
18/05/2011	24.388	29.015	27.621
19/05/2011	22.417	28.615	26.215
20/05/2011	23.617	29.665	26.820

B. Repository

Figure 4.5 shows the measured indoor air temperature measurements in the repository during the study period. The minimum, maximum and mean daily temperatures during the study are given in table 4.4. Also the maximum and minimum recorded temperatures were 30.596 □C and 29.916 □C respectively.

Table 4.4 Minimum, maximum and mean daily temperatures of the repository
(Source: Author, 2011)

Day	Minimum daily Temperature, °C	Maximum daily Temperature, °C	Mean daily Temperature, °C
16/05/2011	29.991	30.243	30.145
17/05/2011	30.217	30.444	30.310
18/05/2011	30.394	30.596	30.499
19/05/2011	29.941	30.596	30.285
20/05/2011	29.916	30.142	30.018

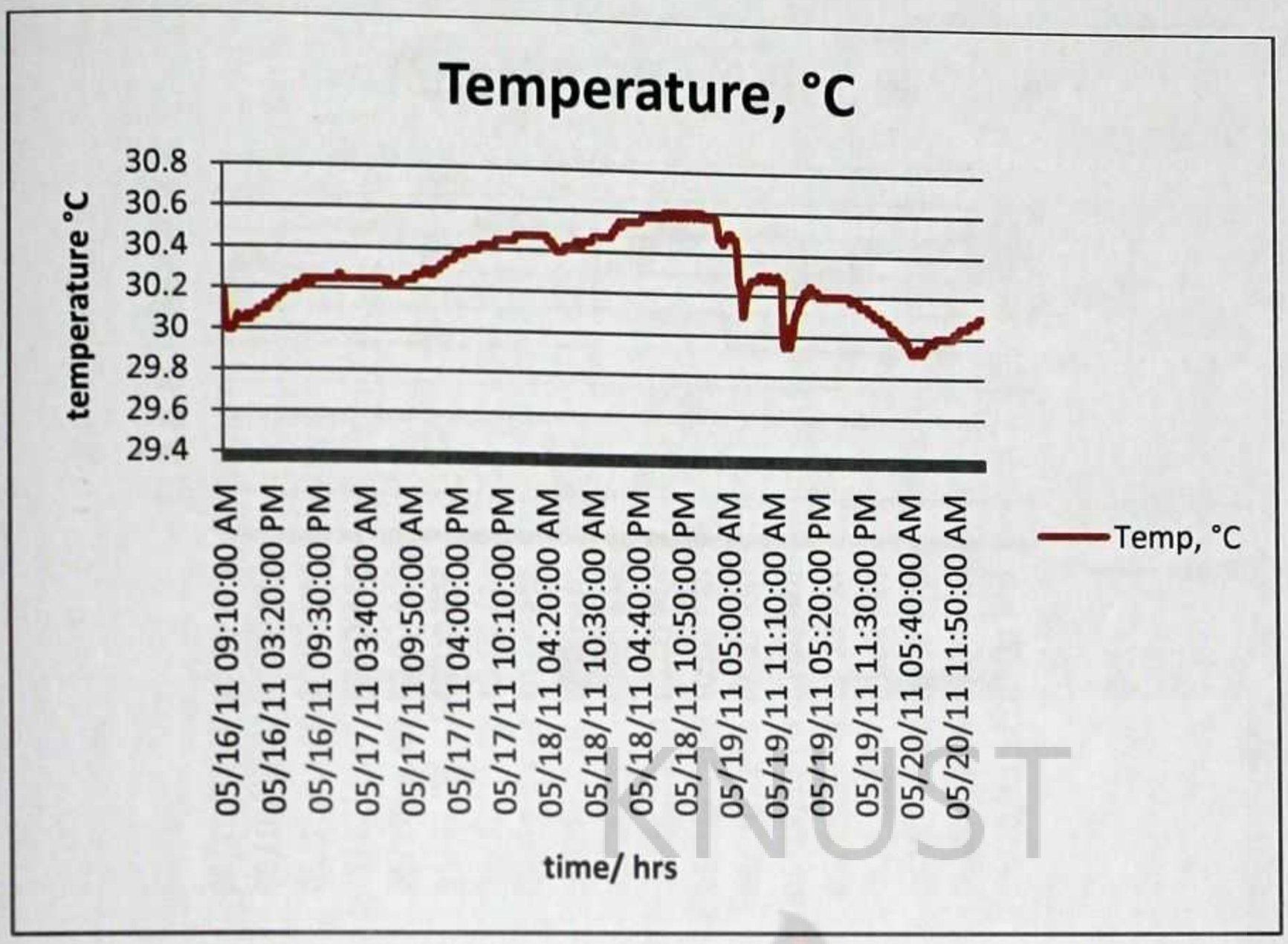

Fig. 4.5 Line chart showing the temperatures recorded in the repository *(Source: Author, 2011)*

4.5.2 Measured Internal Relative Humidity

A. Search Room

Figure 4.6 shows the measured indoor relative humidity measurements in the search room during the study period. The minimum, maximum and mean daily relative humidity measurements during the study are given in table 4.5. Also the maximum and minimum recorded relative humidity measurements were 87.121% and 60.699% respectively.

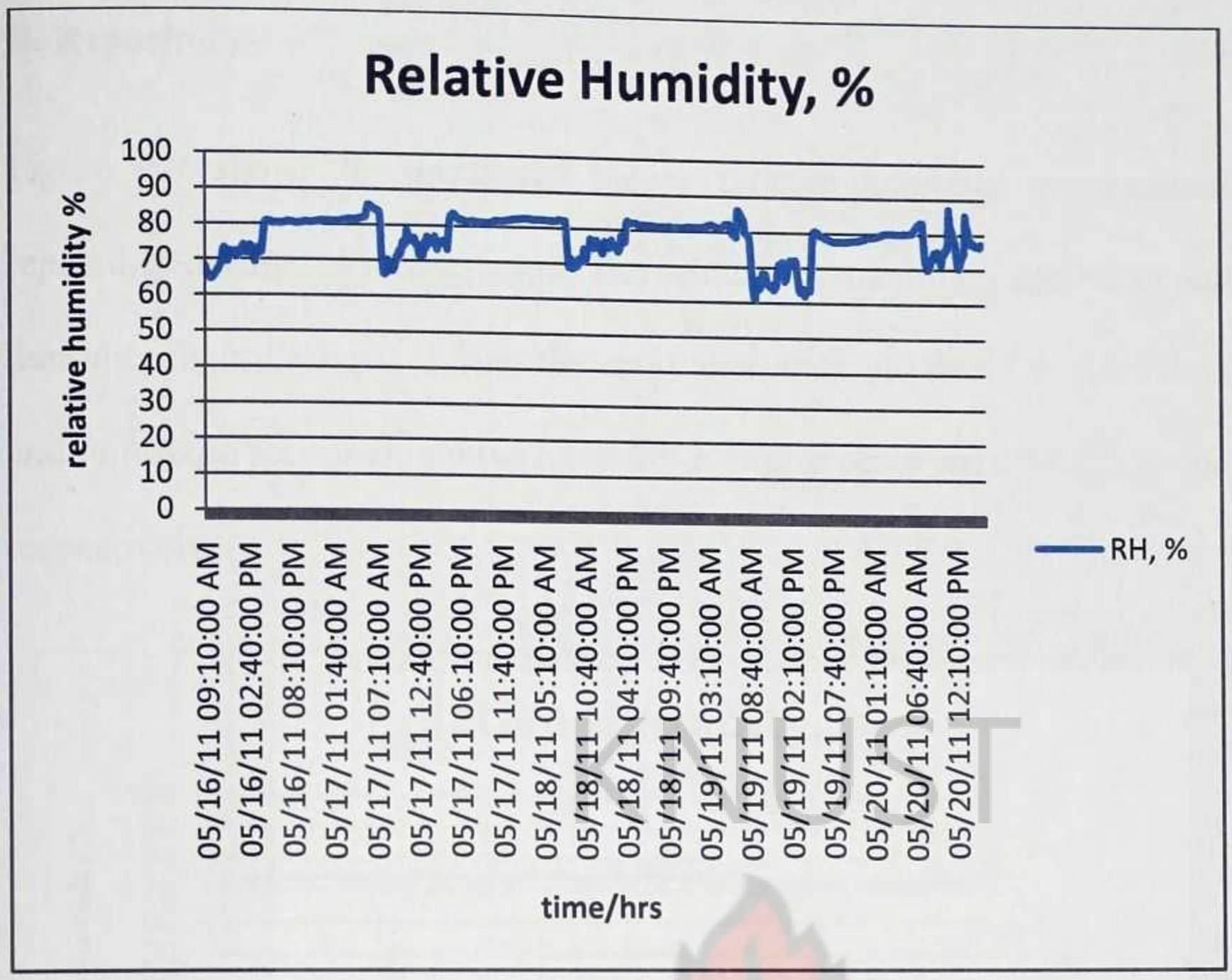

Fig. 4.6 Line chart showing the relative humidity recorded in the search room

(Source: Author, 2011)

Table 4.5 Minimum, maximum and mean daily relative humidity measurements of the search room *(Source: Author, 2011)*

Day	Minimum daily Relative humidity, %	Maximum daily Relative humidity, %	Mean daily Relative humidity, %
16/05/2011	64.336	80.741	75.143
17/05/2011	65.937	85.504	78.479
18/05/2011	68.532	82.400	79.056
19/05/2011	60.699	86.140	75.386
20/05/2011	69.743	87.121	77.926

B. Repository

Figure 4.7 shows the measured indoor relative humidity measurements in the repository during the study period. The minimum, maximum and mean daily relative humidity measurements during the study are given in table 4.6. Also the maximum and minimum recorded relative humidity measurements were 74.823% and 71.784% respectively.

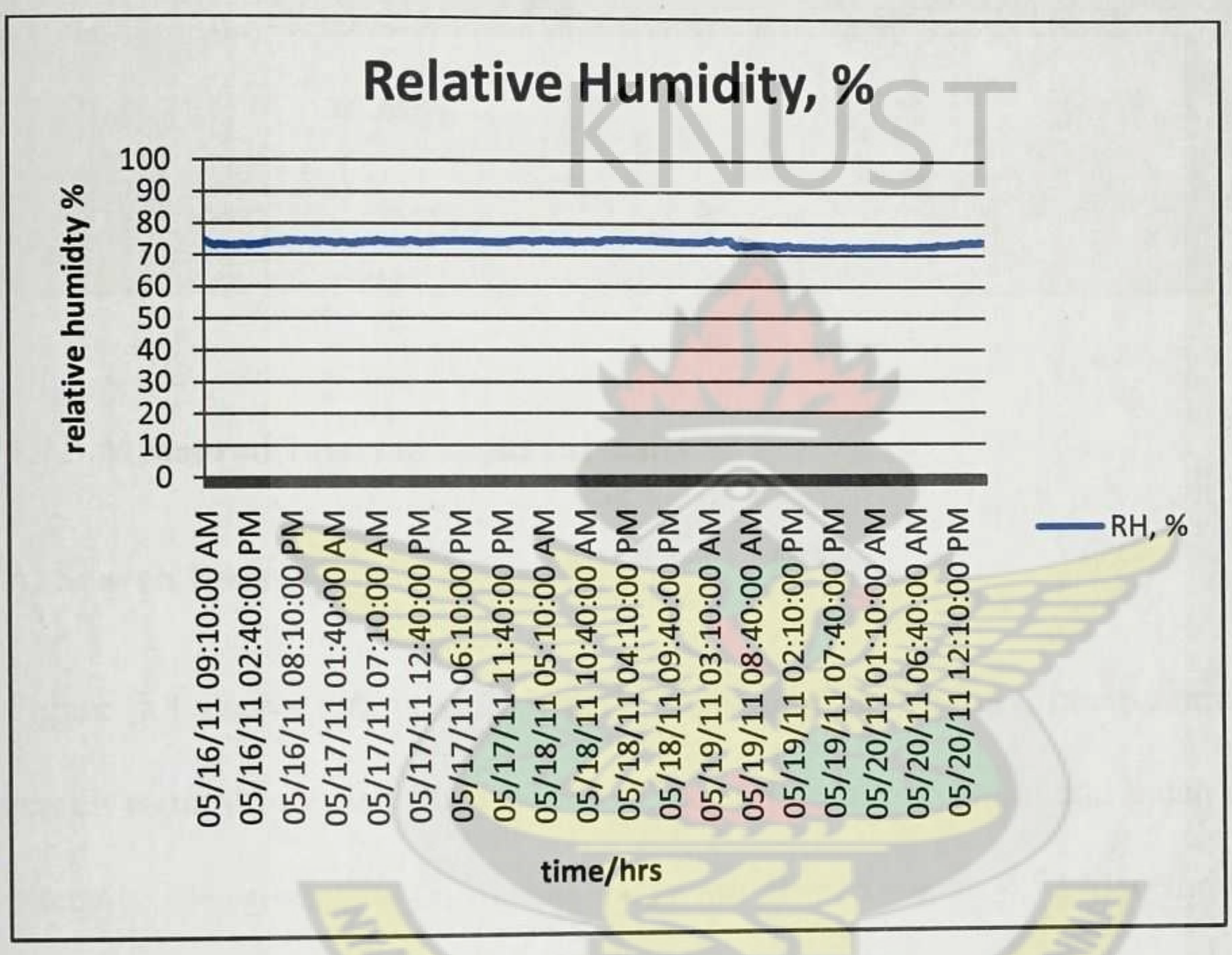

Fig. 4.7 Line chart showing the relative humidity recorded in the repository *(Source: Author, 2011)*

Table 4.6 Minimum, maximum and mean daily relative humidity measurements of the search room *(Source: Author, 2011)*

Day	Minimum daily Relative Humidity, %	Maximum daily Relative Humidity, %	Mean daily Relative Humidity, %
16/05/2011	72.857	74.530	73.619
17/05/2011	73.521	74.563	74.619
18/05/2011	73.956	74.823	74.391
19/05/2011	71.784	74.706	72.997
20/05/2011	72.238	74.002	72.872

4.4.3 Measured Internal Light Intensity

A. Search Room

Figure 4.8 shows the measured indoor light intensity in Lux, measurements in the search room during the study period. The minimum, maximum and mean daily light intensity measurements during the study are given in table 4.7. Also the maximum and minimum recorded light intensity measurements were 902.7 Lux and 3.9 Lux respectively.

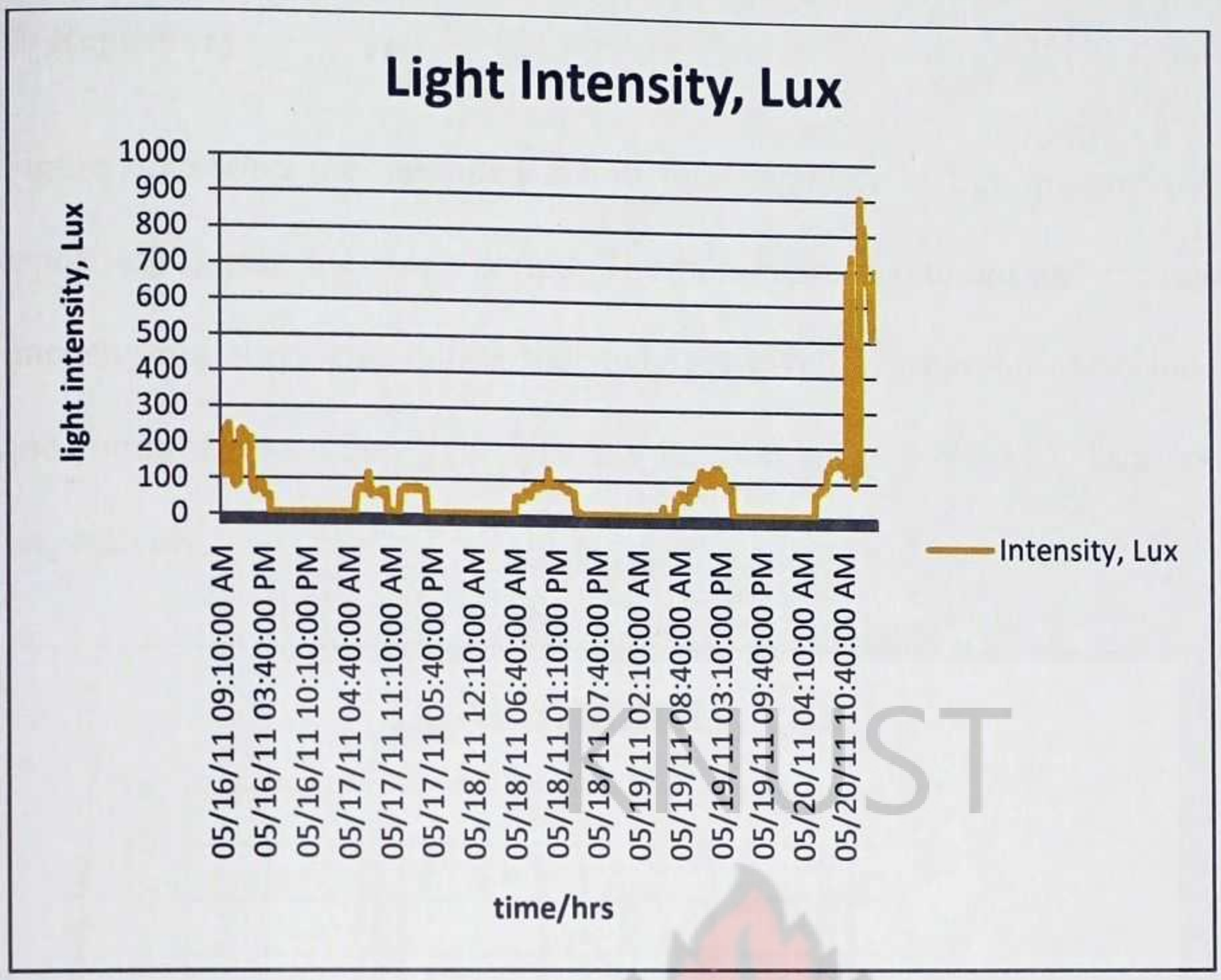

Fig. 4.8 Line chart showing the light intensity recorded in the search room *(Source: Author, 2011)*

Table 4.7 Minimum, maximum and mean daily light intensity measurements of the search room *(Source: Author, 2011)*

Day	Minimum daily Light Intensity, Lux	Maximum daily Light Intensity, Lux	Mean daily Light Intensity, Lux
16/05/2011	3.9	248.3	73.0
17/05/2011	3.9	114.3	28.1
18/05/2011	3.9	130.1	31.2
19/05/2011	3.9	138.0	36.1
20/05/2011	3.9	902.7	195.6

B. Repository

Figure 4.9 shows the measured indoor light intensity in Lux, measurements in the repository during the study period. The minimum, maximum and mean daily light intensity measurements during the study are given in table 4.8. Also the maximum and minimum recorded light intensity measurements were 11.8 Lux and 3.9 Lux respectively.

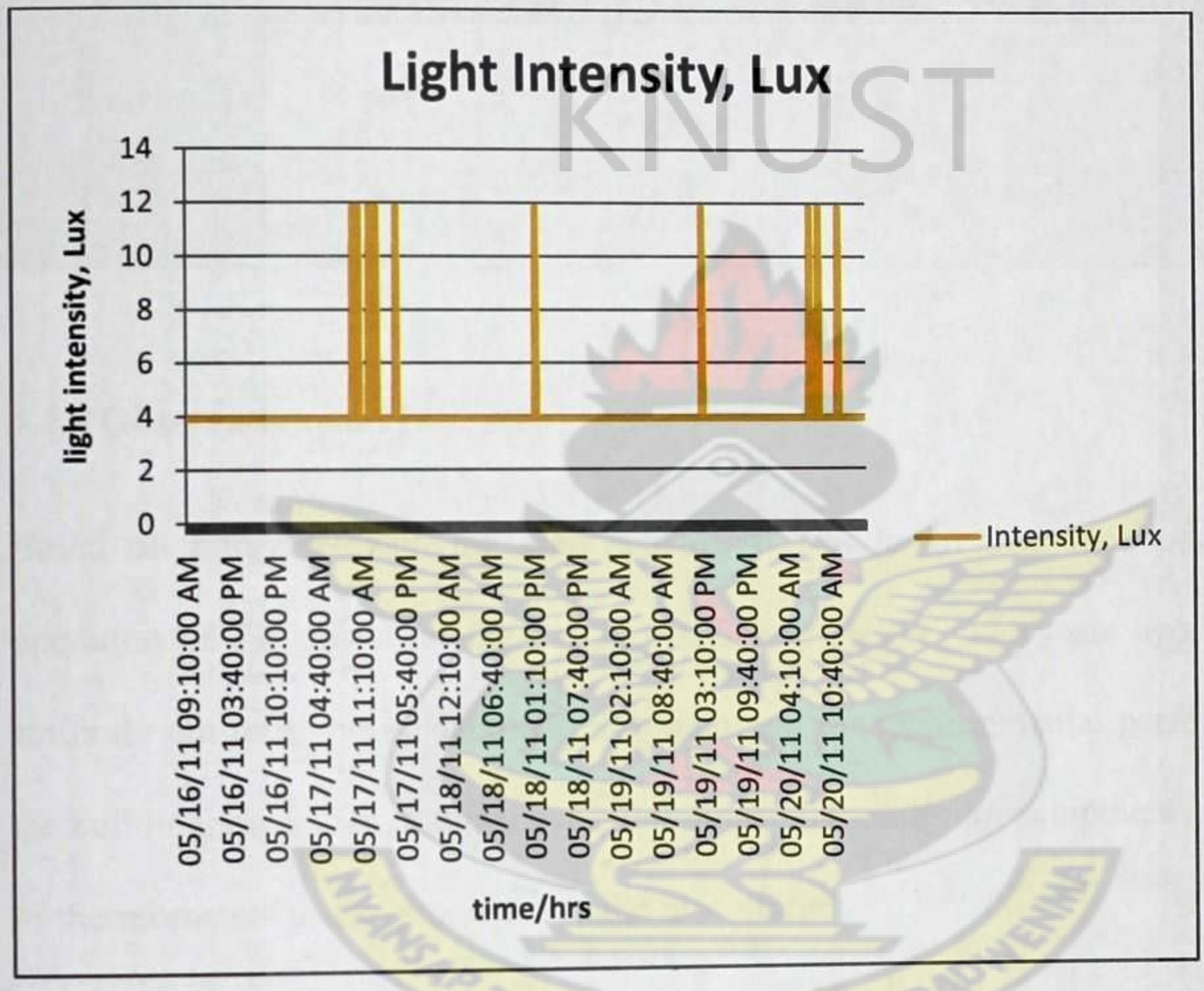

Fig. 4.9 Light intensity recorded in the repository *(Source: Author, 2011)*

Table 4.8 Minimum, maximum and mean daily light intensity measurements of the repository *(Source: Author, 2011)*

Day	Minimum daily Light Intensity, Lux	Maximum daily Light Intensity, Lux	Mean daily Light Intensity, Lux
16/05/2011	3.9	3.9	3.9
17/05/2011	3.9	11.8	4.2
18/05/2011	3.9	11.8	4.0
19/05/2011	3.9	11.8	4.0
20/05/2011	3.9	11.8	4.2

4.4.4 Observation and Interview

Based on interview with the archive staff, it was learnt that knowledge on the operation of the operation the building had stop twelve (12) years ago. Thus the staffs do not receive any detailed information on the environmental performance of the building, even though they have environmental monitoring equipment in the form of thermometers and hygrometers in the repositories.

Also, the air conditioners and dehumidifiers present in the repositories were all not in use since the electricity power supply to the building has been in adequate to power them since 1999, leading to the repositories to operate without mechanical control. In a bid to solve this problem the facility has donated a parcel of land to the Electricity Company of Ghana (ECG) to build a new substation. The interview further revealed that the facility was without backup power, resulting in the operation of the repository without a mechanical system, when ECG's power supply was not enough.

Furthermore, the building has not seen any major renovation works since its construction in 1960, with the only additional building being the new records store for the storage of semi-current records. It was sad to note that the archives did not have a copy of their building documentations in the repository.

Visual inspection showed great deal of neglect for the building and lack of understanding of how important it is to maintain strict environmental performance guidelines for a building of this nature. The HVAC system been abandoned during the lack of power to operate them and has therefore been overtaken by overgrown bushes and groundcover. The dehumidifiers have also been overtaken by dust in the repository due to its non usage and regular cleaning.

Also the search room which is suppose to have almost the same internal environmental conditions as the repository, had louvers blades which allowed for filtration of outdoor air into the space. Even though two (2) number 2.5 hp air conditioners are used in the search room, the use of louvers blades windows and windows without air seals allows for great filtration of outdoor air into the space. This same effect occurs at the points where plywood has been used to cover the high level window opening in the search room.

Lastly, it was observed that due human comfort needs and the easy manipulation of the window system present, the louver blades were opened as and when it improved human comfort at the detriment of the records. This situation was observed to worsen when there is power outage by ECG since; there is no backup power for the mechanical systems in place.

4.4.5 Questionnaires

Respondents were asked, in their opinion, to indicate how comfortable they felt about the following environmental control factors; lighting, temperature, dampness, air cleanness and odour in the search room and repository. Using a six point likert scale where zero (0) represents "not comfortable at all" and five (5) represents "very comfortable".

The results of the study are represented here, with Fig. 4.10 representing the percentage of occupants' perception on the indoor lighting levels within the search room and repository. Fig. 4.11 shows the percentage of occupants' perception on the indoor temperature levels within the search room and repository. In addition Fig 4.12 and Fig 4.13 show the percentage of occupants' perception on indoor dampness and indoor air cleanness respectively in the search room and repository.

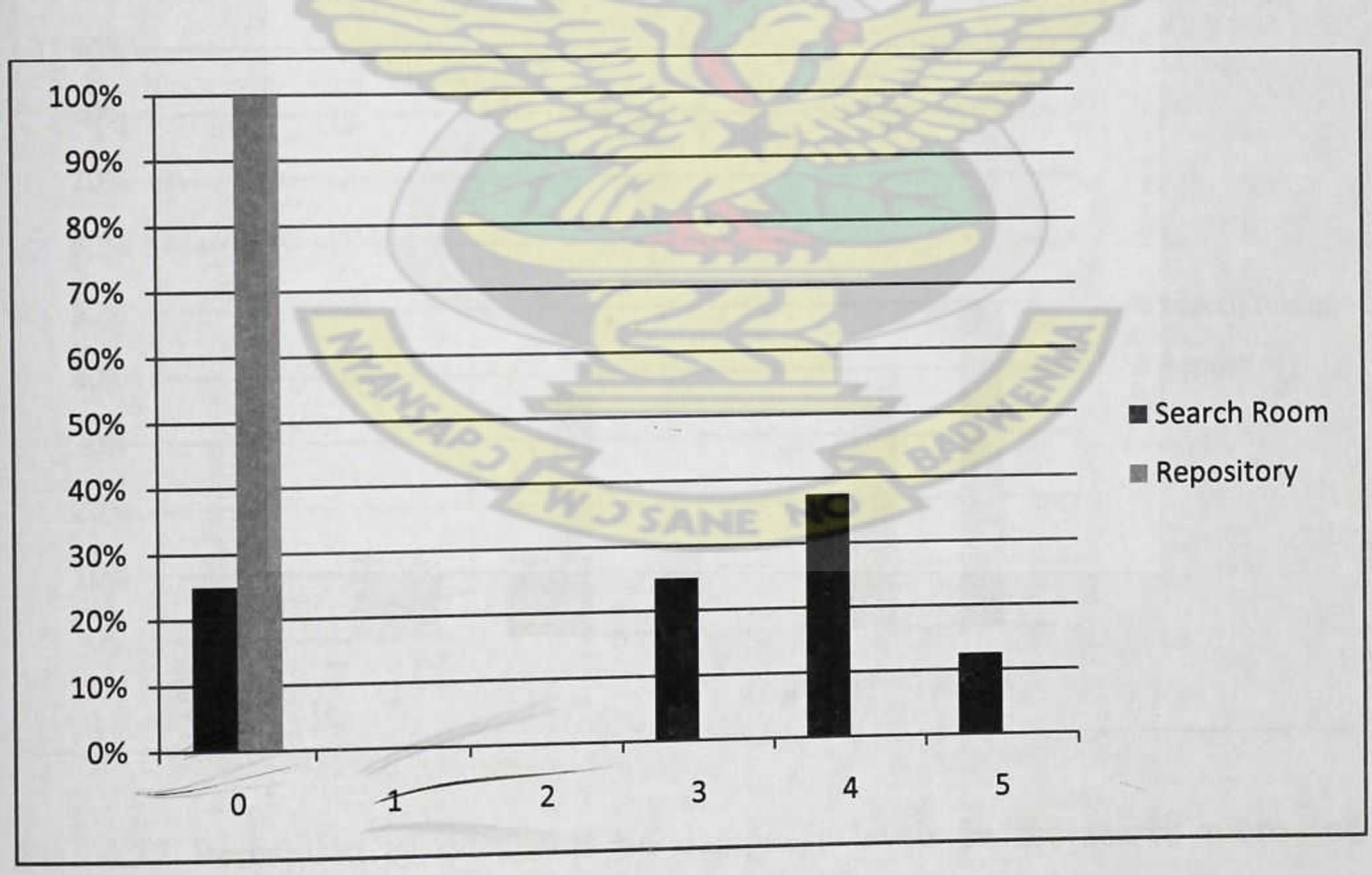

Fig. 4.10 Perception of occupants on light levels in the search room and repository

(Source: Author, 2011)

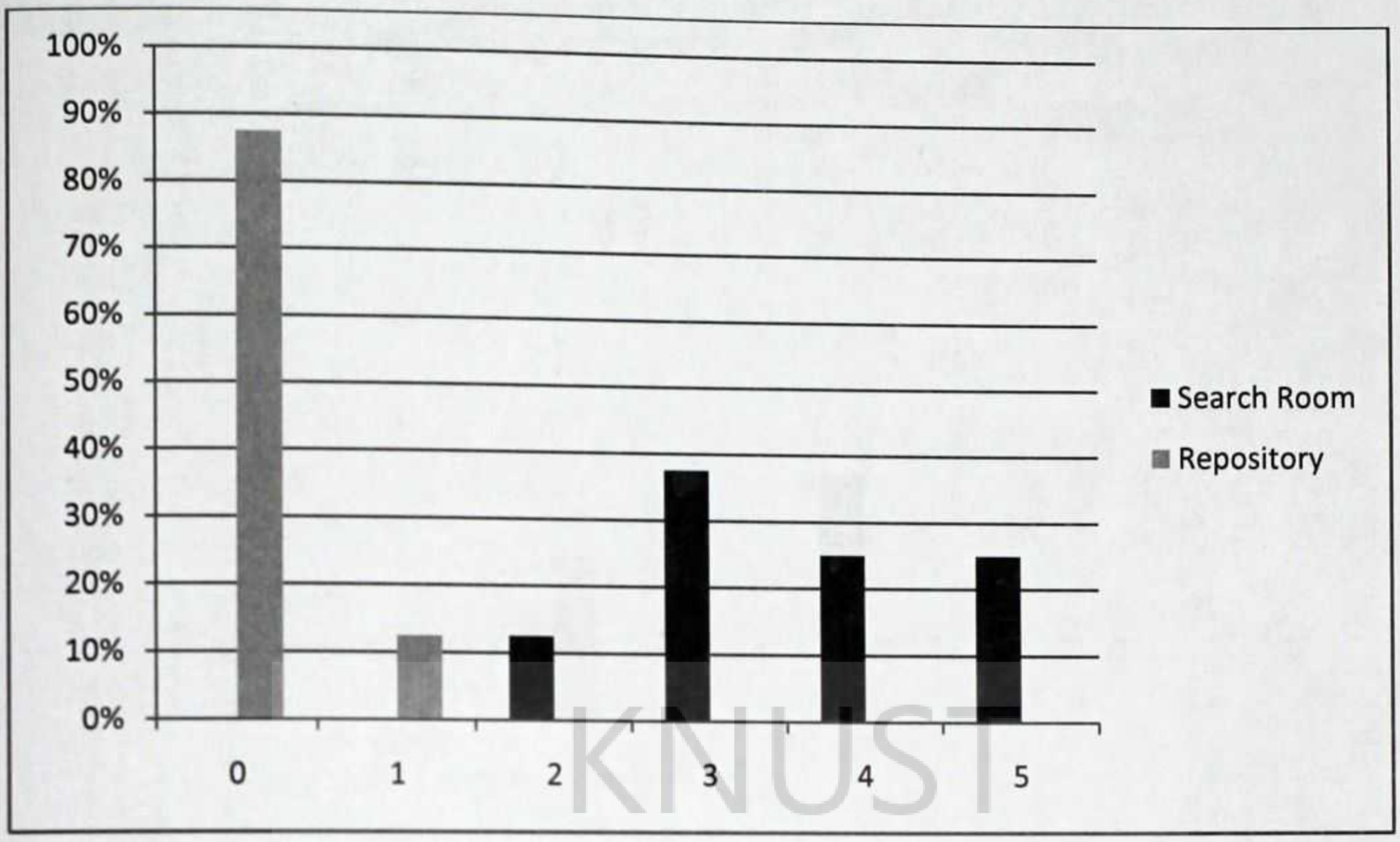

Fig. 4.11 Perception of occupants on temperature levels in the search room and repository *(Source: Author, 2011)*

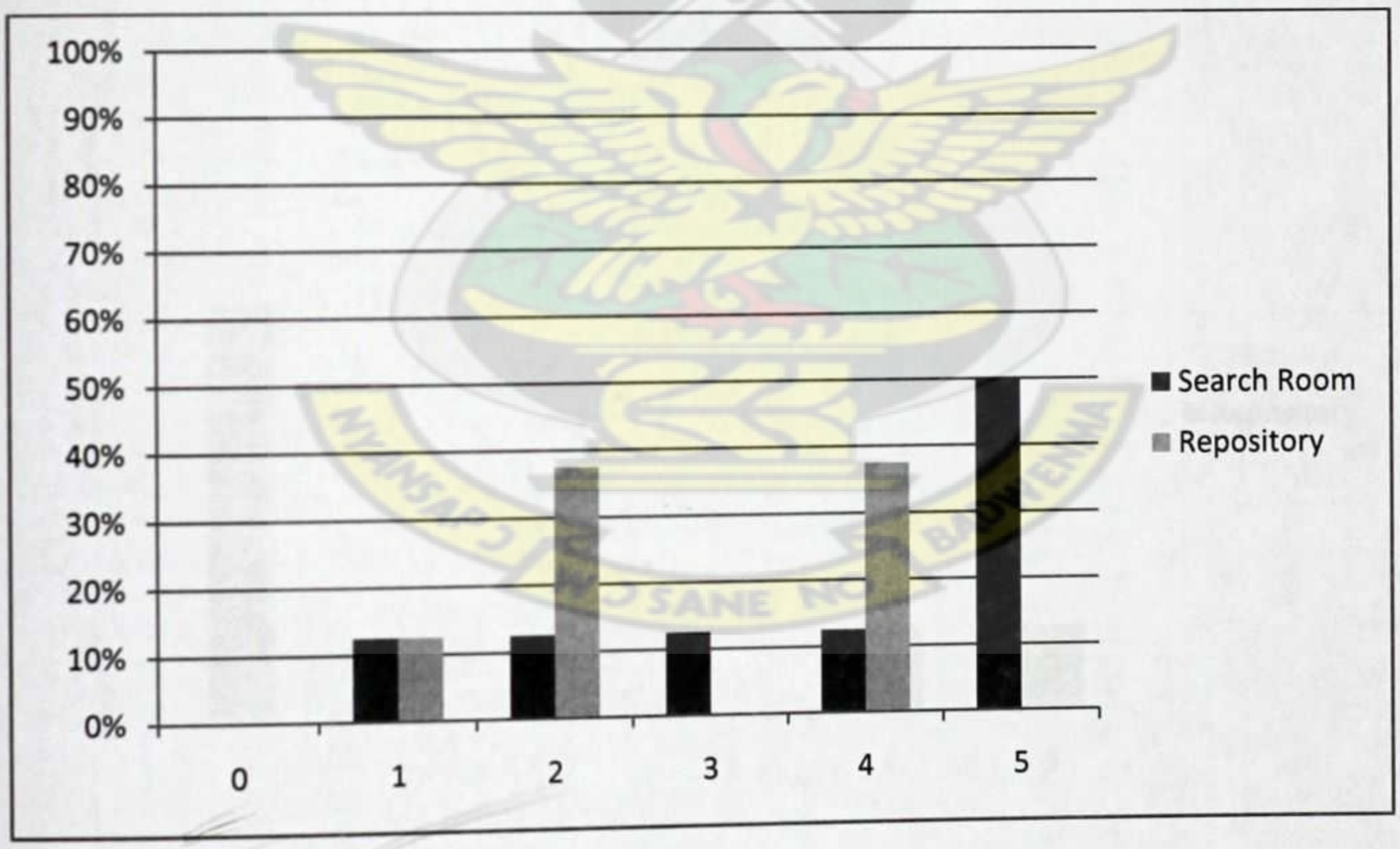

Fig. 4.12 Perception of occupants on dampness levels in the search room and repository *(Source: Author, 2011)*

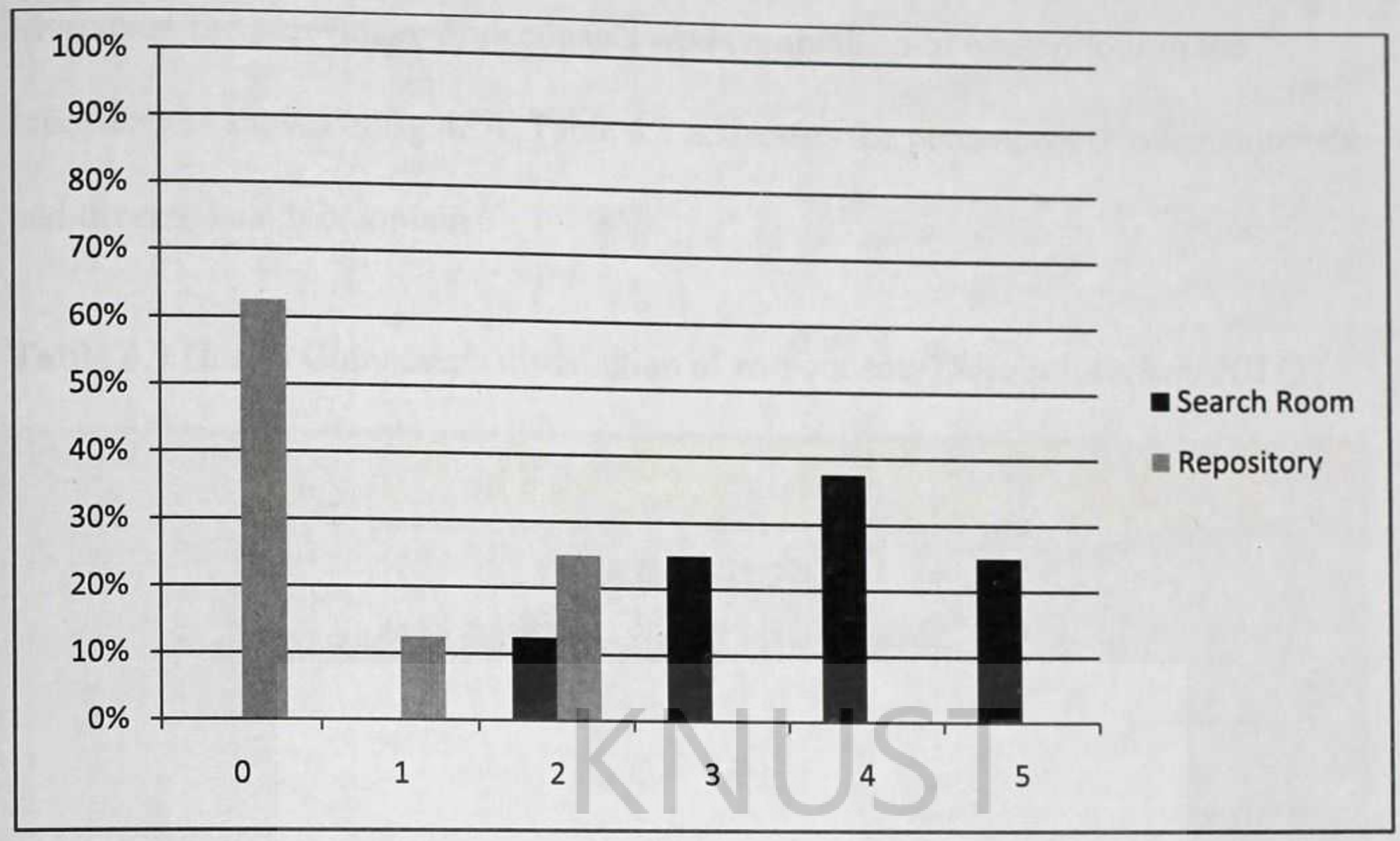

Fig. 4.13 Perception of occupants on air cleanness levels in the search room and repository *(Source: Author, 2011)*

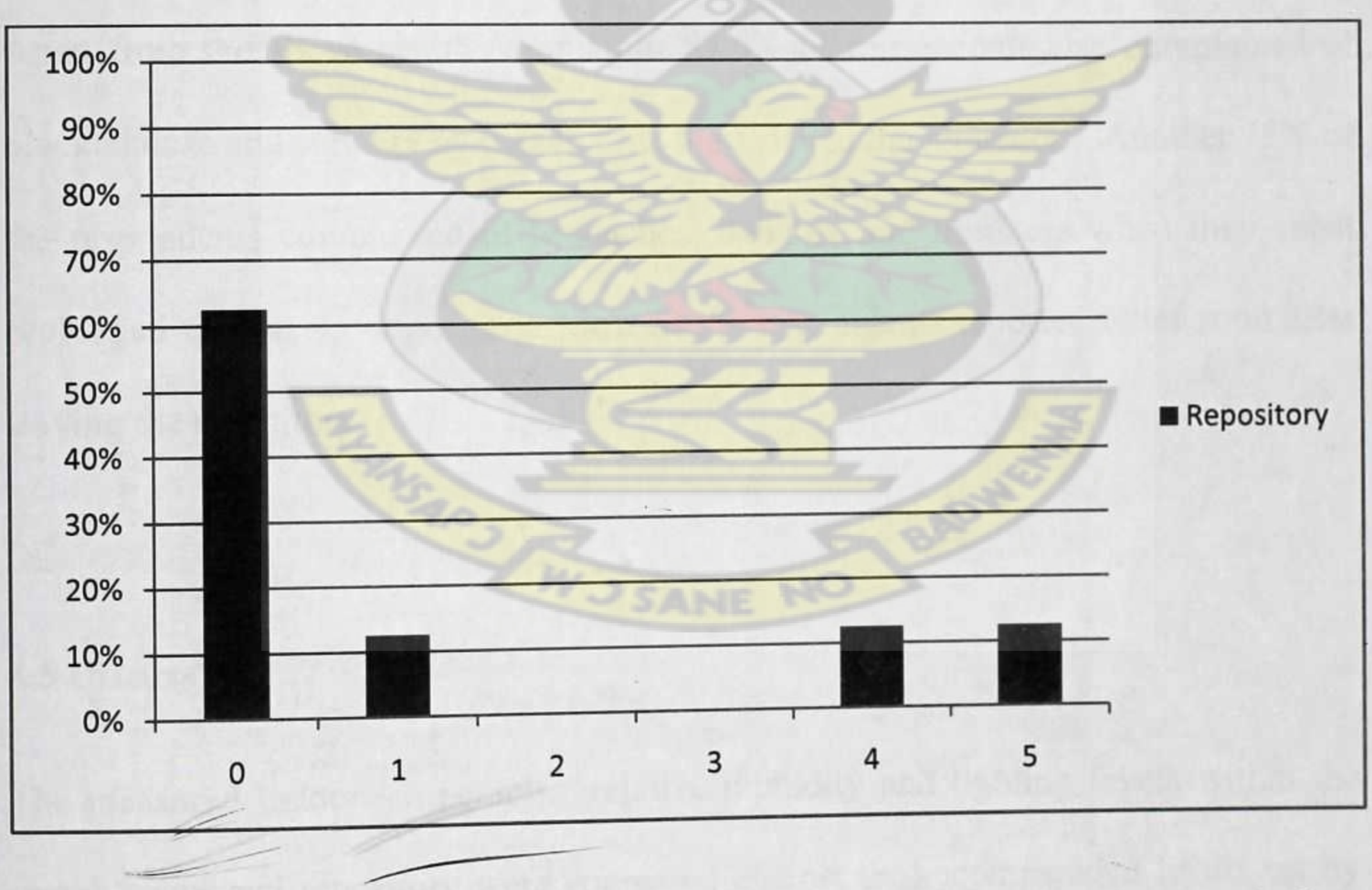

Fig. 4.14 Perception of occupants on odour levels in the repository *(Source: Author, 2011)*

Moreover, the percentage of occupants who complained of book odour in the repository is shown in fig 4.14. Table 4.9 addresses the percentage of occupants who had diverse health complains.

Table 4.9 Health Complaints distribution of respondents *(Source: Author, 2011)*

Health Complaints	Frequency	Percentage (%)
Headache	6	75
Aches and pains	8	100
Cough	4	50
Lethargy	7	87.5
Generalized malaise	6	75

Apart from the above health complaints, 87.5% of respondents also complained of blocked nose and sore dry eyes each time they visited the repository. Another 75% of the respondents complained of headaches, lethargy and tiredness when they spent prolonged time at the repository. Most of the respondents reported relief soon after leaving the repository.

4.5 Discussion

The measured indoor temperature, relative humidity and lighting levels within the search room and repository were compared against the recommended levels set by the British Standard for archives, BS 5454:2000, the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE), the National Archives and

Records Administration (NARA) of United States of America and the National Information Standards Organisation (NISO) of United States of America.

Air temperature, relative humidity and lighting level were significant problem in the search room. The one week measurements of showed a temperature range of 22.417 to 29.665°C in the search room. This temperature exceeds the maximum recommended by BS 5454:2000 (18.3°C), ASHRAE (18.3°C), NARA (18.3°C) and NISO (18.3°C) by 4.117 to 11.365°C. This was a significantly larger than the +/- 1°C recommended for human comfort and archival preservation. Thus the archival collections in the search room have to adjust to a large temperature difference which leads to faster deterioration of the collections. 75% of the respondent expressed satisfaction with the indoor air temperature, despite the large temperature difference they had to adjust to. This could be attributed to the light clothing the worn at search room and their ability to manipulate the rate of air exchange by opening the glass louver blades as and when they wanted.

Relative humidity ranged from 60.699 to 87.121% in the search room, a difference of 42.121%. This was significantly larger than the maximum 5% change recommended by BS 5454:2000, ASHRAE, NARA and NISO. Furthermore, the minimum of 60.699% far exceeds the maximum limits of BS 5454:2000 (40% +/-5%), ASHRAE (45% +/-5%), NARA (35-45% +/-5) and NISO (30-50%). Despite the light clothing worn by the respondents and their ability to manipulate the environmental control systems 50% of them expressed dissatisfaction with the level of dampness in the search room. These high level could explain why 75% of the respondents had respiratory health complains since mould growth occurs at relative humidity of 70% and above (Wilson et al, 1984).

The one week measurements of showed a maximum lighting level of 902.7 Lux in the search room. This lighting level exceeds the recommended level by BS EN12464-1:2002 (300Lux), NARA (250Lux) and NISO (250Lux) by 602.7 to 652.7 Lux. This could account for the faded nature of books that were housed in the search room and the 100% of respondents being extremely comfortable with the lighting levels.

Thus the humidity levels within the search room had to be lowered but not more than 2% per month till it reaches a range of 40 to 50% to prevent paper based records from cracking and becoming brittle. Similarly, the air temperature should be lowered not more than 3°C per till to 18.3°C +/-1°C to prevent paper based records from cracking and becoming brittle. The bulbs in the search room should be changed as a onetime thing and the lighting level measured to make sure it is within 250-300 Lux and subsequently maintained. These will ensure the search room meets and remain at an acceptable level for human comfort and archival collection according to the British Standard for Archives, ASHRAE, NARA and NISO since the search room is accessed by people throughout the day.

Also, air temperature, relative humidity and lighting level were significant problem in the repository. The one week measurements of showed a temperature range of 29.916 to 30.596°C in the repository. This temperature exceeds the maximum recommended by BS 5454:2000 (16°C), ASHRAE (16°C), NARA (15.6°C) and NISO (15.6°C) by 14.316 to 14.996°C. This was a significantly larger than the +/-1°C recommended for human comfort and archival preservation. Thus the archival collections in the repository have to adjust to a large temperature difference which leads to faster deterioration of the collections. This high air temperature explains why 100% of the respondent expressed discomfort with the indoor air temperature in the

repository. This high value was recorded due the absence of HVAC systems in the repository. Relative humidity ranged from 71.784 to 74.823% in the search room, a difference of 29.823%. This was significantly larger than the maximum 5% change recommended by BS 5454:2000, ASHRAE, NARA and NISO. Furthermore, the minimum of 71.784% recorded in the repository far exceeds the maximum limits of BS 5454:2000 (40% +/-5%), ASHRAE (45% +/-5%), NARA (35-45% +/-5) and NISO (30-50%). Despite the light clothing worn by the respondents 62.5% of them expressed dissatisfaction with the level of dampness in the search room. These high level could explain why 75% of the respondents had respiratory health complains since mould growth occurs at relative humidity of 70% and above *(Wilson et al., 1984)*.

The one week measurements of showed a maximum lighting level of 11.8 Lux in the repository. This lighting level exceeds the recommended level by BS EN12464-1:2002 (100Lux), NARA (80Lux) and NISO (80Lux) by 602.7 to 652.7 Lux. This is due to that fact that due to inadequate power supply to PRAAD from ECG, the repository has been operating without power for 12 years and as such the 100% of respondents being uncomfortable with the lighting levels. This is because the 300mm high level windows cannot provide enough natural lighting for the repository.

Furthermore, the humidity levels within the repository had to be lowered but not more than 2% per month till it reaches a range of 40 to 50% to prevent paper based records from cracking and becoming brittle. Similarly, the air temperature should be lowered not more than 3°C per till to 18.3°C +/-1°C to prevent paper based records from cracking and becoming brittle. First of all, power needs to be restored to the repository and the lighting level provided by the bulbs checked to make sure that it is in the range of 80-100 Lux and only used when the repository is visited. These will

ensure the search room meets and remain at an acceptable level for human comfort and archival collection according to the British Standard for Archives, ASHRAE, NARA and NISO since the search room is accessed by people throughout the day.

Also based on interviews with the PRAAD staff, it was learnt that environmental monitory had stopped 12 years ago, when the power supply to the facility was inadequate to power the whole facility, as such the repository operates with any power. Thus, the staff did not receive any information on the environmental performance of their building and therefore could not determine how much their practices and the indoor climate was affecting the archival collections. The thermometers and hygrometers which was even used 12 years ago were only located in the repository, as such leaving the search room with monitoring. It would have been beneficial for the environmental performance of whole facility to be monitored by the staff so that there can maintain a conservation level environment which are acceptable to human comfort.

It was also learnt that the mechanical systems had been in place since 1996, when the PRAAD was formed. Furthermore, these systems had not been operational for over 12 years, even though there were good. These equipments needs to be checked by a mechanical engineer, serviced and upgraded where necessary to help maintain a conversation level environment.

In addition, the interviews also revealed that the mechanical system was without back-up power, which has resulted in the repository operating without mechanical system, when the ECG power supply to the facility was inadequate. Since, PRAAD has volunteered land on it premises for the construction of an ECG substation it is recommended that a back-up power alternative is provided to prevent the facility

from operating without mechanical systems, which lead to high relative humidity and temperature which exceeds the maximum recommended for archives.

Visual inspection revealed that books along the perimeter of the search room showed signs of deterioration. This was because the external windows do not have of UV light filters applied to them. If a conservator was part of the design process, this particular issue could have been addressed before construction. Also if periodic checks were made on the collections, this situation could have been addressed by applying UV light filters to the external windows.

Also, the visual inspection of the building showed a great deal of neglect and lack of understanding of how important it is to maintain a strict environmental performance guideline for archives. The mechanical and HVAC systems had been abandoned and un-operational due to the inadequate power to the facility. The HVAC system had been overtaken by overgrown bushes and groundcover. The dehumidifiers in the repository had also been overtaken by dust due to lack of regular cleaning. The collection was however protected from dust since kept in acid boxes. Even though the archival collection was protected, 75% of the respondents expressed discomfort with air cleanness within the repository and high health complaints were recorded.

Furthermore, it could account for why 87.5% of the respondents complained of blocked nose and headaches each time, they visited the repository. The use of fixed glass within the repository and the non-functioning of the HVAC systems results in inadequate ventilation. Also the Indoor Air Quality (IAQ) is affected since the rate of indoor and outdoor air exchange is very slow. Even this exchange occurs since they are no seals present in the fixed windows and as such air can leak around it and when

the door to the repository is own. As such seals need to be introduced in the windows to prevent leaking of cold air when the HVAC system becomes operational.

The lack of air exchange and poor ventilation in the repository could be the cause of the 87.5% respondents' complaining of headaches, lethargy and tiredness when they are in the repository and express relief soon after leaving. This health complains could be due to the inadequate ventilation, chemical contaminants from indoor sources, chemical contaminants from outdoor sources and biological contaminants. The poor ventilation leads to high concentration of indoor chemical contaminants within, the repository due to chemicals used as preservatives.

The fact that 100% of these respondents expressed acute discomfort and relief soon after leaving the repository means, they suffered from Sick Building Syndrome (SBS). This was a result of the tightness of the space and the other factors mentioned above. The other health complains can be classified as Building Related Illness (BRI), since the respondents complained of some long lasting symptoms and required prolong time and in some cases drugs after leaving the building.

Similarly, the high level of relative humidity (approximately 71-75%) in the repository encouraged biological contaminates growth since mould are present everywhere, but become active at 70% relative humidity or more.

Although the building was original designed as a state-of-the-art archival environment in the early 1960s, today it environmental performance is in the state of distress, unfit for archival needs and human comfort. This downturn in performance is contributed by three main issues. Firstly, the building and energy codes/guidelines in the 1960's were less stringent than there are today. An example is the designing of the external windows without UV light filters and thermal break. Secondly, the lack

of monitoring of the environmental performance of the facility. This result is compromising the more stringent indoor environment for humans and archival collections. Also, the lack of maintenance and understanding of the importance of archives has resulted in poor maintenance and improper decisions on sharing of power in the facility. This is evidenced by the fact that the facility managers preferred to let the repository run without power as opposed their offices.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study showed that employing both quantitative (experimental) and qualitative (interviews, observations and questionnaires) research methods helped to give a broader view of the PRAAD's environmental performance and its occupants perceptions and associated health complaints *(Thomson, 2001, Ulrich et al., 2004)*. Based on the findings, it showed the relative importance of subjective opinions of occupants in improving building performance and design. Also, the non-functioning of the HVAC systems in the repository due absence of power from ECG for 12yrs, had caused several periods of high indoor relative humidity and indoor air temperature resulting in high levels of dissatisfaction and health complaints with the environment.

5.2 Recommendations

As a result of the significant problems identified with indoor air temperature, indoor relative humidity and indoor lighting levels in the spaces understudy, coupled with the high level of health complaints and dissatisfaction with indoor environments, the following are the list of recommendations.

i. Power needs to be restored to the repository as soon as possible. A back-up generator is recommended to be put in place to power the repository till the sub-station being built by ECG is completed. Afterward, the back-

up generator should be kept to power the facility when there is power outage.

ii. These problems need to be addressed at the design stage since solving them during post construction can be very costly. The architect and engineers must understand the rudiments of deterioration mechanisms and explore the underlying issues affecting collection preservation. Also, conservators and preservationist must be involved in providing inputs to facilities management because the highly specialised knowledge archival environment needs lie with them, not mechanical engineers. Thus, conservators, curators and preservation specialist must understand the rudiments of HVAC operations and explore with architects and engineers to design a safe operating envelope that maximises preservation quality and human comfort. This is also the case during the design stage. Knowledge must be shared across the disciplines to achieve such a specialised environment. Architects with knowledge of designing the building, engineers with the construction and building systems, preservationist and conservators with the needs of the collection.

iii. From the results of the data collected from the repository, it appeared that poor Indoor Air Quality (IAQ) resulted from the non operation of an HVAC system that helps create and maintain a healthy indoor environment. As such it is recommended that, a good HVAC system is put in place, maintained and upgraded to meet the current standards by a mechanical engineer. Also a dehumidifier should be installed to help maintain a constant temperature while reducing the relative humidity. A review of building investigation reports suggests significant benefits to

health and thermal performance in the presence of a good HVAC system *(Sieber et al., 2001)*. Thus, these benefits would result in consistent good thermal and ventilation control whist also reducing the risk of biological contaminants.

iv. Efforts need to focus on reducing the relative humidity levels in the search room and repository to 45% with +/- 5% allowance. This reduction should be done with the relative humidity being reduced by not more than 2% per month to prevent paper based records from cracking and becoming brittle.

v. Similarly, the air temperature should be lowered to 16°C +/-1°C to meet for the repository and 18°C +/-1°C for the search room to meet the recommended levels for archives. This should be done by lowering the air temperature by not more than 3°C per month to prevent paper based records from cracking and becoming brittle. Furthermore, it recommended that air temperature during the day and night and seasonal changes are evaluated and eliminated by installing a modern environmental control system

vi. The repository should be compartmentalised so that various records and materials brought in from the various MDA's can be grouped according to the air temperature and relative humidity to prevent damage to records as shown in figure 5.0.

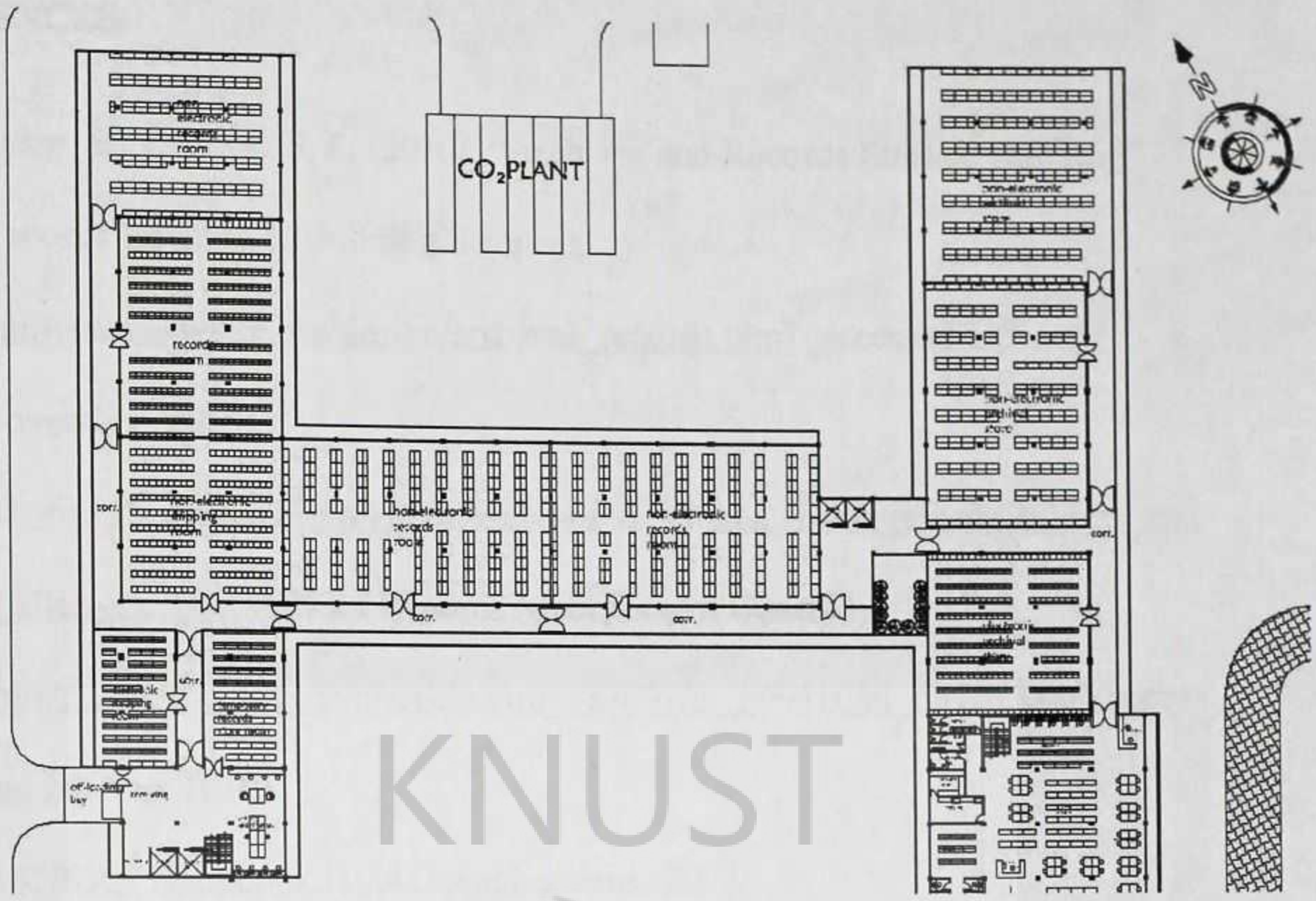

Fig. 5.0 Compartmentalised records area *(Source: Author, 2011)*

vii. The further spot checks should be done both the search room and repository and the lighting levels corrected once. The search room should set to between 250 to 300 Lux and 80 to 100 Lux for the repository.

viii. The external windows should be fixed with thermal breaks and UV light filters to reduce infiltration of conditioned air and UV light exposure on records.

ix. Everyone in the specification process should consider the comfort needs of the building operator (the human occupants) who must make complex designs and equipments function the way it was designed. As such, simplicity and functionality go hand in hand for a successful overall result.

x. Finally a facility manager should be hired to improve and maintain the indoor environment. He must however work hand in hand with conservators, preservationist, engineers and occupants of the facility.

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29. Wilson, W., Environmental Guidelines for the Storage of Paper Records, National Institute of Standards and Technology, Bethesda, 1995.

APPENDIX 1

OTHER ANALYSIS AND CONCEPTUALS.

INTRODUCTION

PROBLEM STATEMENT

1946	1955	1991	1996
DEPOSITORY	NATIONAL ARCHIVES		PRAAD
	Public Archives Ordinance 1955 (No. 35)		Legislative Instrument No. 1628 of 1996, Act 535
Gold Coast Secretariat		National Commission on Culture	

- No more a purely cultural institution but manage current and semi-current government records.
- The PRAAD is now a national records service with the responsibility of managing the entire life cycle of records.
- Need to develop all the regional PRAADs to be able to meet its new funtions.

OBJECTIVES

- To enhance PRAAD's capacity to deliver services in the region.
- To ensure quality service to users through the provision of effective support systems.
- To establish effective record management systems in the MDAs.
- To ensure quality services to the users through the development of well trained and committed human resource in PRAAD
- To provide a model design for PRAAD.

SCOPE

- Archives Division
- Records Management Division
- Training and Research Division

AIM

Preserve Ghana's Collective Memory by facilitating and overseeing the efficient management of records of all Ministries Departments and Agencies(MDAs)

CLIENT

PRAAD

FINANCIERS

- Government of Ghana
- DANIDA

TARGET GROUP

- RESEARCHERS/STUDENTS
- MDAs
- MEDIA
- TOURISTS
- GENERAL PUBLIC

PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

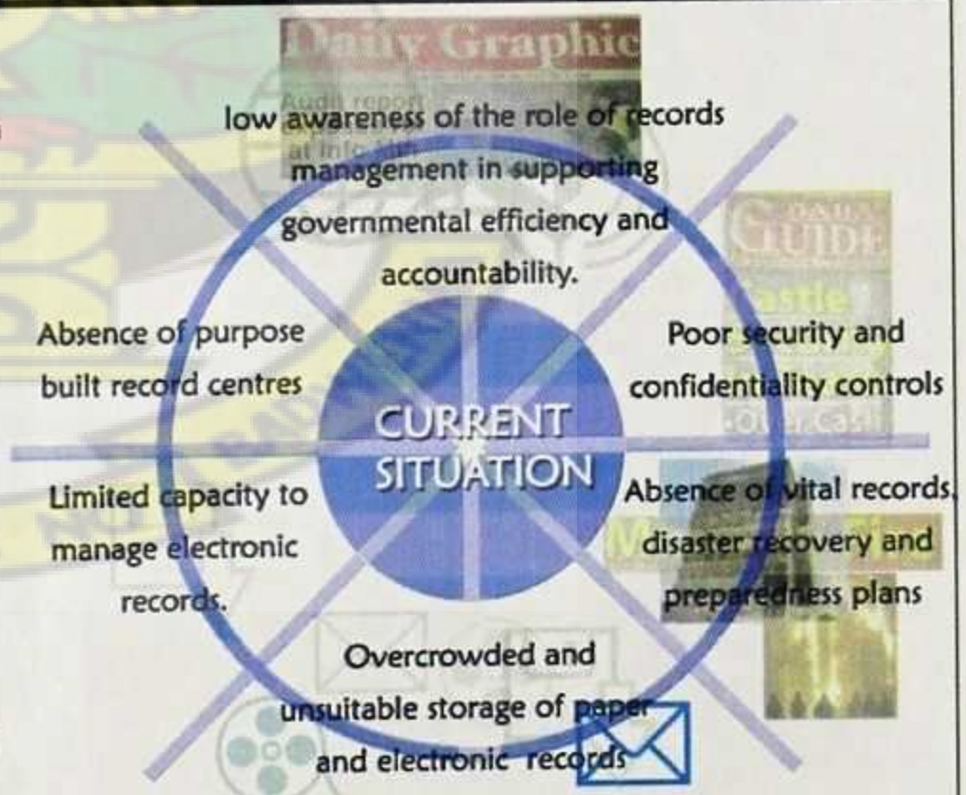
DEPARTMENT OF ARCHITECTURE,KNUST
NAME:EMMANUEL FORI ASAFETE
COURSE:DESIGN THESIS
SCALE: YEAR: M.ARCH II DATE: MAY, 2010

PROJECT JUSTIFICATION

WHY PRAAD?

"The key to effective and sustainable development and poverty alleviation lies in expanding the traditional theories of development economics."
World Bank President James D. Wolfensohn.
[www.worldbank.org (accessed 22/12/2009).

- All of the elements for effective development depend upon an effective records management infrastructure.
- Records management infrastructure helps government to effectively manage current operations.
- Records increase transparency, accountability and good governance.
- Lack of records management is directly linked to the persistence of corruption and fraud. *www.worldbank.org (accessed 22/12/2009).*



- Ghana is the second most currupt nation in the subregion.
  www.myjoyonline.com (accessed on 01/02/.2010)
- The development of regional PRAADs will help the government in its fight against curruption.

PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

DEPARTMENT OF ARCHITECTURE,KNUST
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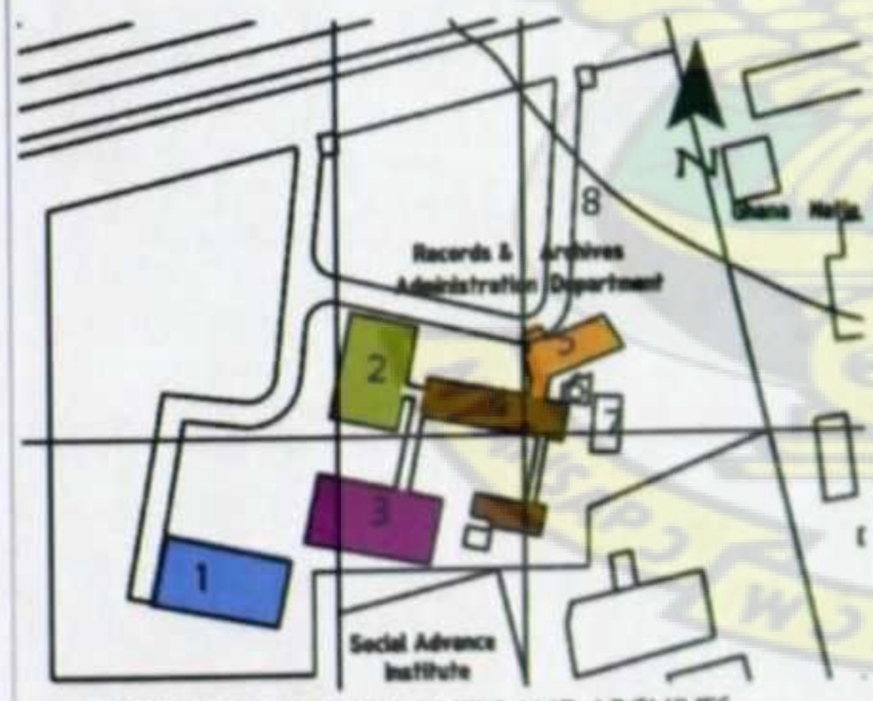
COURSE:DESIGN THESIS
SCALE: YEAR: M.ARCH II DATE: MAY, 2010

PHILOSOPHY & CONCEPT

PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

CASE STUDY(PRAAD,ACCRA)



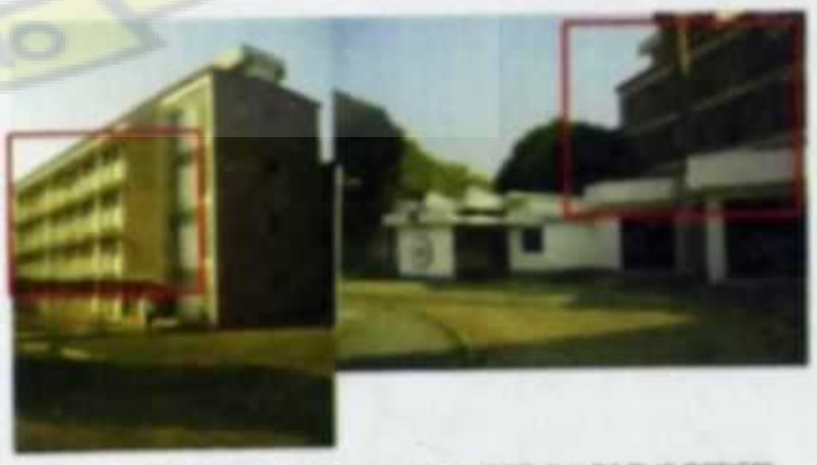
LEGEND
1-RECORDS STORE
2-ARCHIVAL STORE
3-RESEARCH & TRAINING
4-READING ROOM, EXHIBITION, ADMINISTRATION ON THE UPPER FLOOR.
5-RECEPTION
6-FOOD SERVICES
7-STAFF PARKING
8-PUBLIC PARKING

LAYOUT OF PUBLIC RECOREDS AND ARCHIVES ADMINISTRATION DEPARTMENT, ACCRA

USE OF 450mm HIGH WINDOWS AT ARCHIVAL ROOMS TO REDUCE LIGHTING LEVEL IN THE ROOMS

USE OF SKYWALKS TO LINK SPACES

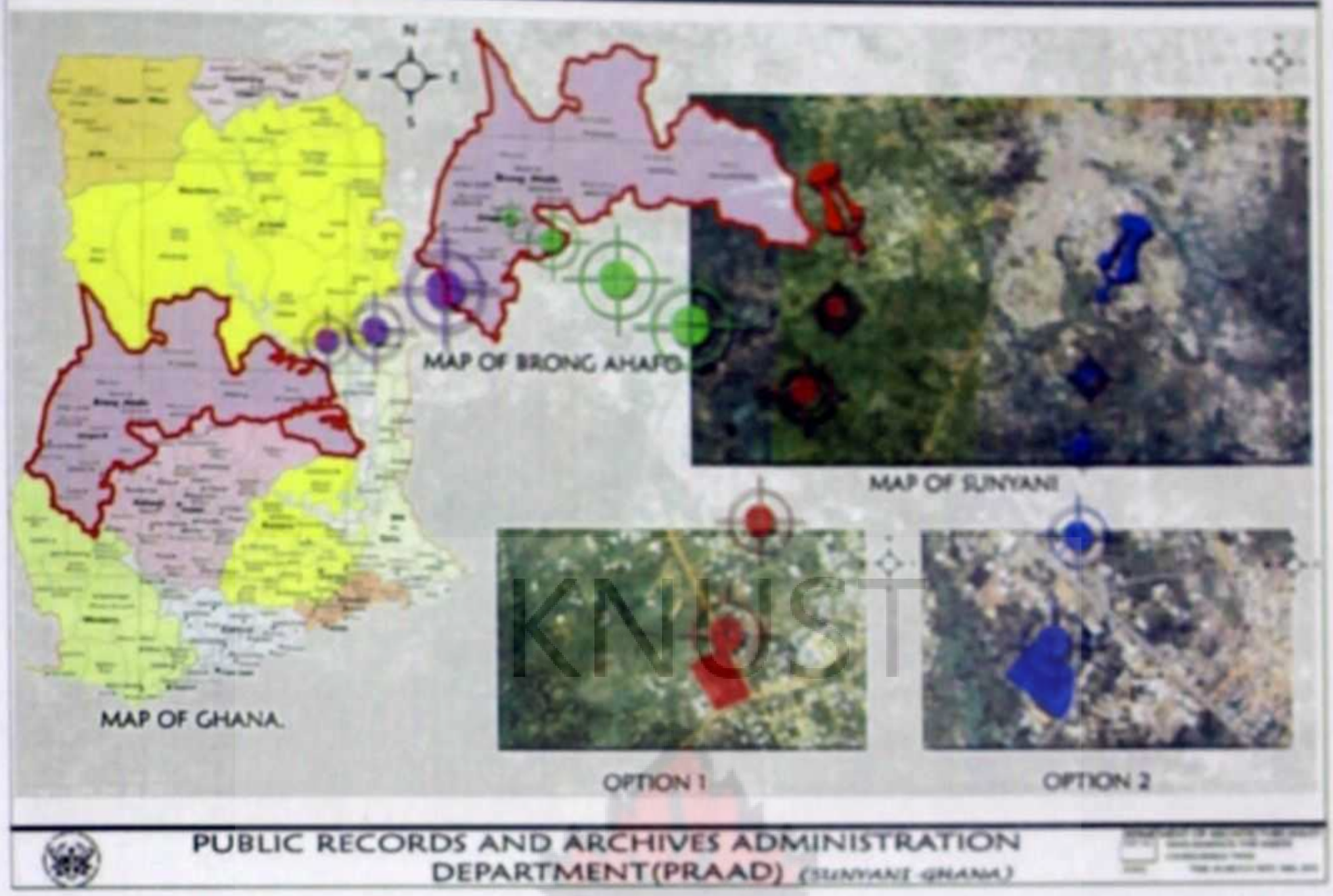
NON LINKED STRUCTURE, ISOLATED



USE VERTICAL CONCRETE FINS TO SHADE THE OFFICES

PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

SITE LOCATION



PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

SITE SELECTION

MERITS

- Wide land area(app.42.223m²/10.4 Acre)
- Good views
- Serene atmosphere
- Two road access to site

DEMERITS

- Poor access road to site
- No utility service on site
- Too far from ministries and Sunyani-Kumasi road
- Encroachment on site
- East-West orientation
- Located within a residential zone

MERITS

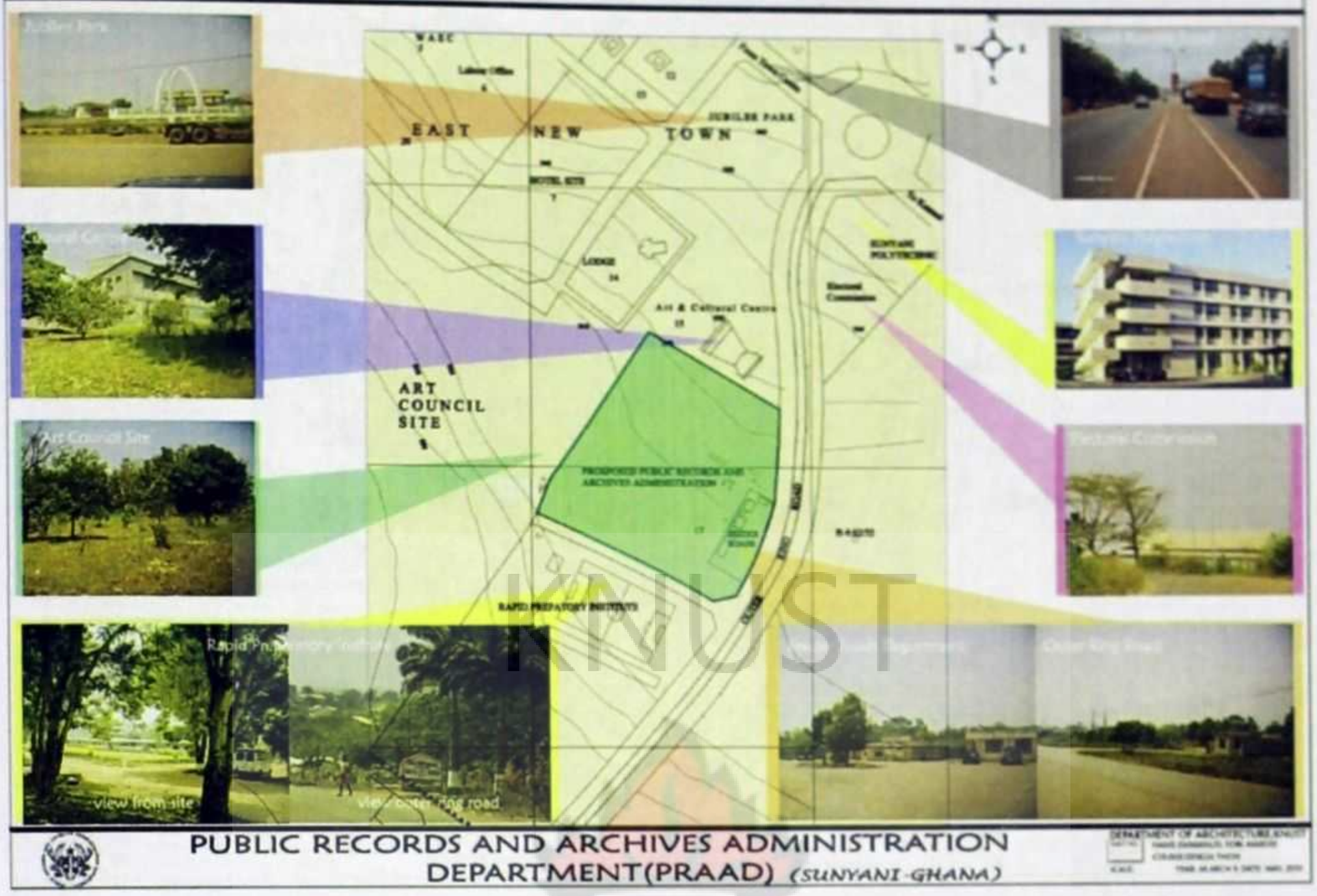
- Wide land area(app.46.807m²/11.5 Acre)
- Vehicular traffic is general calm
- Proximity to Sunyani-Kumasi road
- Sunyani outer ring road as access road
- Proximity to Police Headquarters
- All utility services available
- Proximity to Ministries
- Proximity to Sunyani-Kumasi road

DEMERITS

- Encroachment of some areas
- Noise from school
- No storm drain
- Single road access to site

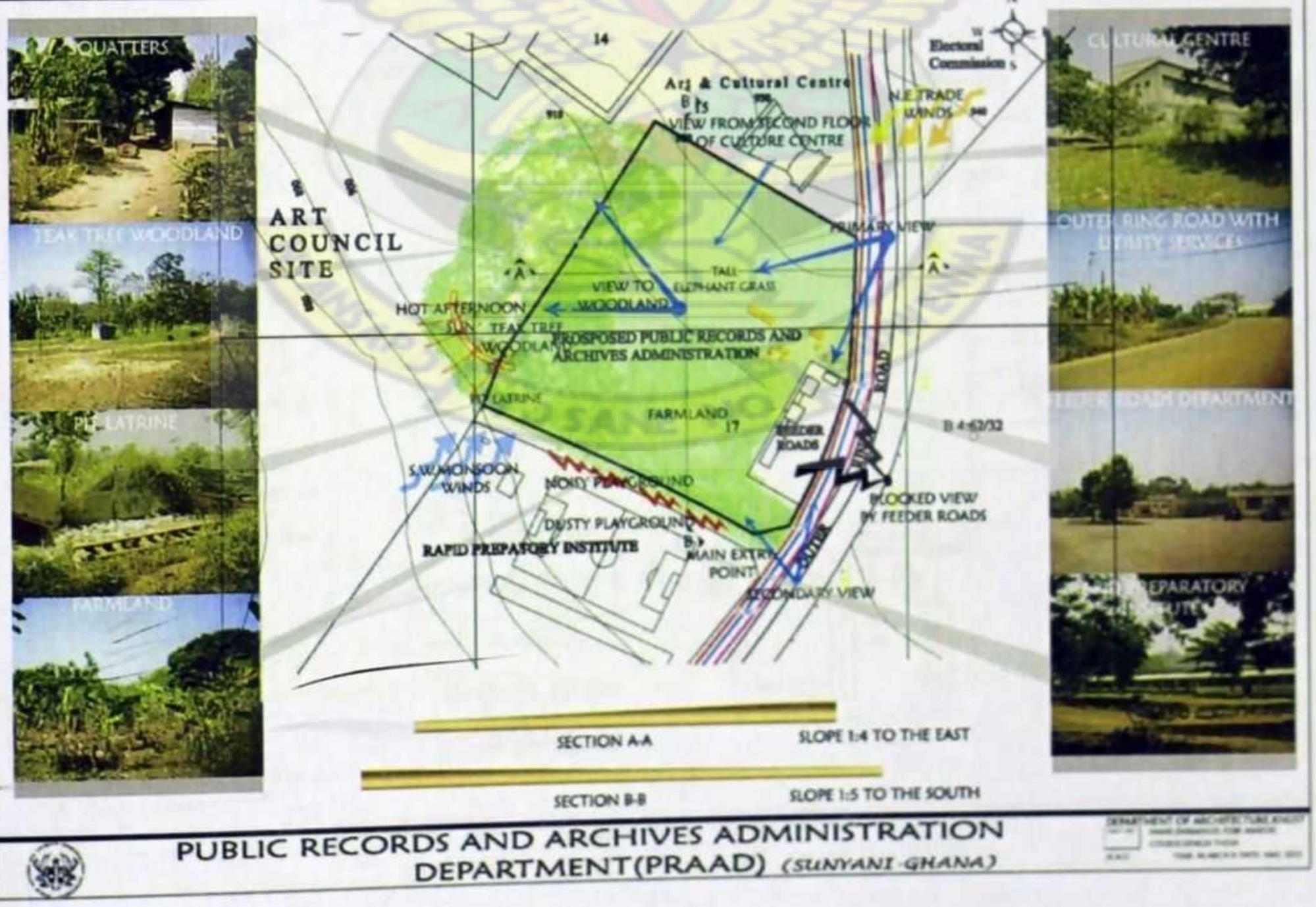
PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

SITE PERIPHERAL STUDY



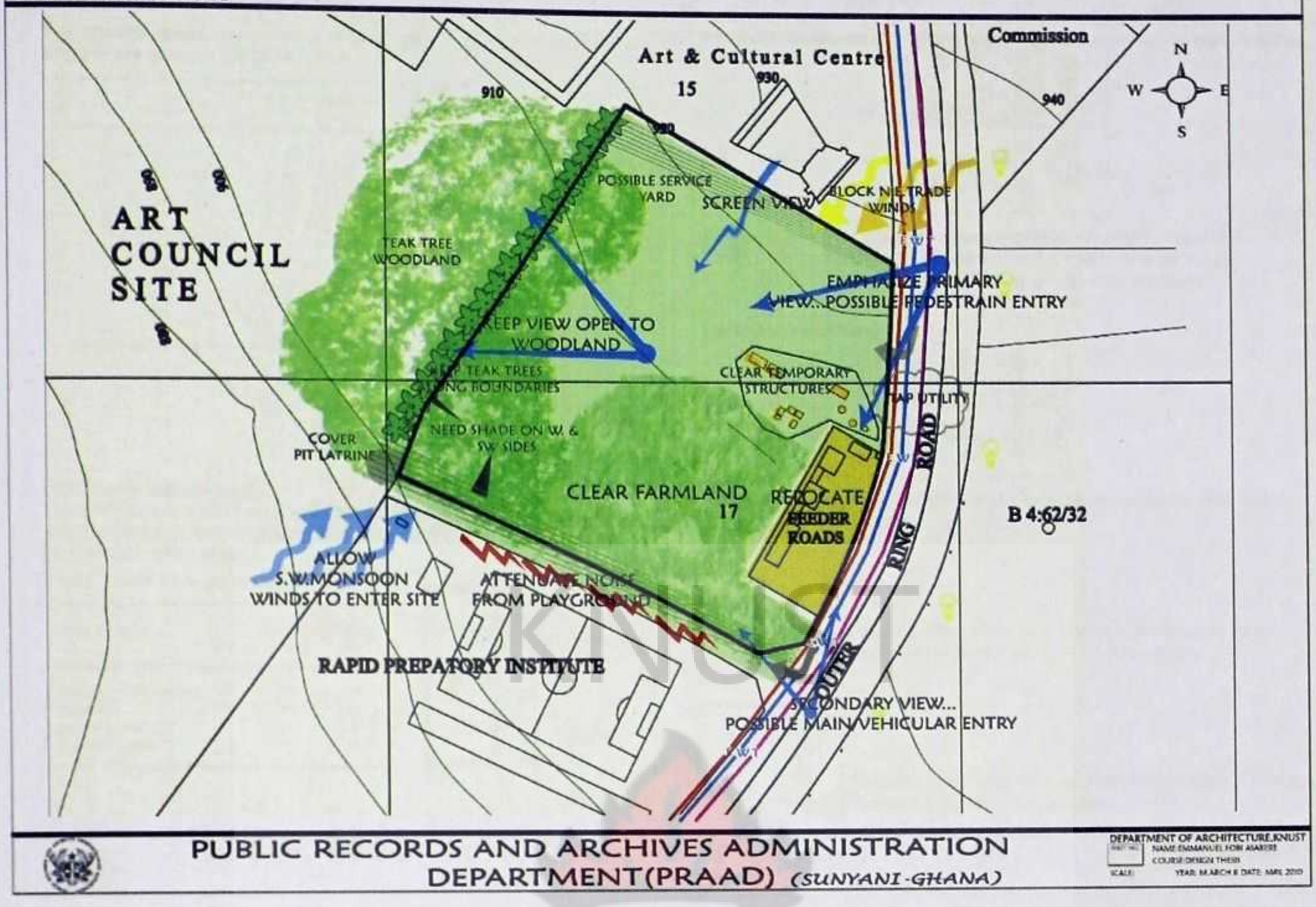
PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

SITE INVENTORY



PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

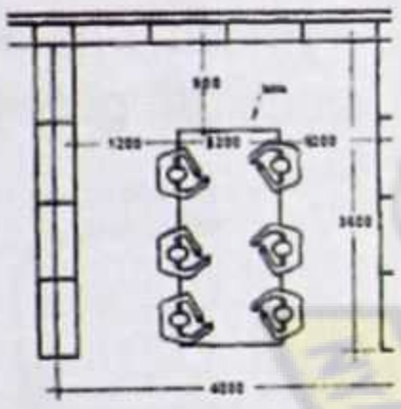
SITE ANALYSIS



PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

DEPARTMENT OF ARCHITECTURE.KNUST
NAME:EMMANUEL FOBI ASAKERE
COURSE:DESIGN THESIS
SCALE: YEAR: M.ARCH II DATE: APRIL 2010

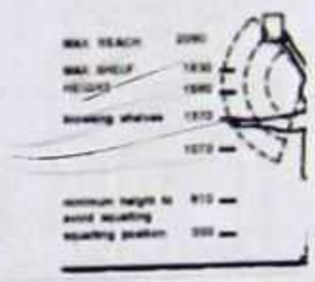
TECHNICAL STUDIES



In cases where the alcoves also accommodate reading tables the figure below is used.

Shelf heights

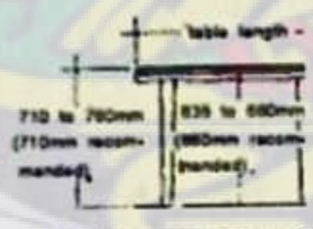
The easiest shelves to access are those at the user's eye height wheelchairs will need assistance from staff In libraries designed to cater particularly for wheelchair users, only shelves between 400 and 1200 mm above the floor should be used



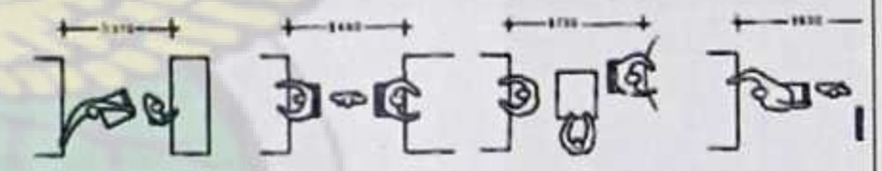
Optimum shelf heights for adults

TABLES.

Most readers are expected to use communal tables.



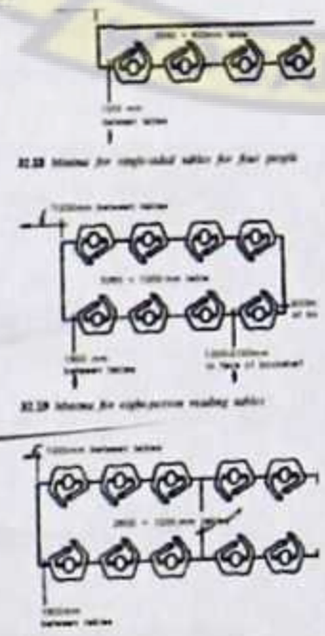
The minimum design parameters for these are given beside.

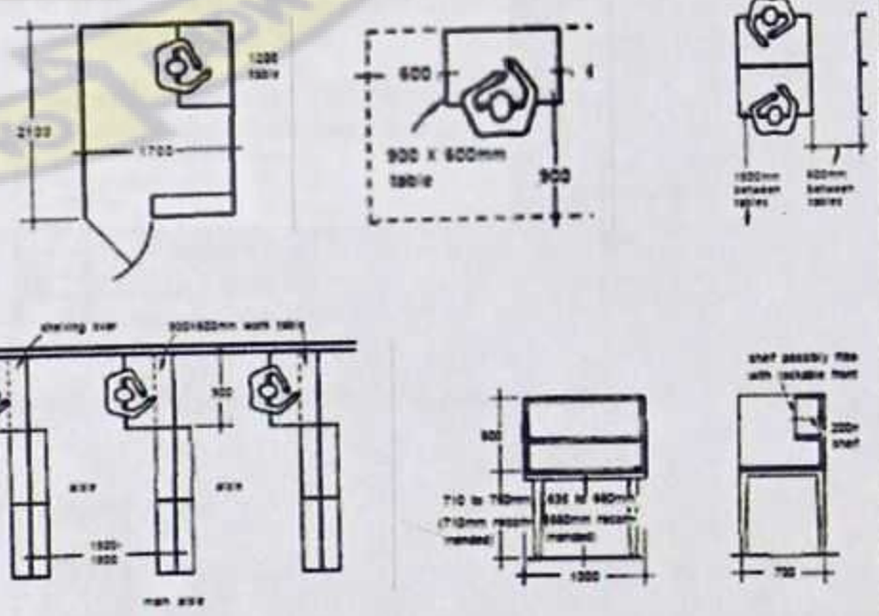


In reference libraries tables are commonly arranged in rows in areas separate from the bulk of the books.

Various private seating configurations.

The various group seating configurations.





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The average space requirements of each type of book are given in the table below.

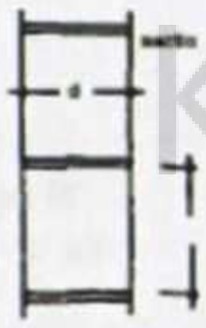
Grid size m	Spacing of stacks	No. of double-sided stacks	Books per structural bay
5.6	1.4	3	5012
6.0	1.5	3	5460
6.0	1.2	4	6860
6.3	1.1	6	8060
7.0	1.55	4	8320
7.25	1.45	4	8610
7.2	1.2	5	10270
7.3	1.25	5	10780
7.7	1.1	6	12960
7.8	1.56	4	9360
7.8	1.30	5	11290
8.4	1.68	4	10220
8.4	1.2	6	14360
8.4	1.4	5	12290

Book capacity at various sizes of structural grid

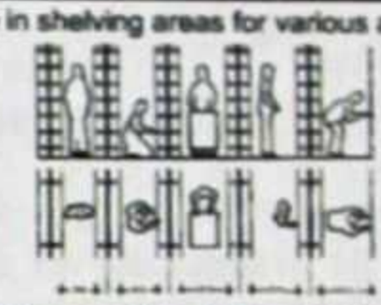
Shelf depth and spacing
The table below gives the recommended shelf depth and the average spacing along the shelf for the main types of book.

Table V Shelf depth and spacing

Type of book	% of total	Spacing mm	Depth mm
Popular (light novels)	50	225	230
General	97	280	230
Bound periodicals	—	300	230
Oversize books	3	500	300–400

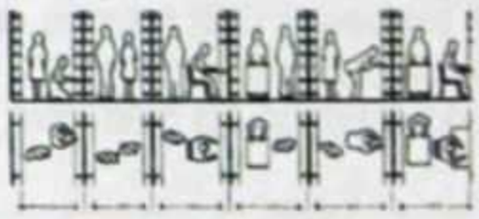


Minimum clearance in shelving areas for various attitudes: narrow aisles

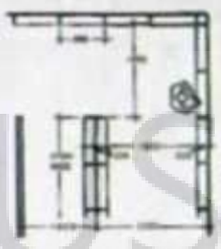


Anything less than 610 mm makes it difficult to bend to reach the lower shelves. 810 mm is the minimum if a trolley is to be used. As space is often at a premium, sliding stacks may be used. These provide for only one such 900mm aisle.

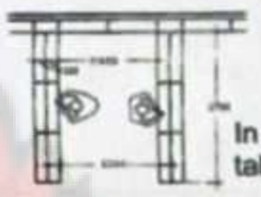
Open-access systems



Minimum clearance in shelving areas for various attitudes: wide aisles

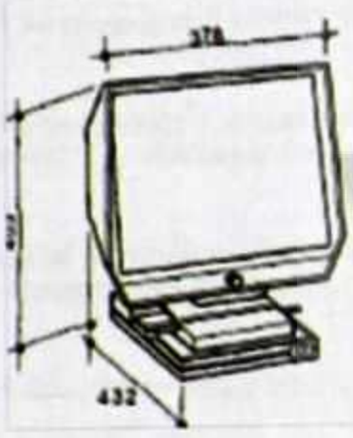


Libraries often have their shelves arranged to form alcoves with books shelved on three sides.

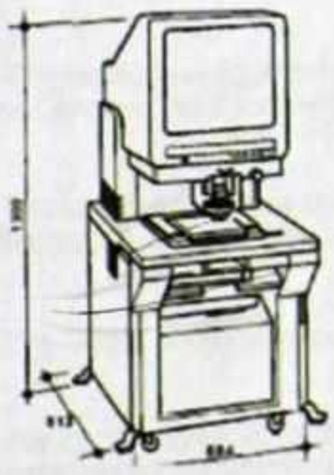


In cases where the alcoves also accommodate reading tables the figure below is used.

Design Criteria
Viewing facilities

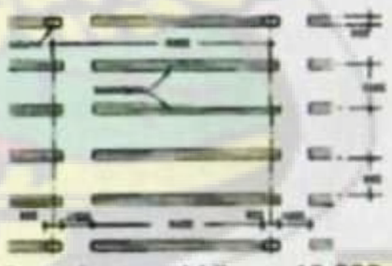


a simple microfiche viewer with its special requirement.



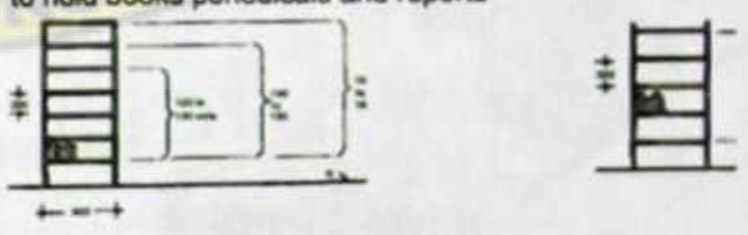
a type of printer/reader suitable for both microfiche and microfilm..

A layout for stacks within a 6900 mm structural grid is given below...

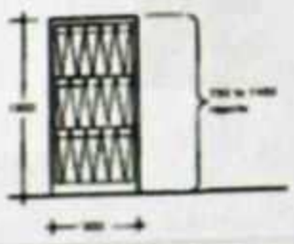


2 stacks on grid line = 10 800
8 stacks in bay = 47 200
= 58 m run of shelves
58 m of shelves 7 high = 406 m run of books
406 m at 20 books/m = 8120 books per bay
Or 169 books/m2 floor area.

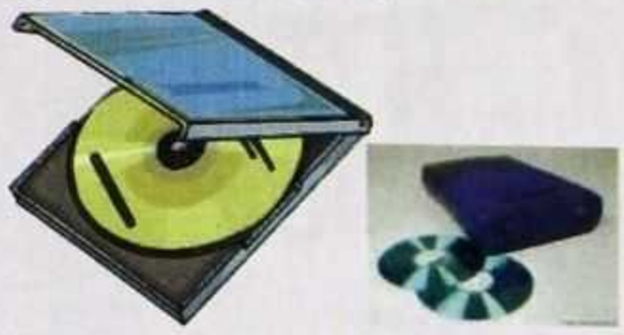
The capacity of standard 900 mm bookshelves to hold books periodicals and reports



Capacity of lateral filing cabinets to hold reports



Storage for Other Media



A CD-ROM disk is often supplied in a 'jewel case'.
This is a transparent plastic box 140 × 125 × 10 mm.
these disks take up additional storage space

An alternative form of storage is in pocketed albums holding up to 48 disks in a space 320 × 160 × 45 mm.

Microforms are:
·Microfilm stored in cabinets, 32.28.

These cabinets will hold 675 reels of 35 mm film, or 125 reels of 16 mm film.

·Microfiche, previously in a number of sizes varying from 75 × 125 to 100 × 150 mm but the current ISO Standard specifies only 105 × 148 mm. However, storage for older sizes may also be necessary.

·Micro-opaques, the usual sizes of which are 125 × 75,225 ×150 and 215 × 165 mm.

Conclusion

From the studies the following conclusions were drawn

1.All records and exhibits in the PRAAD should have an illumination of 50 lux per annum.

2.Direct sunlight should not fall on any collection or record item and UV radiation must be effectively eliminated from all light reaching a collection or records item

3.The illumination levels should be controlled such that there is no sharp contrast between space of high illumination and low illumination.

4.Space for various reading conditions should be provided to allow for all user comfort.

5.There is the need for high security and supervision to prevent damage to documents in the open reference areas.

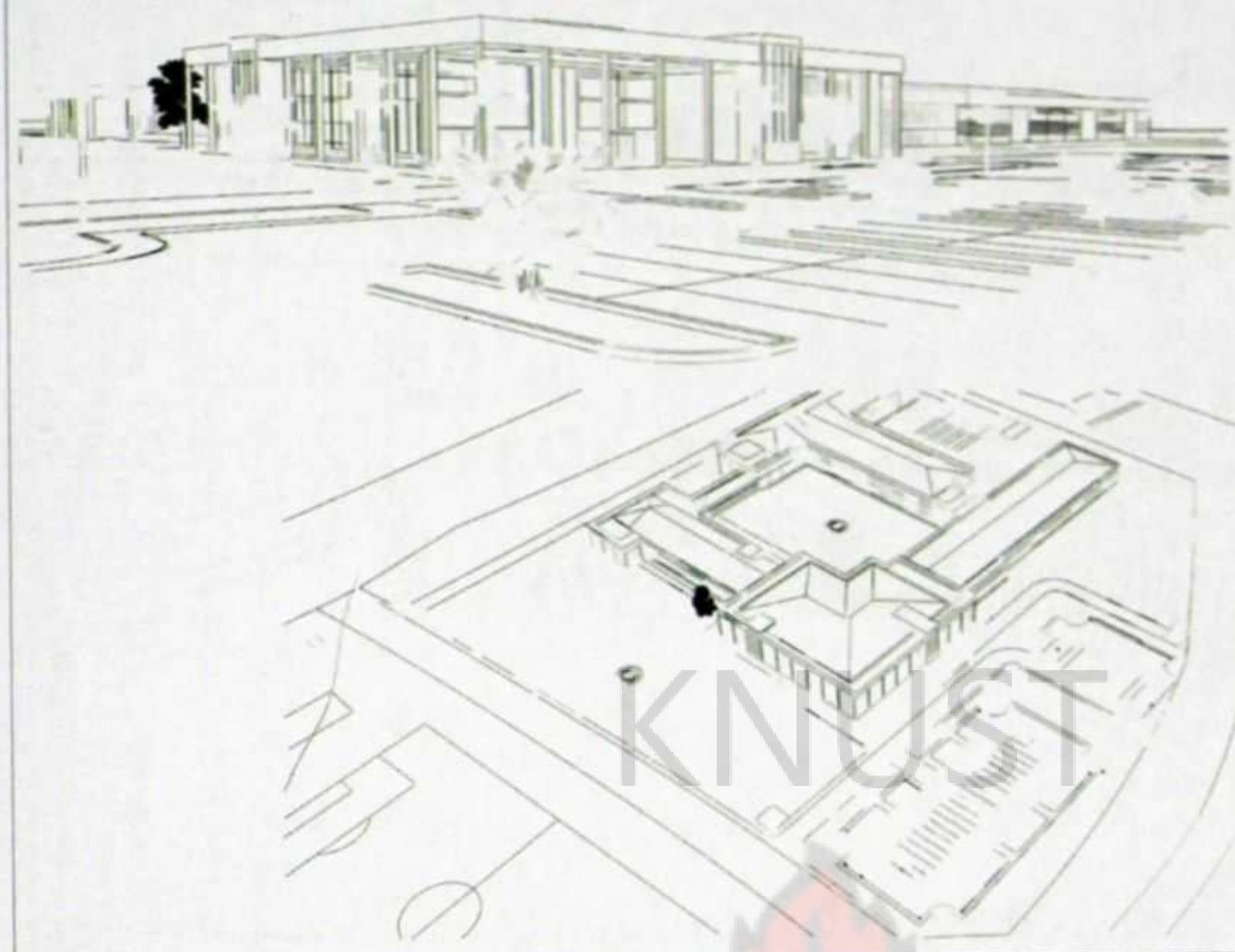
6.The facility should be fully air conditioned to allow for constant temperature and humidity need to store the documents.

7.The building envelope should be designed to allow for repairs and renovations without affecting considerable the internal environmental conditions.

8.The height of shelve should not exceed 2050mm.

9.For security reasons public entry into facility should be one and staff entry also one each monitored by receptionist and security personnel's respectively.

CONCEPTUALS

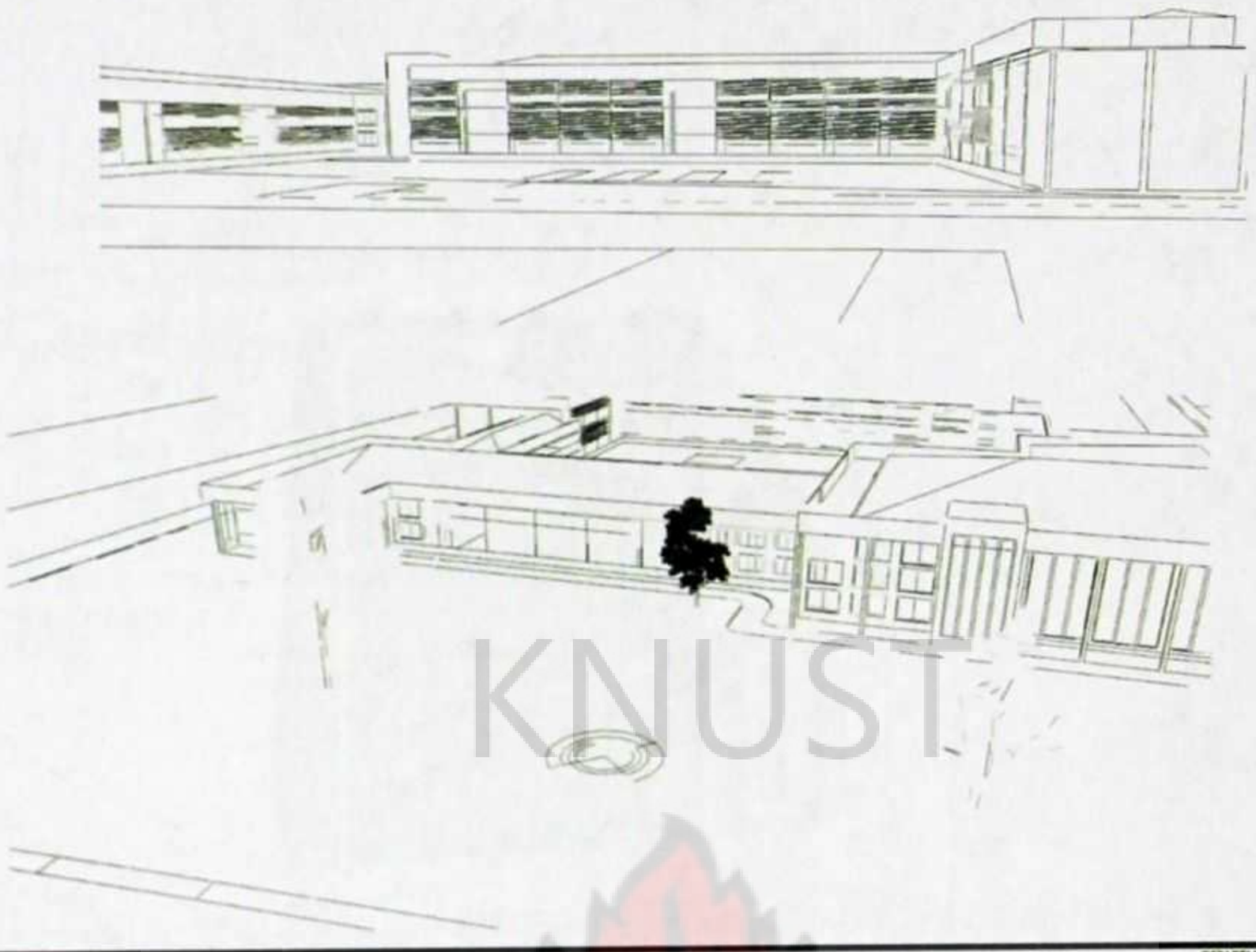


PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

CONCEPTUALS

PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

CONCEPTUALS



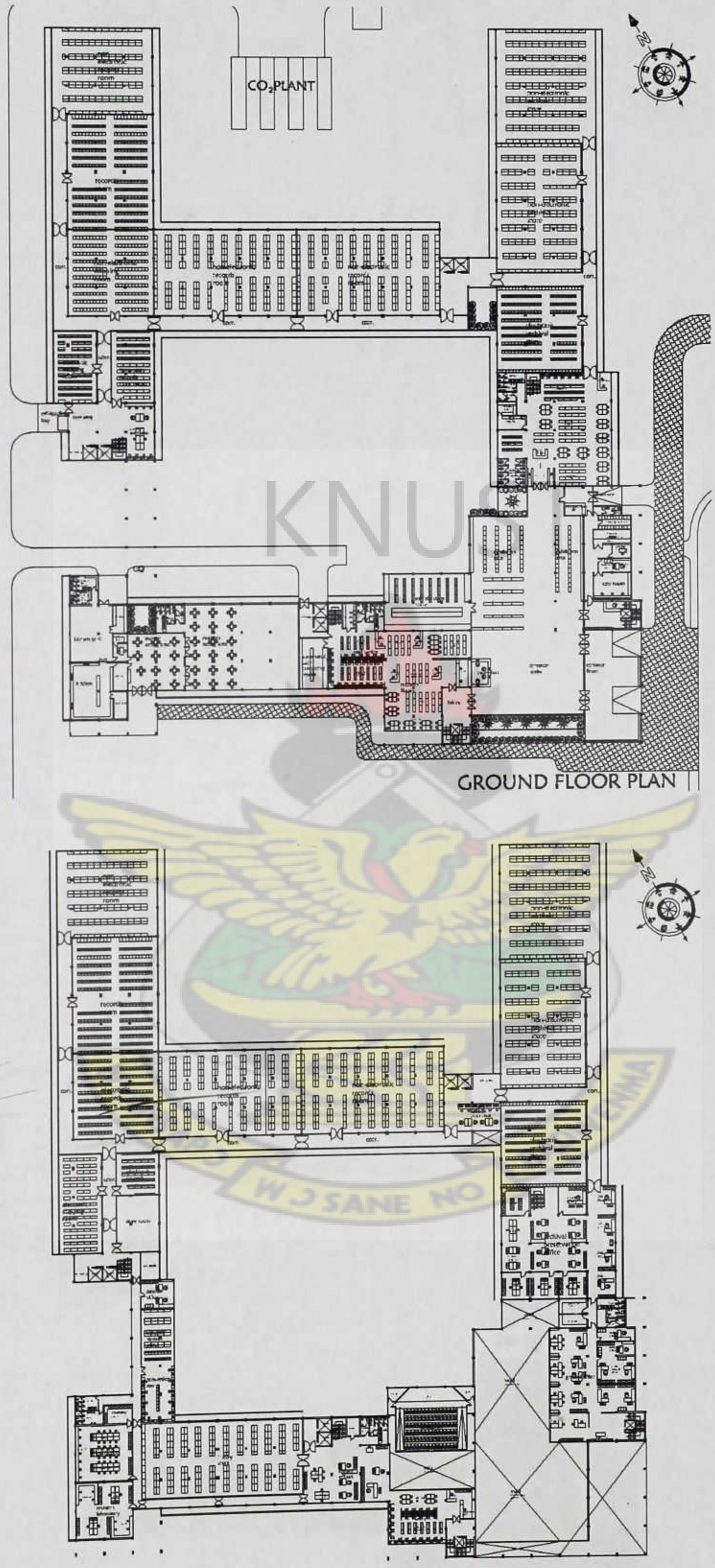
PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

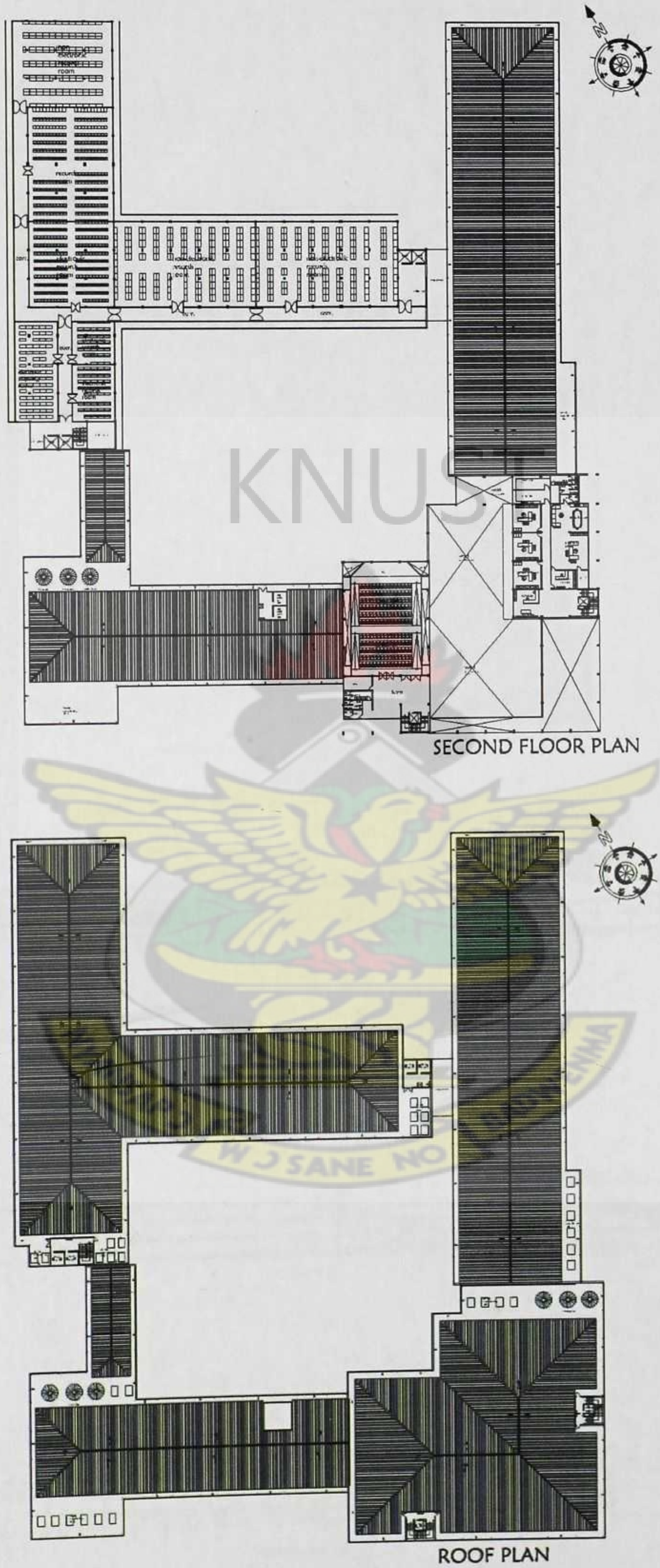
DEPARTMENT OF ARCHITECTURE,KNUST
NAME: EMMANUEL FORI AMARTEI
COURSE: DESIGN THESIS
SCALE: YEAR: M.ARCH II DATE: MAY, 2010

APPENDIX 2

Site Plan.

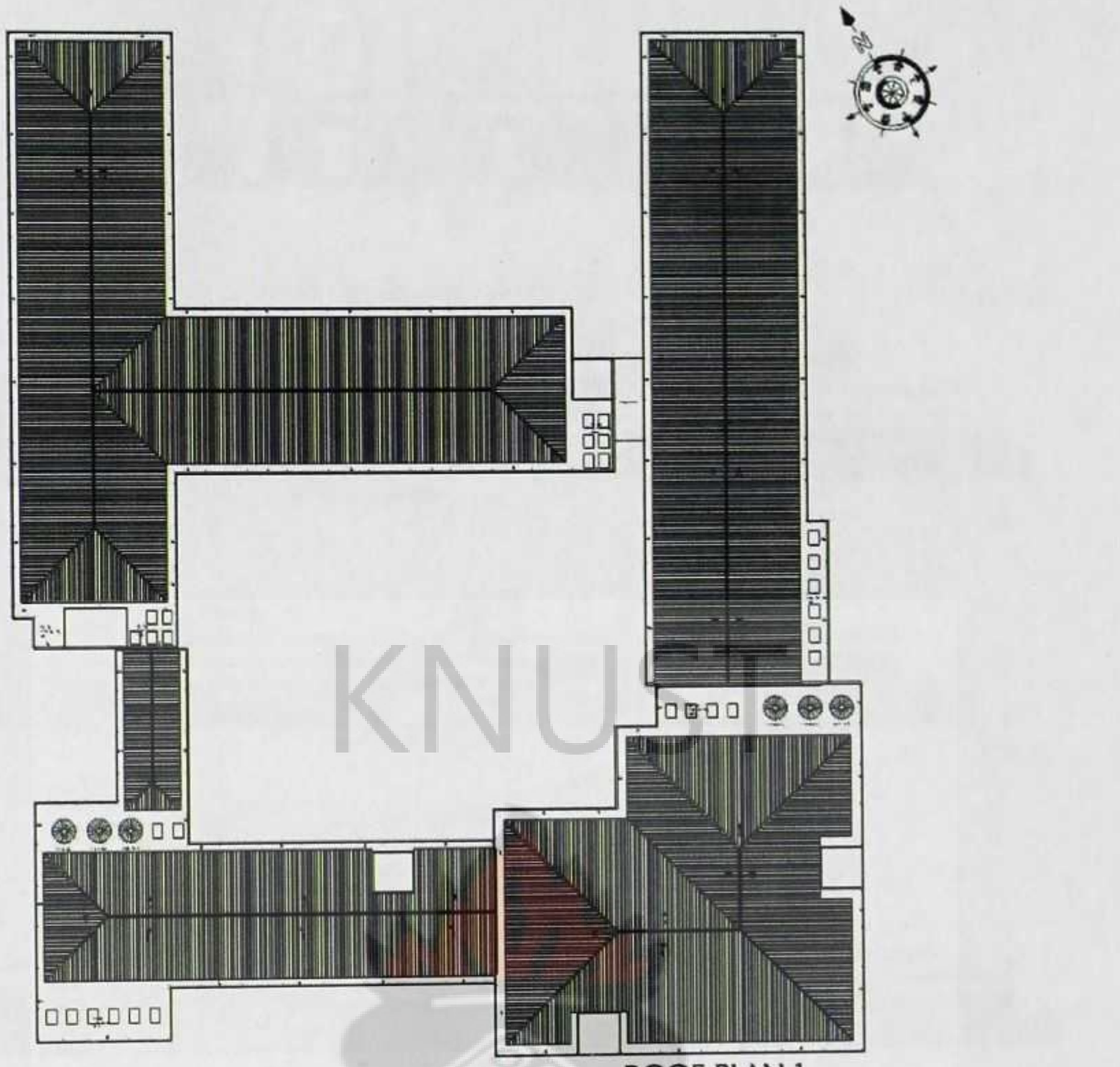
Block Plan



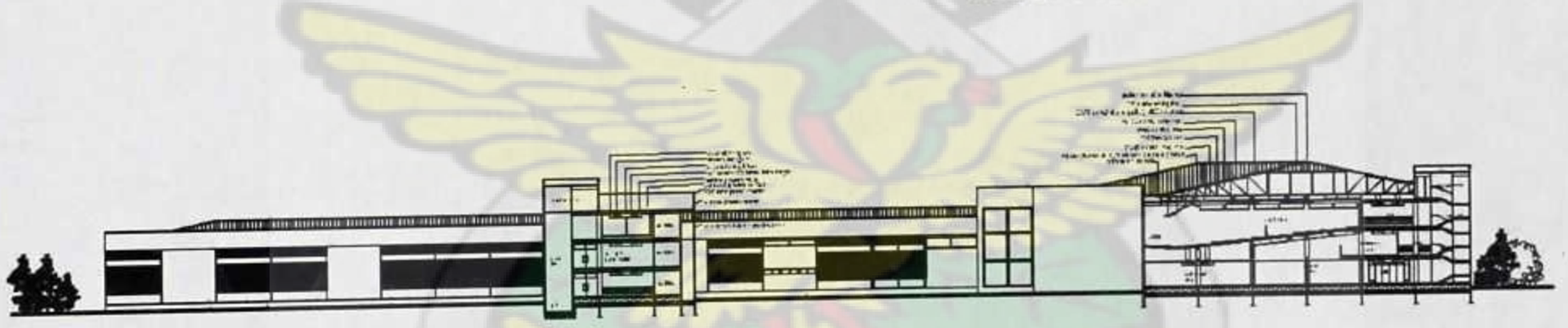


SECOND FLOOR PLAN

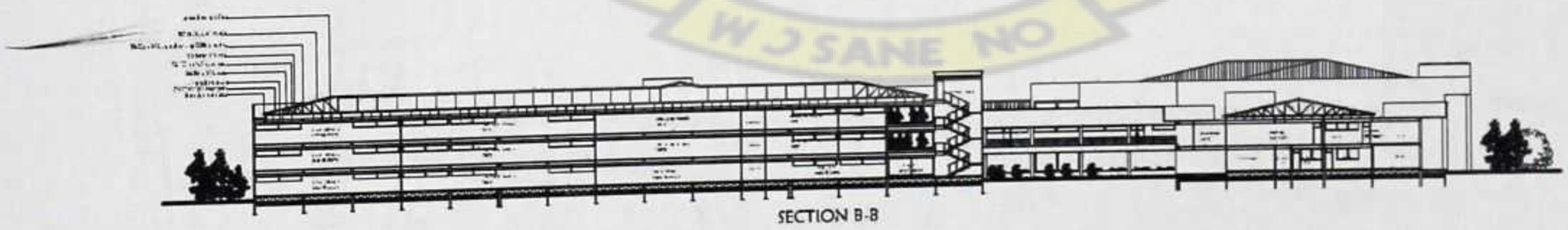
ROOF PLAN



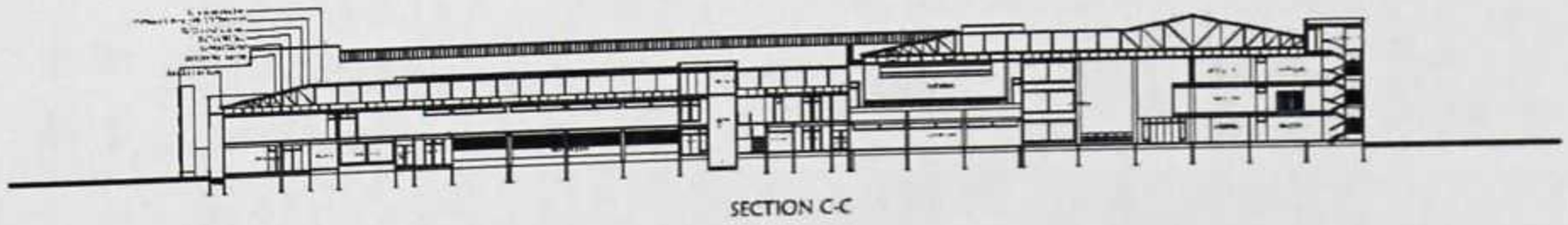
ROOF PLAN 1



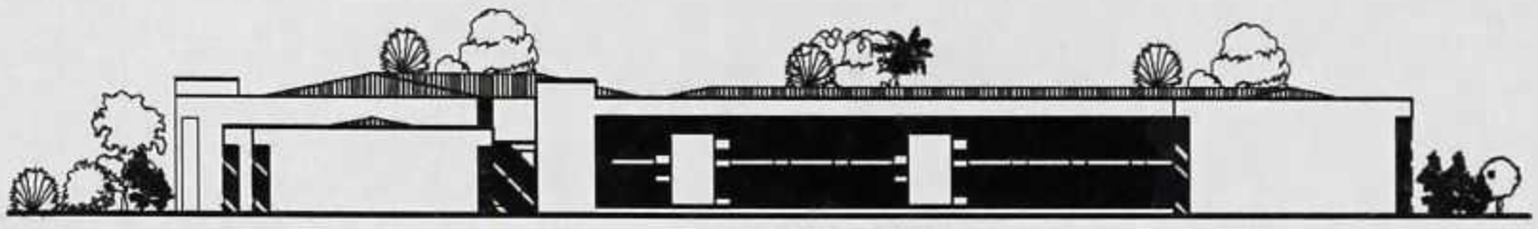
SECTION A-A



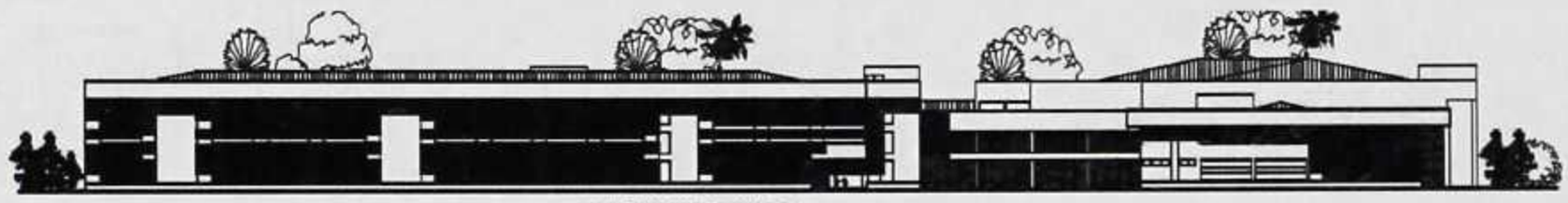
SECTION B-B



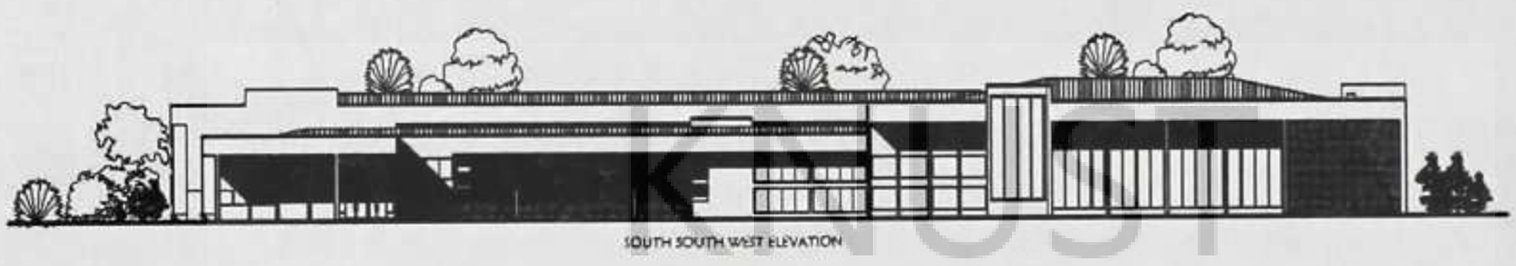
SECTION C-C



NORTH NORTH EAST ELEVATION



WEST NORTH WEST ELEVATION



SOUTH SOUTH WEST ELEVATION

EAST SOUTH EAST ELEVATION

APPENDIX 3

PERSPECTIVES.

EXTERIOR PESRPECTIVE

SOUTH EAST PESRPECTIVE VIEW

PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

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EXTERIOR PESRPECTIVE

SOUTH WEST PESRPECTIVE VIEW

NORTH EAST PESRPECTIVE VIEW

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EXTERIOR PESRPECTIVE

SOUTH EAST AERIAL PESRPECTIVE

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EXTERIOR PESRPECTIVE

NORTH WEST AERIAL PESRPECTIVE

PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

DEPARTMENT OF ARCHITECTURE,KNUST
NAME:EMMANUEL FOBI ASARERE
COURSE:DESIGN THESIS
SCALE: YEAR: M.ARCH II DATE: MAY, 2010

EXTERIOR PESRPECTIVE

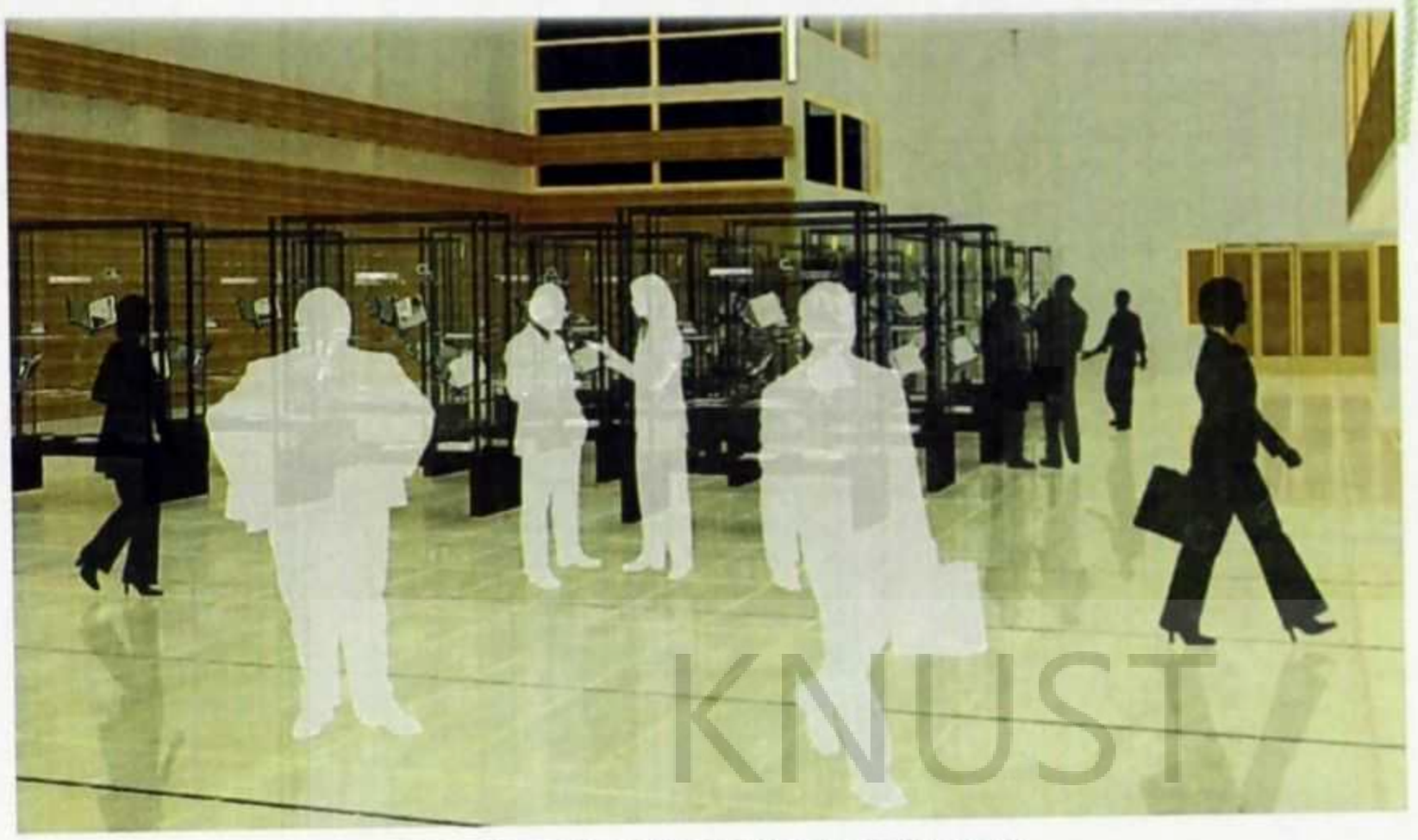
SOUTH WEST AERIAL PESRPECTIVE INTO COURTYARD

NORTH WEST AERIAL PESRPECTIVE SHOWING CO_2 PLANTS

PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) (SUNYANI-GHANA)

DEPARTMENT OF ARCHITECTURE,KNUST

INTERIOR PERSPECTIVE



INTERIOR PESRPECTIVE OF EXHIBITION AREA

PUBLIC RECORDS AND ARCHIVES ADMINISTRATION
DEPARTMENT(PRAAD) *(SUNYANI-GHANA)*

DEPARTMENT OF ARCHITECTURE,KNUST