IMPROVING INTERIOR ENVIRONMENTAL QUALITY USING SUSTAINABLE DESIGN IN JORDANIAN HOSPITAL BEDROOMS

A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY

By
SAEED HUSSEIN ALHMOUD

In Partial Fulfillment of the Requirements for the Degree of Master of Science in Interior Architecture

NICOSIA, 2020

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that I have fully cited and referenced all material and results that are not original to this work, as required by these rules and conduct.

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To my parents...

ABSTRACT

As the wave of sustainability is sweeping across the major countries and cities of the world, the effect of the inevitable change is finding its way through to the health sector as well. Since the main functions of the hospital include healing the patient, it aims to provide adequate health services to people. Hospitals managers should strive to realize facilities that meet a certain level of demand. The aim of this thesis is to present the interior environmental quality of bedrooms (IEQ) in Jordanian hospitals and propose solution to improve indoor environment quality using sustainable design principles. A qualitative research methdology is used in this thesis. A comparative analysis is made between the original set up of the hospital buildings and the present conditions in which they are in. During the research, it was found that the design to be applied for a hospital should be in accordance with the healing environmental characteristics. Besides, the design of hospitals should be made with the climatic conditions of the area in mind. In the advanced countries of the world, hospitals are generally built with extensive research and important factors such as temperature, wind direction and humidity are taken into consideration. The design for a hospital building should be assessed according to the German green building assessment (DGNB) criteria. It has been found that the one-bed room is ideal for patients because it provides the necessary privacy and also greatly reduces the spread of the disease. In hygienic practices, there should be a first-class healing environment with evidence-based medical research. It was concluded that the practices involving the use of sustainable designs can be followed with the hints received from hospitals in the advanced countries of the world.

***Keywords*:** Hospital; bedroom; interior design; environmental sustainability; healthcare; green building (DGNB) factors

ÖZET

Sürdürülebilirlik dalgası, dünyanın büyük ülkeleri ve şehirleri arasında genişlediğinden, bu kaçınılmaz değişimin etkisi sağlık sektörüne de yansımaktadır. Hastane ana işlevleri hastayı iyileşmeyi içerdiği için, insanlara yeterli sağlık hizmetleri sunulmasını amaçlar. Hastanelerin yöneticileri belirli bir talep seviyesini karşılayacak tesisleri gerçekleştirmek için çaba göstermelidir. Bu tezin amacı Ürdün hastanelerinde yatak odalarının iç ortam kalitesini (IEQ) incelemek ve sürdürülebilir tasarım ilkelerini kullanarak iç ortam kalitesini iyileştirmek amacıyla çözüm önermektir. Bu tezde nitel bir araştırma yöntemi kullanılmıştır. Çalışma, hastane binalarının tasarımını ve günümüzdeki kullanımını karşılaştırmalı olarak analiz etmektedir. Araştırma süresince bir hastane için uygulanacak tasarımın, iyileştirici çevre özelliklerine uygun olması gerektiği görülmüştür. Ayrıca, hastanelerin tasarımında, bölgenin iklim koşulları göz önünde bulundurularak yapılmalıdır. Dünyanın ileri ülkelerinde hastaneler genellikle çok geniş araştırmalarla inşa edilmekte ve ortamın sıcaklık, rüzgar yönü ve nem gibi önemli unsurları göz önünde bulundurulmaktadır. Bir hastane yapısı için uygulanacak tasarım, Alman yeşil bina değerlendirme (DGNB) kriterlerine göre değerlendirilmelidir. Gerekli mahremiyeti sağladığı için bir-yataklı odanın hastalar için en ideal olduğu ve ayrıca hastalığın yayılmasını büyük ölçüde azalttığı da tespit edilmiştir. Hijyenik uygulamalarda kanıta dayalı tıbbi araştırmalarla birlikte birinci sınıf bir terapi ortamı olmalıdır. Dünyanın ileri ülkelerindeki hastanelerden alınan ipuçlarıyla sürdürülebilir tasarımların kullanımını içeren uygulamaların takip edilebileceği sonucuna varılmıştır.

***Anahtar kelimeler*:** Hastane; Yatak odası; İç dizayn; Çevresel sürdürülebilirlik; Sağlık hizmeti; Yeşil bina

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

LED:	Light Emitting Diode
HAI:	Hosptial Acquired Infections
HVAC:	Heating Ventilation and Air Conditioning
IAQ:	Indoor Air Quality
HSE:	Health and Safety Executive
IEQ:	Interior Environmental Quilty
UN:	United Nation
ER:	Emergency Room
ICU:	Intensive Care Unit
EBD:	Evidence Based Design
DGNB:	German Green Building Council
ASHRAE:	American Society of Heating, Refrigeration and Air conditioning Engineers
FT:	Feet (1 Foot = 30.48cm)
M:	Meters
OT:	Occupational Therapist
3D:	Three Dimensional
SARS:	Severe Acute Respiratory Syndrome

CHAPTER 1
INTRODUCTION

1.1 Background of the study

Since last period, the perception of people about what wellness entail has led to important shift in the architectural layout of hospital environment, thus improved result is felt in the health status of patients.

When structures are put in place in the past for a proposed health institution, only the factors that will assist the medicine and nursing staff are considered. Unlike today, priority is given to the well-being of patients and staff, patient, visitor and staff safety and stress reduction to ensure all possible components are phantom in when make important decisions. The results realized has suggested that the recent changes adopted has yielded positive impact as seen in the quality of services rendered to patients by staff.

According to Lomas and Giridharan (2012), even after the implementation of findings from a research, the weight of arriving at a "healing environment" is further aided but does not guarantee its success. For it to be effective, Lomas and Giridharan said the decisions arrived at must be designed to meet your specific requirements environment and projects. People involved in the planning and design of hospitals are better served to stay up to date with occurrences and happenings that back the influence of healing environment on different individuals such as patients, their families, and healthcare personnel.

Research on hospital environment and architectural layout has revealed that the decisions embarked on can have telling influence on health status, hasting recovery, alleviate stress and discomfort in patients and also improve the general level of activities and services that is delivered by an health institution (Lomas and Giridharan, 2012).

Latest set of intelligence that has been gathered has emphasized the need of hospitals designs to ensure recovery in the environment of location. Eventual outcomes to be expected from research finding should therefore be able to provide practical solutions to the problems encountered in health institutions and also an upgrade on the existing practices.

Through this, the decision making process is guided by information derived from previous work of research, projects and evidences gathered from the operations of the client (Lomas and Giridharan, 2012). This has led to project works to suit the laid down objectives. At conclusions, effective hospital layout should bring about marked improvements in the grand performance, workability, effectiveness and overall delivery of services. The positive results of incorporating the natural environment to design of hospitals has shown positive impacts on the visitors in a hospital as they experience better quality time and medical practitioners that dish out medical services and also stakeholders as they enjoy highflyer and improved yield on hospital investments.

Another quality idea is the incorporation of natural endowment in the design of healing houses. This has resulted in encouraging outcomes in the level of stay experienced by visiting individuals, consultants and practitioners and also administrative arm of hospitals that are tasked with ensuring profit is maximized.

When the hospital environment is well designed and properly managed, with adequate spaces ensured in between structures and units, patient, visitors and the hospital staff are better served and operations and activities can be carried out stress free (McCullough, 2010).

The environment created in a hospital serve as different things and functions to different people. It is a derived social environment that offers value in health, structure, interrelationship and day to day interaction between people of different interests and goals. They ply their trade towards their diverse needs without necessarily limiting OT inhibiting that of others. While to staff of all class, be it doctors, nurses, gardeners or janitors, it serve at a work environment, to patients, it serve as a place where they can repair their ill-health and to the governing administration, it likely serve as a business center or an avenue to reach out to people.

1.2 Problem Statement

The building structure of a hospital has a great deal of influence on the various set of individuals that come in contact with it. Of high note is the fact that health institutions are places where people receive medical attention and recuperate from illnesses and sicknesses.

The hospital is a healing institution where people can attend to heal up. The kind of environment which it represents therefore has a telling effect not only on the state of health of patients, but also that of the staff and even the visitors. In addition to positively affecting well-being, the functions performed by hospital environment includes alleviation of pain and stress in patients, limiting errors involved in health care administration and also preventing disease and falls. Important components of the environment which should be treated with utmost priority are adequate ventilation plan, provision of spaces and natural views, Hospital environments should have the ability to positively affect the healing, state of health, eliminate discomfort and stress in patients and also rid of infections, injuries and errors. Such issues as natural ventilation strategies, open spaces and gardens, adequate lighting and controlled noise levels are paramount in hospital environments towards improving patient's stay and staff operations.

Hospitals in Jordan reflect a manifestation of the health care system and are in essence the spaces and institutions through which healthcare is administered to the public and are central to the process of healthcare. As such, they contribute to a large extent, the health quality of the Jordanian population through the services they offer. It is with this reason that such hospitals should be effectively organized and designed to give a positive effect on "health and wellbeing" of its users.

Many issues have to do with the layout and operations of health institutions in Jordan as they contradict the precept that hospitals should be easily habitable. Even though hospitals in Jordan are often designed without taking sufficient account of the outdoor conditions and indoor environmental satisfaction by the patients, workers and visitors, there are some level of adjustment that can be carried out to cater deficiencies.

Spatial planning towards staff efficiency and noise control are a challenge since such a hospital experiences excessive background noises higher than the World Health Organization's considerations in hospitals that can cause irritations and discomfort, and increased Hospital Acquired Infections (HAI) infection rates are being experienced through re-transmitted air borne diseases caused by poor ventilation strategies. There is a general lack of open spaces for positive distractions in hospitals in the main suburbs and the indecent lighting conditions in these hospitals cause patient depression, confusion and staff medical errors. This creates a paradox in which industry of healthcare that contributes to solvent the problem. This study therefore seeks to understand the causes for the mismatch and propose solutions towards directing hospital design in Jordan towards improving patient's stay and staff operations.

1.3 Aims and Objectives

Many studies have been done on the aspects of Healing Environments in hospitals and evidence based design and this study will, in line with the appropriate and carefully laid down procedure, seek to;

- Expound on what constitutes a Healing Environment.
- Outline environmental strategies that can be employed to support healing environments.
- Develop selected sets of design guidelines that can be employed in hospital design and planning to support healing environments.

1.4 Methodology

This is a qualitative study that aims to look at the evolutionary trends of hospital buildings from the initial design with which it was implemented. Inferential conclusion will be arrived at from the set of information gathered from various sources which will majorly be evaluation. The study will make comparison between the original set up of the hospital building and the present conditions in which they are in. This should not be difficult to adopt as changes are common in these forms of set up due to the operations they engage in from time to time.

This study will be based on 4 pre-selected Jordanian hospitals as case studies. We chose the case study approach because it provides the best opportunity for contrasting and comparing differences and similarities between each. They are;

- Islamic hospital
- Aljazeerah hospital
- Princess Rahma hospital
- Princess Basma hospital

Data will be collected on factors such as site planning of the hospitals, units and ward planning and arrangement, openings in rooms and the materials used in the construction of the various parts including foundation, walls and roof as all these affects the components of natural environment in health.

Photographic images of both the interior and exterior of case studies were taken and also obtained from some reliable sources for clear understanding of the current condition of the hospitals. The analyzed data will be presented in tables, photographs, architectural drawings and 3D images. Tables will be used to make comparisons. Photographs will be for the sake of making adequate observations of the case studies, 3D images and visualization is used to present computer generated models so as to put the form and structure of the hospital components into proper perspective.

Finally, after the completion of the findings, necessary recommendations will be made which will serve to provide templates to follow for professionals that are involved in erecting a building, in this case hospital building and also the various stake holders in the health care sector in view if assisting them create an improved healing environment with reduced out of operation.

1.5 Limitations

Like any issue of importance all over the world, healing environment falling under the health sector has attracted its fair share of interest since the not too long ago past. The topic of discussion here i.e. healing environment has been of interest to researchers over the past

years as so much has been said and written on it. But unfortunately, the scope of our study will not cover much of the literature that has been written instead, it will focus on the most recent of publications as it is almost not feasible to work with their entirety with this particular time frame.

Also, a whole lot of researches will not be reckoned with even though they are well within the investigated field as the concept is a multi-faceted one. This work will be carefully operating within the tentacles of Evidence Based Design and the engagement of Architectural practices and knowledge in arriving at hospitals which seems healthy to the individual that are involved with it day in day out.

1.6 Research Significance

There is need is to establish, within the building industry and specifically within the healthcare industry, a set of criteria and strategies that can govern the way in which hospital environments develop and are designed to create healthy living spaces that , as a result, do not harm either the planet or the occupants. This research is of significance to the domain of hospital planners and designers as it extends the knowledge base that currently exists in environmental strategies for hospital design.

As it stands, the state of things has necessitate that standard should be set in the health administration and building construction industries that will serve as a form of template to implementing plans to create a healthy wellness center which will possess little to no threat health wisely to the environment and its people. This intended work serve to further enrich the pool of knowledge that is available on building plans for hospitals.

From careful analysis of the case study of choice, a better work of idea is to be laid on the bedrock of foundation on which designing of hospital environment are initiated. This entire finding will be based on proposing new ideas that are already been implemented and in use in advanced nations of the world, to provide a better sustainable healing environment and limit the level of disease contamination. It will establish a bases on which planners, decision makers and investors can focus for the not too distance future.

1.7 Thesis Structure

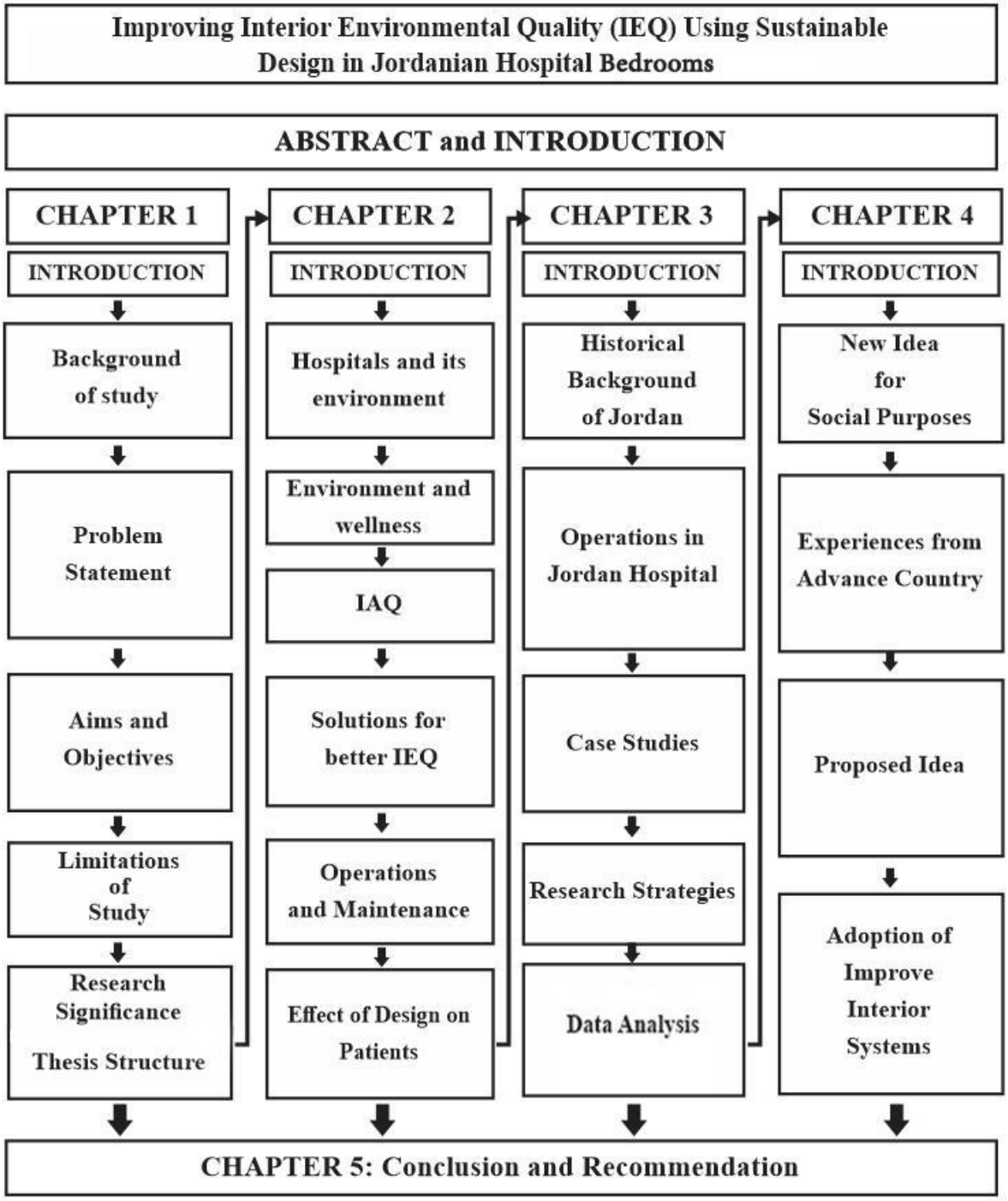


Figure 1.1: Thesis structure

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The hospital is not just where someone goes to receive medical attention. It is a health institution that addresses various problems of man. With respect to this important role which it playa in our society, it has therefore become imperative on the governing body of such centers to pay critical attention to the various components of that affects the services which they render. Factors such as lighting, ventilation, daylight and views, acoustics and thermal comfort are critically discussed in this chapter.

The problems that were identified in previous work were reviewed and in accordance with the current trend in building design, probable solutions were identified and inferential conclusion was made.

2.2 Hospital and its Environment

The implementation of hospital environment should be focused on the impact of the design structures on ground on the different individuals that patronize the institution and not be in a way that only ensures optimum service delivery, but also be. This is an obvious variation from the norms in the past. Instead, the direction has shifted towards designs that allows for quick patient recovery, stress alleviation and good health status of patients, hospital staff and visitors (Lechner, 2014).

According to (Elf et al., 2015), in the early days, the arrangement pattern of hospitals follows that which was stipulated by a then nurse, Florence Nightingale. Her plan involves aspects like good/adequate ventilation, balanced meal, landscape and cleanliness (Burpee, 2008). Through the elements of her input, she has touched the well-being of individuals and their social being. Stinger plan approach was used in the construction of hospital rooms, and also, the rooms receive adequate level of lighting and natural air.

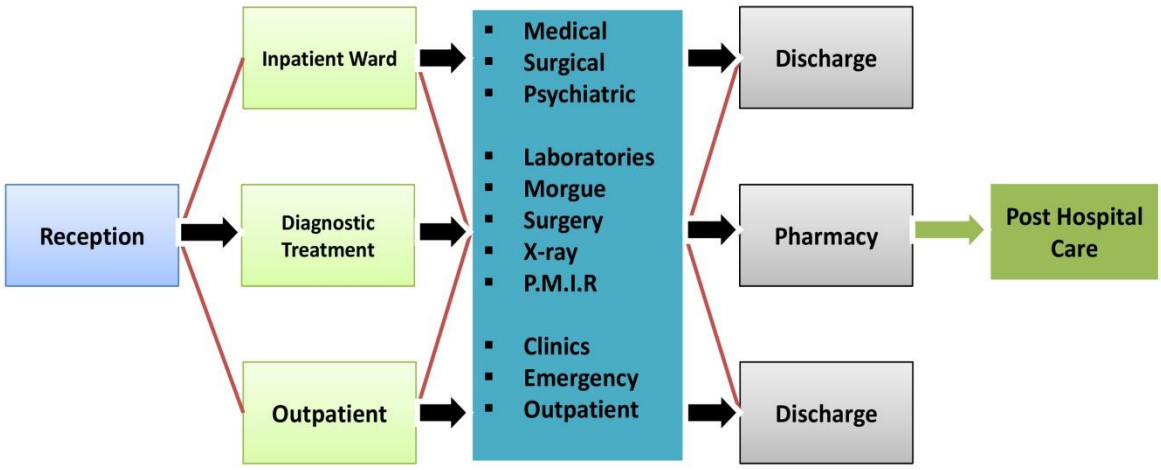


Figure 2.1: Typical layout of a Hospital

Initially, hospitals were not operated as commercial institutions. Rather, they were church owned institutions before the responsibility shifted to communities. And as ownership changes, the structural design of their buildings changes as well to cater for some pressing needs over another. The earliest forms of hospitals are the one that allow for podium on a platform. These sorts of buildings provide adequate lighting exposure and ensure more exterior space.

Another is the horizontal forms. Here, structures are constructed on the same placement, ensuring that wards and other sections of the hospital are places side by side to each other. The main advantage of this sort of design is that it eliminates the problems associated with upward/vertical movement of sick people which could too much stress for them to bear in their ailing condition (Bachrach et al., 2012). It is not without a disadvantage in that there are varying floor heights in different section of the hospital and there are also prolonged spaces to be covered due to the nature of the structures.

The community transformed model is come about as built houses within hospitals that metamorphosed into hospitals. It is never that the health institution has its own establishment, but rather resulted from the inclusion of buildings clustered within an area.

A modern approach is called progress styled hospital structures. This model ails from existing styles while also incorporating modern systems of construction into its application.

2.3 Components of the Environment that Associates with Wellness

A huge percentage of budgets and allocation of any government administration goes into the health sector. This is meant to manifest in the quality of facilities and equipment on ground, livelihood of staff and quality health care delivery. It is given unfortunate that a lot of hospitals now serve as a source of disease infections for unsuspecting staff and patient alike (Frampton and Charmel, 2009). This is as a result of unpaid attention to the built environment, the components of which include;

2.3.1 Lighting

Since light affects the psychology and physiology of people in their day-to-day existence, different degree of lighting is recommended for different wings of the hospital. For example, consultation offices, examination rooms and reception should be the brightest for surgery and other important operations, followed by the general ward and then the intensive care unit (ICU) due to sleep patterns.

Some of the advantages of light include reducing tiredness, increased alertness, reducing depression amongst others (Appleby et al., 2012). In the same research by Boyce and Co. in 2012, it was revealed that daylight allows workers to maximize their potential in their place of work. The problem that stems from inadequate lighting conditions can be solved when there is inadequate blend between artificial light and daylight. When it comes to artificial light, it can be properly optimized by design the entire structure in intelligent manner not minding the particular lighting equipment through which the light is generated (Weal et al., 2007). Although is recommended to changes fluorescent lamps with full-spectrum light bulb as the former which has been in use over time is able to induce stress in individuals.

2.3.2 Ventilation Effectiveness and Indoor Air Quality (IAQ)

To sustain life, there is the need to ensure continuous inflow and out glow of fresh air in a hospital environment, making it an important aspect of designing that one cannot undervalue.

Table 2.1: Design Features for Enhancing Natural Ventilation (Birkeland, 2012)

Design	Description
Building Layout	For air-conditioned buildings
	Compactness of the building to better manage space
	Windows size should be reduced to minimize heat inflow and outflow
	For naturally ventilated buildings
	Buildings should not be too crowded within a spot, instead spread out in strategic spots.
	Spacious garden should be provided and windows should be wide enough to ensure adequate cross ventilation, thereby facilitating better sleep patterns.
	Impeding wind direction in the site should be considered when erecting the building so as not disrupt air flow and allow for adequate cross ventilation.
Plan for Major Rooms, Doors and Windows	- The plan should consider positioning rooms, wards and offices right for adequate ventilation - Do not allow sun rays to fall on the walls on the east and west ends. - The orientation of the windows should be designed in such a way that it does not hinder adequate inflow and out flow of air and lighting from sunshine is not obstructed. It is advised to site the windows at oblique points which are parallel to walls that are not directly opposite the ones to the east.
The relation of the building to the land	Structures of buildings that are raised to some floors above the ground rather than disjointed buildings on the horizontal will give more access for more ventilation to reach the building and the presence of tall vegetative cover will only aid air movement and circulation.
Operations and Management of Interiors	At day times, efforts should be made to reduce the level of heat that reaches hospital buildings. This can be done by keeping windows and doors shut while curtains can be kept down or over the window. This is particularly about windows that are sited in the same side as sunrise and sunset.
Vegetative Materials in Proximity to the Building	Vegetative covers of any form that are in and around the hospital building be it on the ground in spaces in the hospital environment, rooftop gardens and taller plants can be used to a greater advantage to combat urban heat effect. Limited surfaces are also exposed to direct sunlight and as a result, energy is conserved from reduced use of cooling systems.
Wall and roof thermal properties	- When selecting materials of choice, they should be those that have the ability to reduce heat at noon and increase cooling at midnight. One should therefore ensure that there is adequate ventilation to prevent buildup of stale air. - A form of heat radiation element usually made with aluminum can be installed as roof underlay to prevent most of the sunrays from gaining access through the roof. - High quality roofing sheets will absorb less heat so as to reduce that which is felt indoor and will also be capable of holding water for cooling purposes. In a kind of setting where the upmost decking provide room for a light cultivation of crop materials. It adds thermal and acoustic insulation, preserves the roof underlay and enhances its lifetime.

Tang et al., 2006 said the ventilation is directly related to thermal comfort in a structure as it helps to regulate the level of coolness and hotness, and also decrease the possibility of spreading air borne infections like tuberculosis, small poses, and influenza among others.

In addition to giving way for natural lighting to fall into a building, fitting rooms with windows and adequate door spaces ensure that they receive good quality air and also allow stale smell to be expelled (Bachrach et al., 2012). In general wards those holds quite a number of patients, it is important to ensure constant movement of air/cross ventilation to prevent transmission of diseases among people (Verheyen, 2011). While any design plan to be implemented should carefully cater for exposure to natural ventilation, the use of artificial ventilation system also serve as supplement, and both should be properly incorporated in hospitals.

2.3.3 Acoustics

Sound, as perceived by our ears have varying effects on individuals. While some may have relieving effect, some others serve as form of disturbances. Same others may be therapeutic and others may be annoying. Noises, i. e unwanted sound usually present itself in an unorganized manner and can negatively affect the well-being of individuals in a hospital setting. Communication within and interaction between staff and patient can be in a way that allows one to grab the message in sounds with minimal level of stress (Vincent et al., 2010; Verderber et al., 2014).

Table 2.2: Table of sounds levels L and corresponding sound pressure and sound intensity (Bachrach et al., 2012)

Examples	Sound Pressure Level	Sound pressure P N/m2
Jet Aircraft (50m away)	140	200
Threshold of pain	130	632
Threshold of discomfort	120	20
Chain Saw (1m away)	110	63
Disco (1m from speakers)	100	2
Diesel truck (10m away)	90	0.63
Busy road (5m away)	80	0.2
Vacuum cleaner (1m away)	70	0.063
Conversational speech (1m away)	60	0.02
Average home	50	0.0063
Quiet library	40	0.002
Quiet bedroom at night	30	0.00063
Background in TV studio	20	0.0002
Rustling leaves	10	0.00063
Threshold of hearing	0	0.00002

Sound that is generated in a hospital can be properly managed by actually ensuring adequate special arrangement of structures and unit or installation of sound proof materials. The first method can be achieved by locating different sectors of the hospital at strategic points to each other. For example, the reception area is better suited far away from the ICU and the workshop is best placed not close to the children unit. Putting in place sound control materials in the other hand can be cost ineffective.

2.3.4 Thermal Comfort

The temperature that is felt inside a building be it hotness or coldness can lead to decreased functionality in man also loss of performance capacity, and lowered production output has been attributed to extremely hot weather (Godbole, 2018).

Ones state of mind at this period of time cause inability to function ineffectively. As explained by Health and Safety Executive (HSE), the level of thermal discomfort felt in a building is at the minimum at 20% and not when higher.

The factors which affect thermal comfort can either be;

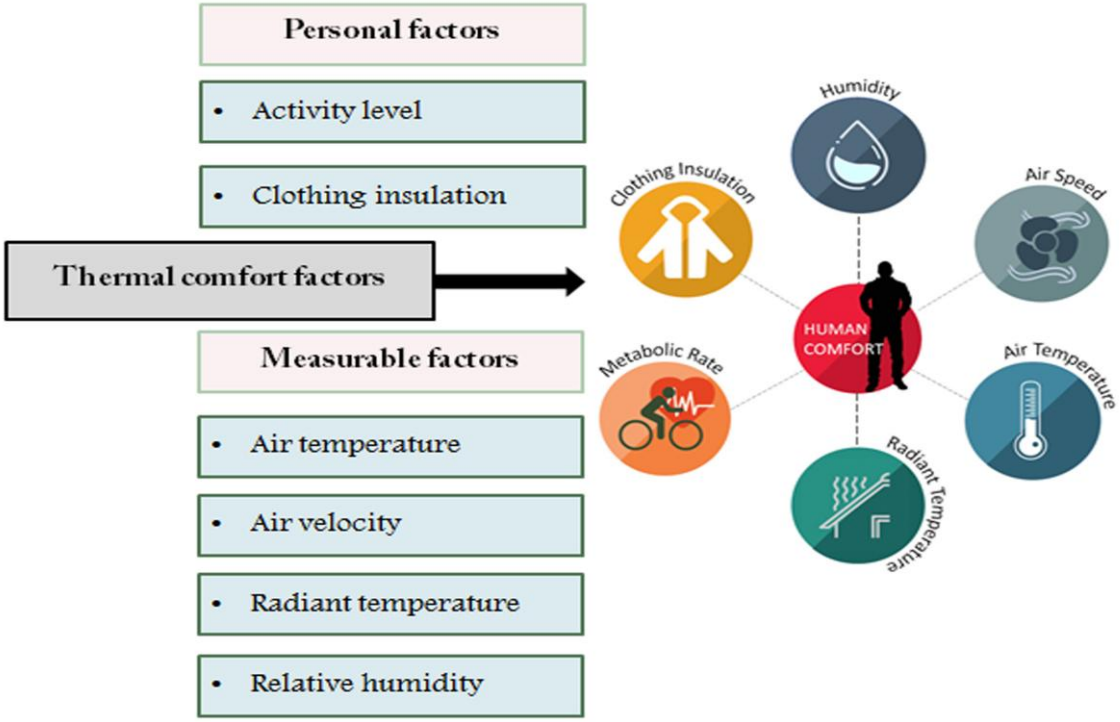


Figure 2.2: Layout of Factors affecting thermal comfort adopt from (Godbole, 2018)

Some of the measures that can be put in place to reduce thermal discomfort are;

- Styling clothes to fit the prevailing weather condition.
- Flexibility in work time.
- Proper derogation of activities to workers.

Thermal comfort is described as the state of mind in which the thermal environment is conducive to making one express no dissatisfaction, according to the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).When considering the temperature of an area to be the level of coldness of hotness, at both sides, the extreme conditions can be severely hot and severely cold of which thermal comfort is experienced when these conditions are balanced (Parsons, 2014).

Researches have been carried out over the years on establishing a standard at which one can experience a balanced state of temperature. In his book in 1970, Fanger gave conditions through which the level of thermal comfort in an environment can be evaluated. The model establishes a form of synchronization between the relative hotness and coldness and the elements of the environment that includes; Temperature, Humidity, Air Speed, Thermal Radiation and also human behavior that influence the level of heat that they generate within themselves like clothing and day to day activities they get involved in.

The landmark which was created by Fragner has been used both in its original form and also in modified form by ASHRAE and other agencies to further establish involved evaluation criteria. This model has had its fair share of success and failure in different regions of the world. For example, according to (Taleghani, 2013), The prediction was accurate in cold regions and monitored buildings for naturally ventilated openings, but not in correspondence when predicting the degree of thermal comfort in hot environment (Wong et al., 2009).

2.3.5 Daylight and Views

When one can enjoy nature by just roaming within a beautiful garden, rocking on a well-crafted couch, pacifying pleasant odor's from flowers, lethargy as well as stress are shaken away from the body and the senses are also kept sharp (McCoullough, 2010). The criminal departments of some agencies do employ the torture strategy of exposing victims to plain walls of a confined enclosure. This will serve as forms of hypnosis that make such individual lose their senses and misbehave. When people experience this, with time they tend to lose track of their surroundings and maybe breakdown to reveal conceived secrets. The idea of designing hospitals should however make special provisions for gardening.

As opposed to blank walls which patients see in wards, they get to experience nature close to them (Ulrich, 2008). In a nutshell, access to views and garden spaces are a vital aspect for hospital atmosphere have been shown to have a positive effect on stress/anxiety, pain medication use, pain tolerance and lengths of stay for patients in hospital wards.

Even as emphasis are laid on maximizing spaces within a hospital environment for bed spaces, little pathways linking different sections together may be well suited to this function.

2.4 Solutions for a Better Interior Environment Quality in Hospitals

After careful run through past work and literature, possible solutions are provided for the various problems that are stated for Indoor Environmental Quality (IEQ) are identified. The solutions are of different forms but are summarized in two headings and explained below;

- Design and Construction Materials

When putting in place a fundamental design for an indoor environment is it of a health institution or not, the layout and material of choice should be that which does not interfere with the well-being of people and also have no adverse effect on mental and psychological health. This will mean ensuring adequate ventilation, ability to enjoy natural view and daylight, optimum and appropriate intensity of lighting, noise minimization and use of sustainable building materials which are capable of reducing the amount of greenhouse gas emitted into the environment (Dascalaki et al., 2008).

It will serve the inhabitants of a potential building under construction well if the builders are inclined towards the idea of going green. Through this, the building materials are protected from contamination and exposure to moisture. Also, the level of waste generated is greatly reduced when the construction materials can be recycled. This way, waste materials can easily be reused.

- Operations and Maintenance

To ensure that a building stands the test of time, it is imperative for the administrative sector to organize a periodic evaluation and assessment of its living conditions. Through this monitoring exercise, inadequacies are recognized and actions are carried out based on the recommendation of the investigative party (Rathert and May, 2007).

2.5 Effect of Environmental Design on Patients in Warm and Humid Climate

In putting in place a building plan, it must go in hand with the nature of the environment in which it is to be sited. Attention should be paid to be relative climatic condition of the area to ensure that one achieve a naturally sustainable indoor condition. This is needed for there to be careful blend in the choice of architectural and environmental elements as this tells how well the previously discussed strategies are managed (Eckelman and Sherman, 2016).

- ***Humid Comfort:*** The hospital can be placed in an area with high humidity which is curbed by ailing wind movement. Such areas will experience good ventilation by the way of allowing unadulterated air to reach people in the hospital and also lowering the level of hotness felt indoor when compared to that experienced outdoor (Taleghani et al., 2013).

- ***Site Planning:*** When choosing a potential site, door the construction of hospital, the land should be a dry land to avoid water logging, and also must not be a swampy area and must have a good terrain to allow for easy accessibility. Also, it should be sited far away from noise generating industries such as factories, night clubs so as not to disturb sleeping patterns or even distract ongoing operations.

Figure 2.3: Sustainable cycle (Wagenaar, 2006)

The pattern of wind flow should also be considered as well to prevent the obstruction of wind flow. Sections of the hospital should be well positioned to go in line with prevailing wind condition. Adequate spaces should be provided within wards. Planning is best done in a way to encourage better exchange and circulation of fresh air. Vegetation should also be taken advantage of. Along the sides of buildings, deciduous trees and shrubs should be carefully planted to serve as shade against sunlight and also support air movement.

- ***Structure and materials:*** Houses can either be built to have walls and roots with different thermal capacity. The very type which is employed in a type of climate varies as a humid climate calls for a thigh structure and vice versa. (Attaianese, 2012). Noted that if heavy walls must be necessarily used, then should be protected from solar radiation so as to minimize the extent of heat absorbed and retained. Walls are essentially important to keep out harsh and inclement weather conditions. Ceiling materials can best be corrugated iron sheet and they appear best for low rise and bungalow buildings.

Patients go to the hospitals to receive attention and advices of the doctors on health related issues. However, this particular service will last for a few proportion of the time which they spend in this institution. They get to interact with the environment even more in different ways which spells that it has a direct influence on their state of health as well.

Research programs in medicine are now moving towards evidence based medicine. Here, choices and plans to be put in place are guided by outcomes and recommendations made from findings that are conducted in relation to patients save staff interaction.

With regards the air and surface water, the staff of hospitals are exposed to infections which can be contacted from patients (Qian et al., 2010; Pasanen et al., 2014). For example, a research shows that the spread of SARS in hospital wards can be significantly reduced when provided with adequate ventilation. This will help to manage the outbreak of the disease and when some personal protection measures are put in place in treatment wards (Qian et al., 2010). Employees that are also exposed to light rays from equipment used in surgical procedure are at a risk of suffering from eye problem (retinal damage).

Krauss et al., (2008) noted in his study that specific architectural factors cannot be responsible for improving the health outcome and level of satisfaction derived from hospitals by patients. Rather, it involves the entire environmental component which includes privacy, community, view and environmental control. According to (Verderber et al., 2014), when patient beds are arranged in an inappropriate manner, stress may set in which may lead to fatigue in nurses.

When at work, nurses spend most of their time walking. Also, the layout of hospital units has an influence on how much walking is done by nurses. The majority of the staff worked on in a previous research has revealed that they prefer to walk in radial units. It also emphasized that walking by nurses can be greatly reduced when nurse's stations are decentralized and more attention can be paid to patients. But on the contrary, when supplies are located centrally, walking may be increased as much as in 2 folds and also affect patient care time not minding where nurses are stationed.

2.6 Functions of a Hospital

Primarily, hospitals should provide healthcare services to in patients and out patients. And as noted by (Wagenaar, 2006), the hospital should allow patients to successfully and easily receive treatment and take time to recuperate and also obtain access to advices and attention from the medical staff, friends and families.

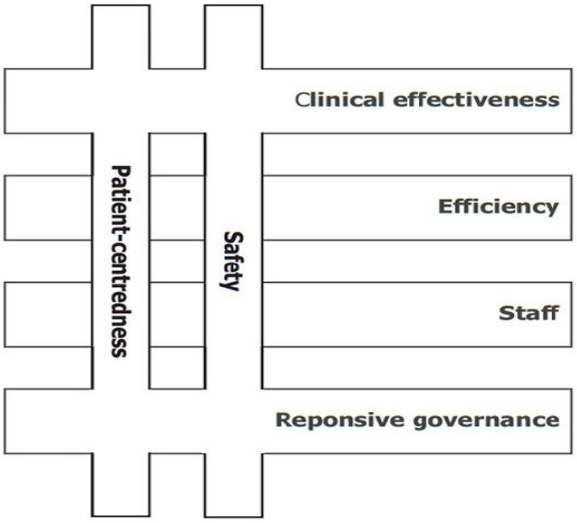


Figure 2.4: Theoretical model for hospital performance (Seitio-Kgokgwe, 2014)

The administration of treatment may be the first set of responsibility which must be performed by any functioning hospital; they also perform some other functions which include teaching and research. As a result of the collaborative efforts and method of operation of some hospitals, research unit of the institutions provide learning services that are usually ongoing there in.

- ***Evidence based design***

Evidence Based Design is a systematic approach to decision making that involves giving careful consideration to previous work and findings that have ensued on a particular model of design of each and every specialized project (Rechel and McKee, 2009).

Evidence Based Design (EBD) usually focuses on certain important environmental features which are;

- Precise result if executed precisely.
- Highly demanding when it comes to cost of implementation.
- Have a negative impact on patients and medical service delivery.
- Subsequent works have set up on a model that takes different path.

Many of these include the installation of an efficient Heating Ventilation and Air Conditioning (HVAC) system, number and arrangement of patient beddings, hand washing basins and general layout of health institutions. If decisions that are arrived at are well applied and followed, have the ability to up the ante in healthcare delivery, foster good and better communication and relationship, reduce stress in staff and patients and lead to increased satisfaction of patient in the quality of services that are rendered to them and state of the environment (Riratanaphong and van, 2015; Sadler et al., 2011).

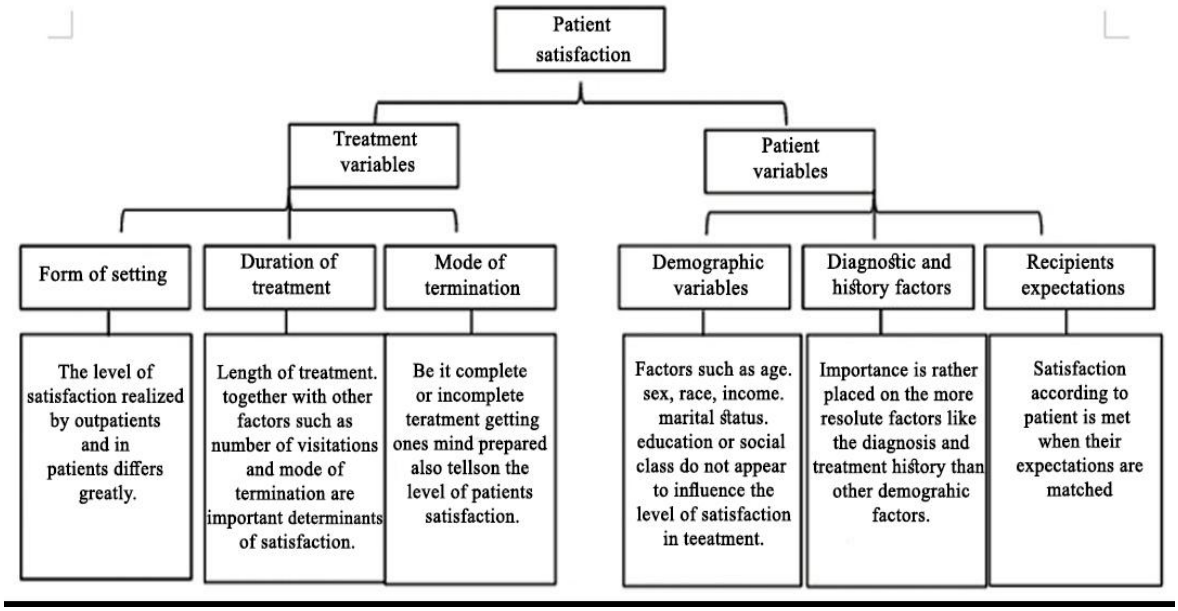


Figure 2.5: Factors determining level of satisfaction in hospital patients

2.9 Conclusion

In light of the reviewed literature, the well-being of everyone that either work (doctors, nurses, attendants), receive treatment (patients) or visitors (family and friends) at the hospital depends on the state of the environment that resides around them.

The various strategies that lead to creating Healing environments are seen to be environments that incorporate elements of a balanced strategy of Natural Day Lighting and Artificial Lighting, Natural Ventilation and Indoor Air Quality, Views in Patient Rooms and Gardens, and Noise Control /Sound Quality within hospital design.

A stale air for example will cause a form of distraction and displeasure among everyone. Natural view which has been associated with wellness will provide a form of tranquil and ease in the psychological presence of patients. When the beddings in a ward of a Hospital are well arranged, nurses can go about to attend to patients with less stress and the building arrangement of wards also simply life for all and sundry.

Lastly, the general layout of hospitals should better be in a way that considers the need and state of being of the people that are majorly involved in the use of the facility. The interactions they have with the environment on its own have its effect on great health. This way, the patients are healed and are also satisfied with the service with which they are rendered.

CHAPTER 3
ANALYSIS OF CASE STUDIES

3.1 Introduction

This chapter started with a look into the political structure and social setting of Jordan as a country. Right from when they were governed by ottoman's ruler ship in the 15th century till when they got liberated by the Hashemite. Then to the not too far back 19th century when the political constitution and heritage in use now took its shape. This period in which King Abdullah was recognized as the leading power and admitted into the United Nation (UN) has its member country. The central focus of environmental design today needs to be on patient and staff safety and comfort. With the acknowledgement of such strategies, this chapter considers how hospital environments will subsequently have improved surroundings that not only offer comfort but still maintain sustainable models.

For the case studies, four hospitals were selected to act as case studies. 3 of these hospitals were selected from Irbid which is the second largest city in the country of Jordan and 1 from Amman, the capital city. While 2 of the hospitals that were selected from Irbid are government hospitals, the single hospital from the capital is a private health center. The different components of the hospital building including the ward or sectional forms, trees and vegetation, verandas are carefully examined. Not only were the strong points of the institutions put into perspective but also the weak points which can be well improved upon to raise the level of healthcare delivery.

In other to properly deliver the points that are tendered, graphic images of the structures were presented in addition to the layout plan with which the entire building designs were implemented.

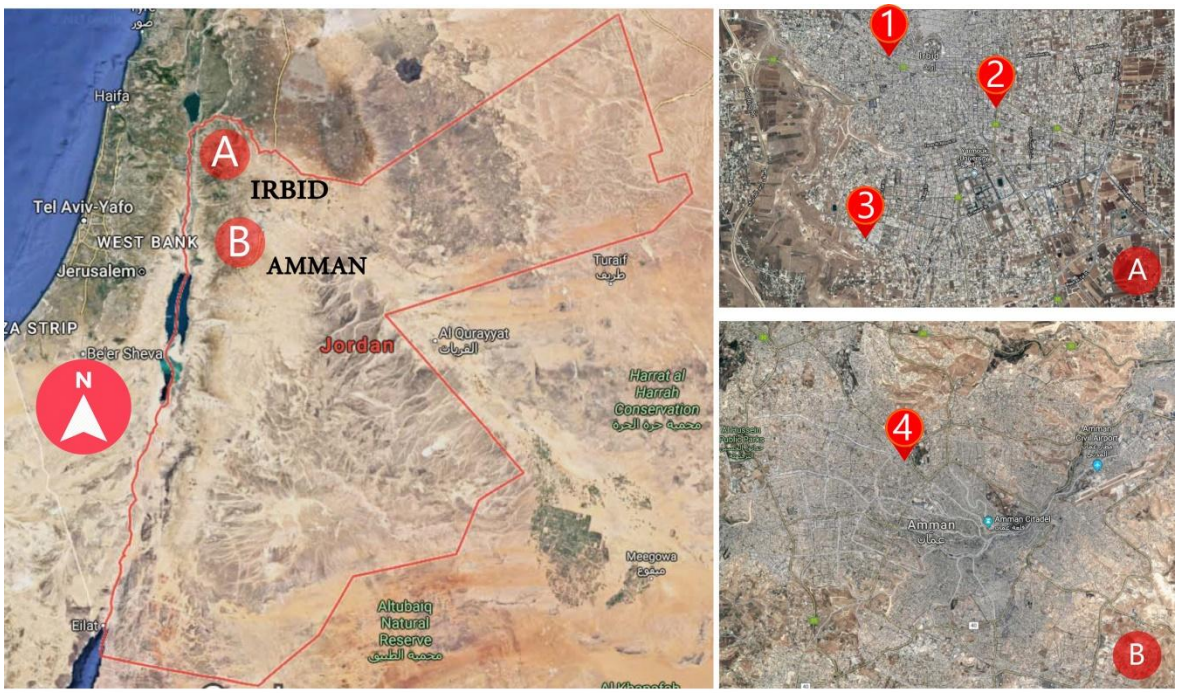
3.2 Historical Background of Jordan

Jordan was formerly within the first Muslim dynasty (Umayyad Empire) in the early 7th century. She had it its capital at Amman which becomes the headquarters of government by then. The ottoman forces were those that rule the land for centuries (1516 - 1918) before they were blindsided during the World War I. With the help of Great Britain and France, the Hashemite were able to take over government from the Turks mainly due to the growing level of hatred developed towards their rule. When the war was over, Britain and France spread their tentacles into countries like Syria and Palestine (Milton-Edwards, 2009).When Transjordan was won at the end of the war, Abdullah I was installed as the ruler then due to the fact that his brother who was previously at the helm over at Syria was taken off to golf a similar role at Iraq even though Abdullah really wanted Syria or Palestine.

Figure 3.1: Map of Jordan (Google map, 2019)

Long Abdullah has always got the support of the British forces especially against the May which do find the way uninvited into his kingdom. Initially, Jordan of today i.e. Hashemite of Transjordan was an emirate not until 1946 when it gained Independence in 1948. The leader of the nation, entitled the 'Amir' was renamed the "King" by members of the Parliament.

The Figure 3.2 shows the geographical location of the site of study as they spread across the 1 largest and most populous cities of the country of Jordan. They are in the coastal areas of the country and shares boundary with Palestine cities.



1 : Princess Basma Hospital
2 : Islamic Hospital
3 : Princess Rahma Hospital
4 : Aljazeerah Hospital

Figure 3.2: Geographical map location of study sites

3.4 Bedroom Analysis of Jordanian Hospitals

For comprehensive analysis of the bedroom space distribution in Jordan, a total of four (4) hospital bedroom were randomly selected from wide district region of the city to fully analyze the space distribution of the hospitals in the cities. Typically, a hospital is expected to be made up of several forms of rooms with ranging category of consulting room, ER room, ICU room, maternity room, surgery.

The study focuses on the analysis of the forms of hospital bedrooms with respects to key factors such as; site, location, landscape, units plan and bedroom plan of the hospital. Table 3.1 below shows the various requirements that are expected of a hospital. Table 3.1 below shows the standard which is employed by hospitals as rolled out by the French red-cross society.

Table 3.1: Criteria for physical conditions of a standard hospital (Pierdait, 2006)

Parameters	Recommendations
Layout	Can be designed to have central space and rays or wings for specialized sectors. Main section of the institution should be differentiating from annexes and circulatory passages. To Layout should prevent excessive distances between the outs and in patients should be easily differentiated from out patients. A garden park should be provided for sound isolation and control in norms.
Plot Orientation	Stores and treatment areas should be sited at the North, North West or North East direction in patient rooms should be at the south or South East some can be places on the north so they can have as limited as possible access to direct sun light.
Dimensioning	Squared area to be occupied by a bed $70m^2$-$100m^2$ for 1 bed units.
Entrances	The hospital should have one main entrance. A Hall should be sited at the entrance to serve as waiting room for visitors and the size is usually determined by the number of the body. Passage path for patient, staff and visitors should be differentiated. Reception should have an area of $12m^2$ to allow for a supervision desk and clear circulation of air. Another entrance should be made available also through the reception with a slop entrance for admission.
Lightning	Operating rooms should have illuminating at about 1000 lx and a luminosity of 500 lx in annexes.
Ventilation	Provisions should be made for made for filtering, dilution and extension of air renewal should be about 15-20 volume changing for 1 hour.
Examination Room	36 Inch (91,44m) minimum room clear space to be provided along the full length of both sides of the bed, the examination tables, procedure tables, gurneys and lounge chairs
Treatment Room	If the examination rooms provided separately the floor area should be out 120sq ft. with minimum of dimension is 10sq ft. Rides of the bed and other and other statuaries should be about 3sq ft. empty space for using. Also to prevent are exam light, counter for places expand, hardworking fixture, cabinets for strong medium. Cubicle should be used to separate beds in multiple bed wards.

In addition to the requirement of a standard hospital, includes the DGNB system. The DGNB System is a building criteria certificating board whose sole objective is to ensure an outstanding building structures by evaluating buildings, its materials and ways of construction to conclusively determine its fulfillment for the varying sectors. The several various sectors of DGNB includes, technology, environment, life cycle impacts, and socio-cultural. Table 3.2 illustrates the various sections of DGNB with annotated points to each sections of the category. The appointed points inform the significance of different part of the building materials and its overall implication.

Table 3.2: German Sustainable Building Certificate Structure Application and Criteria (Miranda, 2013)

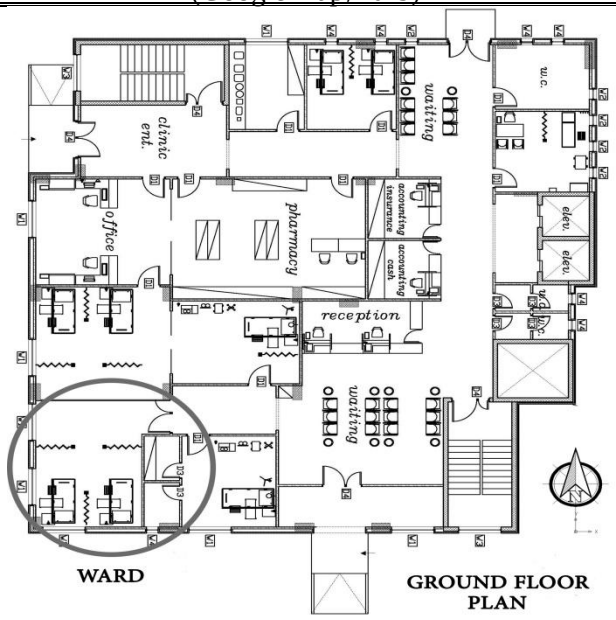
Evaluation Area	Criteria Group	Criteria	Criteria Points Achieved	Criteria Points Max. Possible	Weighting Factor	Weighting Points Achieved	Weighting Points Max. Possible	Group Points Achieved	Group Points Max. Possible	Group performance Index	Group Weight	Total performance Index
Environmental Quality	Life Cycle Analysis	Global warming potential	10.0	10.0	3	30.0	30.0	**178.5**	**200.0**	**89.3**	**22.5**	**DGNB 86.3% (Gold)**
		Ozone depletion	10.0	10.0	1	10.0	10.0					
		Photochemical ozone potential	10.0	10.0	1	10.	10.0					
		Acidification potential	10.0	10.0	1	10.0	10.0					
		Eutrophication potential	7.1	10.0	1	7.1	10.0					
	Global and Local Environmental	Local environmental impact	8.2	10.0	3	24.6	30.0					
		Sustainable use of resources	10.0	10.0	1	10.0	10.0					
	Resource Consumption and Waste Generation	Non-renewable primary energy	10.0	10.0	3	30.0	20.0					
		Total primary energy demand & proportion of renewable primary energy	8.4	10.0	2	16.8	20.0					
		Drinking water demand & volume of waste water	5.0	10.0	2	10.0	20.0					
		Land use	10.0	10.0	2	20.0	30.0					
Economic	Life Cycle Costs	Building-relate of life cycle cost	9.0	10.0	3	27.0	20.0	**47.0**	**50.0**	**94.0**	**22.5**	
	Economic Perf.	Suitability for third-party use	10.0	10.0	2	20.0	20.0					
Sociocultural Functional Quality	Health Comfort & User Friendliness	Thermal comfort in winter	10.0	10.0	2	20.0	30.0	**251.1**	**280.0**	**89.7**	**22.5**	
		Thermal comfort in summer	10.0	10.0	3	30.0	30.0					
		Indoor air quality	10.0	10.0	3	30.0	10.0					
		Acoustic comfort	10.0	10.0	1	10.0	30.0					
		Visual comfort	8.5	10.0	3	25.5	20.0					
		User influence on building operate	6.7	10.0	2	13.4	10.0					
		Quality of outdoor space	9.0	10.0	1	9.0	10.0					
		Safety and security	8.0	10.0	1	8.0	20.0					
	Functionality	Accessibility	8.0	10.0	2	16.0	10.0					
		Efficient use of floor area	5.0	10.0	1	5.0	20.0					
		Suitability for conversion	7.1	10.0	2	14.0	20.0					
		Public access	10.0	10.0	2	20.0	10.0					
		Cycling convenience	10.0	10.0	1	10.0	30.0					
	Aesthetic Quality	Design & urban planning quality by competition	10.0	10.0	3	30.0	10.0					
		Integration of public art	10.0	10.0	1	10.0	20.0					
Technical	Technical Quality of Building Design and Systems	Fire prevention	8.0	10.0	2	16.0	20.0	**74.0**	**100.0**	**74.0**	**22.5**	
		Indoor acoustic & sound insulation	5.0	10.0	2	10.0	20.0					
		Building envelope quality	7.7	10.0	2	15.4	20.0					
		Ease of cleaning & maintenance	7.1	10.0	2	14.0	20.0					
		Ease of dismantling & recycling	9.2	10.0	2	18.4	30.0					
Process Quality	Quality of The Planning Process	Comprehensive project definition	8.3	10.0	3	24.9	30.0	**188.6**	**230.0**	**82.0**	**10.0**	
		Integrated Planning	10.0	10.0	3	30.0	30.0					
		Comprehensive building	8.6	10.0	3	25.8	20.0					
		Sustainable aspects in tender phase	10.0	10.0	2	20.0	20.0					
		Documentation facility manage	5.0	10.0	2	10.0	20.0					
		Environmental impact of construction site & process	7.7	10.0	2	15.0	20.0					
		Prequalification of Contractors	5.0	10.0	2	10.0	30.0					
	Construction Quality	Construction quality assurance	10.0	10.0	3	30.0	30.0					
		Systematic commissioning	7.5	10.0	3	22.5	20.0					
Site Quality	Site Quality	Site location	7.0	10.0	2	14.0	20.0	**93.3**	**130.0**	**71.8**		
		Site location conditions	7.1	10.0	2	14.2	20.0					
		Public image & social conditions	1.0	10.0	2	2.0	20.0					
		Access to transportation	8.3	10.0	3	24.9	30.0					
		Access to specific use facilities	9.7	10.0	2	19.4	20.0					
		Connection to utilities	9.4	10.0	2	18.8	20.0					

3.5 Case Study 1: Islamic Hospital (Private Hospital)

Irbid is the second largest city in Jordan after Amman and has a population of about 1.3 million people. It is an entrepreneurial hospital in Jordan. Islamic Hospital is located at Rateb Al-Battayenah Street, Irbid, Jordan. The building was completed on the 12th of May, 2007. The total area of the entire hospital is about 2,720m^2, consisting of a total of six (6) floors with elevations and stairways. 65m to the West and 40m to the South. Selected sample was described in (Table 3.3).

The hospital takes admission both from within and outside Jordan. Specialized activities do go on at the hospital and has a very large labor force accepting staff in the excess of 300 comprising of the skilled and unskilled staff. There exists a certain level of vegetation close to the building providing shade and also serving as wind break. Parking space is spread across the face of front entrance. There is also an extension beyond the walls of the hospital before the main road where vehicles can be parked.

Table 3.3: Illustration of Islamic Hospital

Islamic Hospital	Explanation
 **Site plan** (Google map, 2019)	- The building is a single structure that has all its sectors in one. - This way, the rooms in the building receive maximum daylight and proper circulation of fresh air is also ensured. - At the frontal entrance, there are the stairs in steps and also the pathway for those on wheelchairs to pass through. - There are trees close to the entrance and at a garden close by. This provides shades and also eliminates stale air.
 **WARD** **GROUND FLOOR PLAN**	- There are doorways at all sides of the building for easy access. - The base floor is some 0.8m above the ground surface. - The offices for receptionists are close to the entrance with those of consultants some distance away.
 **Front Elevation**	- There are 2 general wards in basement floor, the male ward consisting of 12 beds and the female ward having about 16. - The middle floor is where the offices are and also an extension of the store. - The topmost floors are where the Intensive care units is which is extension of 2 beds linked to the base floors by elevator.

1. Choice of site

The hospital is located in moderately populated vicinity. There are clusters of houses but the ways in which they are built gives way for the proper exchange of air and prevailing wind is not disturbed. An artificial garden exists close to the site that consists of greens that allows for view through the entrances and corridors in the eastern and western direction with easy access to the building where the general patient ward is. Even with the presence of garden, there is not much trees and shrubs with the garden consisting predominantly of grasses.

2. Location (Orientation)

A major flaw that exists in the construction of building is that the long sides of the buildings face the east west direction. This way, direct rays of sunlight find their way into the rooms and this leads to increased ambient temperature. This is not to say some others that adopt the North South orientation do not experience heating up but it's usually reduced.

3. Landscape

Green grasses are present at the hospital in gardens that allows patients to enjoy natural views that will aid the healing process. Close to the main entrance a few meters away from the doors are large trees that rarely dry up. They provide a clean bill of fresh air and ensure clean breezes after the sun goes down.

4. Courtyard

Courtyards are not present at the Islamic Hospital because the building stands on their own with a serrated rectangular shape. There is no form of interaction between buildings creating no form of garden or natural sight for positive distraction.

5. Unit and floor plan

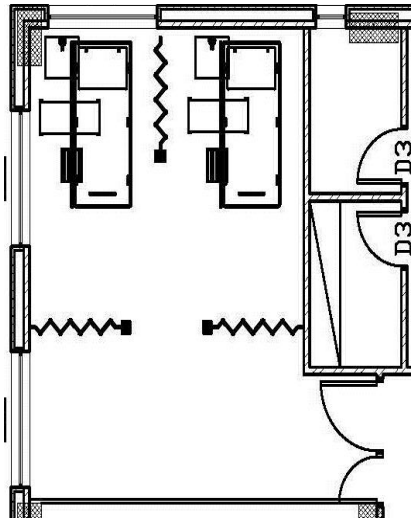
The section of the hospital building that does not hold patients is designed in such a way that rooms are placed parallel to each other and the central position acts as the waiting area. This sort of design is simple and not cumbersome. Therefore, adequate lighting is ensured in the day and cross ventilation is not inhibited either.

A major concern is in the fact that there is a great chance that the transmission of airborne disease will be swift and rapid since the wards share a common waiting area.

6. Bedroom plans (Ward)

The sort of bedroom design adopted here is such that allows the structures to be closely knitted to each other. This thus interferes with the flow of air and natural lighting. Even though this has made possible the proper utilization and management of the little spaces. The mode of construction has made different sectors and units compact and as a result generating noises due to the activities of human going on in there.

Table 3.4: Ward spaces in Islamic hospital

Ward	photo	Remarks
 Two bed room		- The ward is designed to hold 2 patients (beds), while thick clothing is used as curtain to afford some level of privacy. - There is controlled lighting system and ventilation is allowed through the window. The high level of artificial light provided to act as support at night. - Placement of state main in the hospital treatment room should be specific especially.

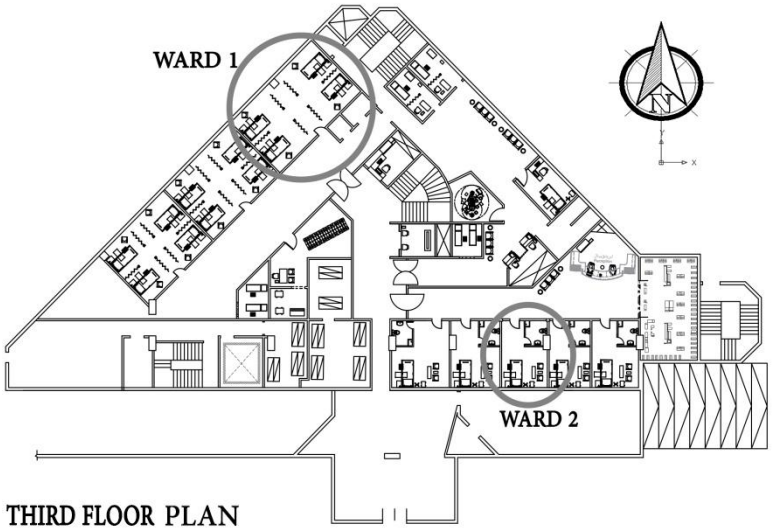
3.6 Case Study 2: Aljazeerah Hospital (Private Hospital)

This is also a private hospital in Jordan. Aljazeerah Hospital is located at the metropolitan city of Amman at Centre Al Jazeera, Haneen Bin Isac Street 8 on a total area of about 3,000 m^2. Consisting of a total of five (5) floors the building is a little over 14 years old as it was built on the 17th of March, 2005 and the plan that is adopted by the hospital is a unique triangular shape with the central area affording it enough space for gardening purposes. Selected sample was described in (Table 3.5).

This hospital affords car drivers with quick and easy accessibility via its main door. Free spaces can be easy to come by both at the front or the rear portion of the building. This control has a better and advantageous control of HVAC system by creating a ventilation pathway which is synced with the natural air. The windows in each room of the building are wide enough and only light curtain materials are placed over them.

The impatient wing is distinctly differentiated from the outpatient wing at the opposite wing of the hospital with the administrative block located at the midline.

Table 3.5: Illustration of Aljazeerah Hospital

Aljazeerah Hospital	Explanation
 **Site Plan** (Google map, 2019)	- The layout of the building is similar to that of Islamic hospital. - The parkway is to the front and sides of the building. - There are also trees close to the entrance. - This provides shades and also freshen the air in the hospital environment.
	- The structure is sort of unique in that it takes a shanty curve at both sides to meet up at the rare. - A long waiting room exists at the left wing of all floors. - Placement should be specific. This will allow easy movement of people and ensure that activities are rendered in no time.
 **Front Elevation**	- Most of the rooms here are at the rare portion of the building. - The 4 bed rooms in this hospital are about 10 while single beds are in excess of 15 spread across different levels of the building.

1. Choice of site

The Aljazeerah hospital is located in a community with sparse population that allows it a large expanse of land. Because of this, the sides of the hospital are field with lush leys that allows the prevailing wind from a nearby river to flow through offices and wards. Green vegetation lies to the east of the building. The buildings that are constructed here are low level houses. The hospital is sited relatively away from the main road, also, critical ward like ICU and the pediatric wards are sited in the uppermost section of the hospital.

2. Location (Orientation)

The major section that holds the inpatients and the outpatients are erected in such a way that thee longer facades are placed to cross part with the rising early wind. The verandas shade offices from receiving hot temperature, with this, a moderate level of natural lighting is still experienced in the rooms.

3. Landscape

Coupled with the flowing river in the neighborhood, most of the land in this area is fertile, and as a result, green vegetation is easily sighted in and around the hospital. Small grasses ate however common than the taller ones. Since the longer facades of the hospital building is facing the water body, the wind reaching the wards may be some worth too strong for patients, and as a result, the trees that are erected serves as wind break. The tree also traps sunlight and prevent heat load from piling up in hospital buildings.

4. Courtyard

The buildings within the hospital are arranged without courtyards and H-shaped forms that not allow for intermediary spaces and it's not hence creating gardens that buffer noise levels and provide for good views. Noise control has not been greatly enhanced through these spaces that absorb sound from other departments. The courtyards also help in trapping wind for good ventilation..

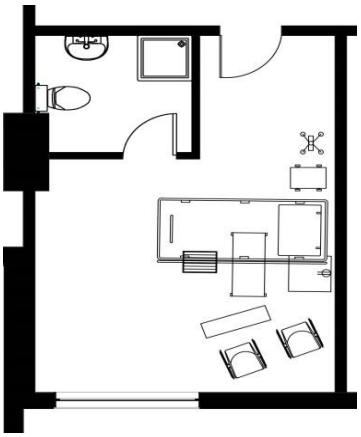
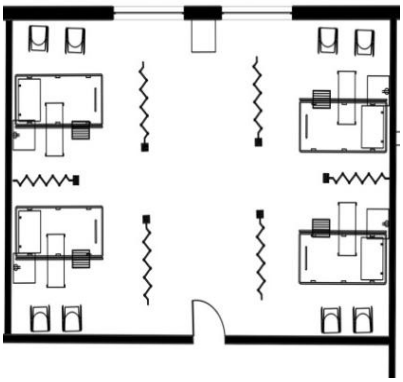
5. Unit and floor plans

The section of the building that does not hold patients as its waiting area as the first unit which one comes across before heading towards opposing rooms with single banked floor plan. Most of the offices which are located at the topmost part of buildings are open.

6. Bedroom plans (Ward)

Just as ample space is provided for the construction of a hospital, this has reflected in the open form of arrangement employed within the hospital. The different sections and units are at some distances apart. The presence of trees in between sections allows for the capture of sounds and reduces the noise level that is generated. The hospital units have been arranged majorly with long facades facing East West so as to capture more wind into the building for thermal comfort.

Table 3.6: Ward spaces in Aljazeerah hospital

Ward	Photo	Remarks
 One bed room		- This is a single patient ward with ample space. - The extent of ventilation is appreciable with curtains also fitted to regulate the level of lighting during day time. - The bedroom is about 18ft long and 15 ft. wide. - There should be more spaces to extend through the length or rooms.
 Four bed room		- This figure shows a typical 4 bed ward at the hospital. - The window fitted here stretches through the length of the room. - With this, minimal level of artificial lighting is provided through the use of LED bulbs. - There is however little amount of space available to visitors within the ward as most ground space is covered by beds. - The hallway is designated as waiting area in the hospital.

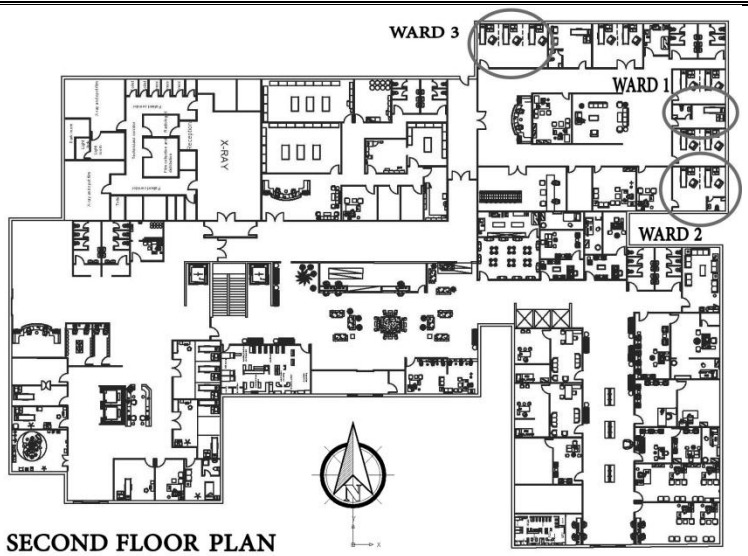
3.7 Case Study 3: Princess Rahma Hospital (State Hospital)

Princess Rahma hospital was built on the 23rd of February, 1995. This is a public healthcare service center located at Zaki Al-Tall Street, Irbid, Jordan. The structure on ground here consists of a compact unit with diverse sections feeding through a particular section and occupies a land area of about 10,540m^2. It is significant to mention the floor consist of 4 elevation sections as described in (Table 3.7).

The architectural design of this hospital is a great masterpiece. Enough space is afforded to the building design that is allows for the creation of small pieces of gardens at the entrance point. This garden serves aesthetic function and the inpatients can also enjoy the luxury view of lush leys which will aid their healing process.

Provision is made for car park at the west side of the building.

Table 3.7: Illustration of Princess Rahma Hospital

Princess Rahma Hospital	Explanation
 **Site Plan** (Google map, 2019)	- There is ample of space in the hospital compound with segments carved out got little flowering and gardening. - A large deciduous tree is also available there in for both aesthetics, shade and replenishes stale air. - Additionally, private wards have balconies that add light penetration into the wards as opposed to the general wards.
	- Most of the inpatient wards are at the middle floor with others at the top. - The offices for the staff is scattered across all level of floors. - Emergency rooms are at the lowest floor as well. - In contrast to the recommended scenario where hospitality is advised to have 2 opening entrances, this hospital has a single major entrance at the front of the building and few other ones at the sides.
 **Front Elevation**	- There are 9 4-bed wards, 16 2-bed wards and 10 single beds in the entire hospital. - The wards of equal number of beds are concentrated within a certain location. - The inpatient department at Princess Rahma Hospital has verandahs within their design that overlook the garden spaces that are located in courtyards. - Prominence has however been given to courtyards.

1. Choice of site

The hospital is sited in an open area with easy reach of wind. The natural condition is taken great advantage of the fact the layout employed in such a way that adequate cross ventilation and thermal control is ensured. Has is occurs, two major roads passes by the North and Eastern sides.

2. Landscape

Most of the land mass of the hospital is made up of built areas, pavements and road network with about 25% covered with trees and grasses. Small gardens are placed close to patient wards. This view of nature aids their healing processes and also ensures that cross ventilation between wards is possible. Trees and shrubs are also present to provide some level of privacies between the male and female wards. They also serve as buffers to the ambient sunlight falling on the hospitalized structures. They help to limit the reflectivity of the ground and therefore the transmittance from the skies.

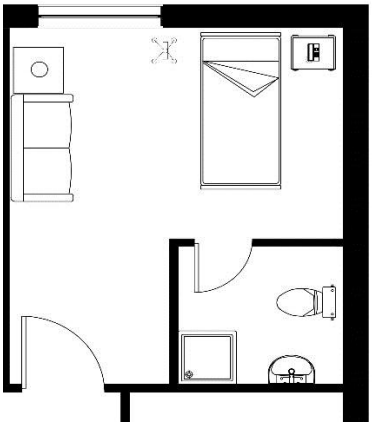
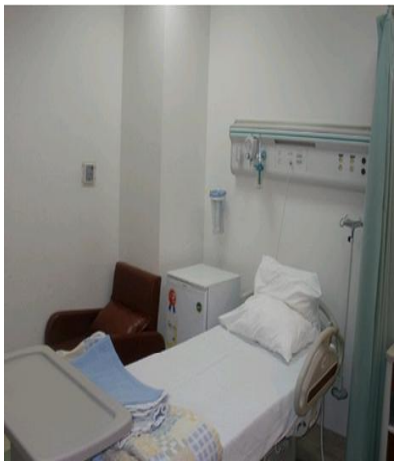
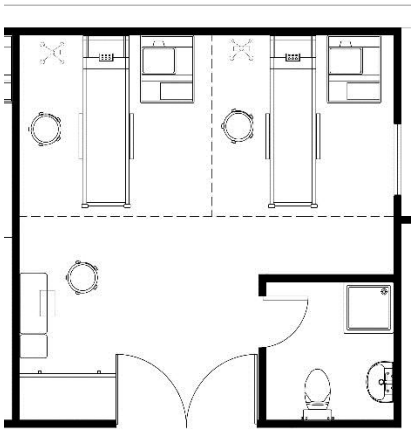
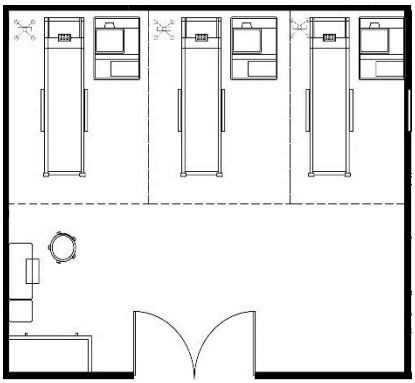
3. Unit and floor plans

The narrow plans of the H-Form however experiences good cross ventilation and air movement into courts with gardens. Re-infection has also been controlled through the siting of the units at isolated intervals across the site and the narrow plan further ensures that no building ventilates into the next hence reducing nosocomial infection rates. The outpatient building has single banked floor plan with rooms parallel to each other and a middle open space acting as the waiting area which ventilates upwards to permanent vents.

4. Bedroom plans (Ward)

The model that is implemented here is the settlement place making type which is arranged in the form that provides enough space for the buildings, thereby ensuring ample spaces between departments. Provision is also made for gardens and vegetated sites. This is a better management of sounds that are generated from within different sections. More audible conversations are allowed for and noises from outside the hospital environment are of low impact on patients hearing and healing. The hospitals are arranged in a way that the hospital is facing the North South direction. This is to allow for better control of ambient temperature while the diffusion of natural lighting into the building is not disrupted.

Table 3.8: Ward spaces in Princess Rahma hospital

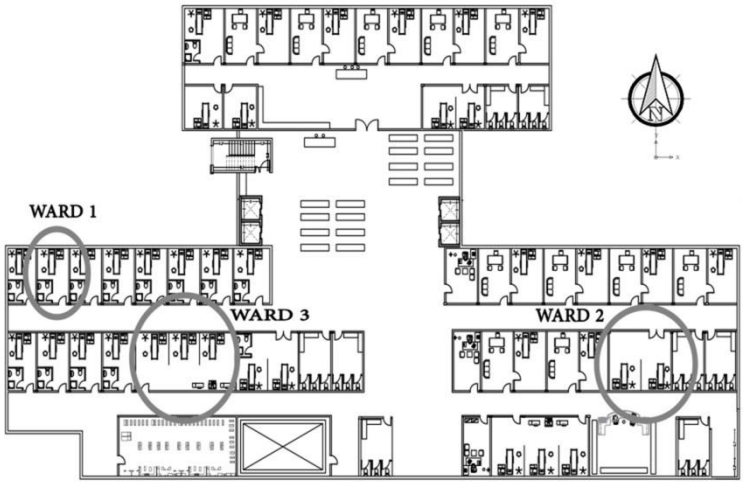
Ward	Photo	Remarks
 One bed room		- This is a single bed ward that holds a single patient at a go. - The level of lighting here is greatly controlled and rays of sunlight rarely find its way in. - Basic equipment's have to be which it absence in a treatment room may makes it substandard.
 Two bed room		- This picture shows a double bed ward at the Rahma hospital at. - The room is spacious enough to conveniently hold the two beds while also providing sitting area for the visitors. - There is also a window that is opened at internal to aid air flow and aid lighting.
 Three bed room		- Also at the Rahma hospital, this is a picture of a 3 bed arrangement in a ward at the east central wing. - The bed spaces are demarcated with draw able curtains so as not to disturb privacies.

3.8 Case Study 4: Princess Basma Hospital (State Hospital)

Princess Rahma Hospital is a government owned health institution that caters for the basic health needs of people and also carryout extensive administration of healing services and caring. It possess an elevation of three (3) building It is located at Faroud Haddad Street, Irbid, Jordan. The total land area is 12,350m^2. Princess Basma hospital was built on the 25th of May 1960. Selected sample was described in (Table 3.9).

The design of this hospital has paid attention to detail. Provision is made for double entrance at the front of the main building. The middle floor serves as the section for treatment and administrative functions.

Table 3.9: Illustration of Princess Basma Hospital

Princess Basma hospital	Explanation
 **Site Plan** (Google map, 2019)	- Trees and shades are at a premium here and winds do have an easy access through the building. - There is a central entrance at the front of the main building. It serves the major function of entry and exists by patients.
 THIRD FLOOR PLAN	- The front part of the building is where the reception is and the general waiting room. - The structure in the rare is where the children ward is with pathways lining across opposing bedrooms.
 **Front Elevation**	- In the hospital, there are 6 3-bed wards, 5 2-ded wards and 8 single bedrooms. - Intensive care units and spread across the hospital buildings. - The other openings to the sides of the building are for selected staffs.

1. Choice of site

The hospital is sited in the very busy surrounding of Irbid. This health center is placed in this region by the government to provide first hand medical services to people of Irbid and its neighboring cities. The hospital in which the hospital is located is previously heir marked for the construction of market. A new administration came on board and decided that part of the land mass be made available for the construction of a school. The school operates on Monday. This means that majority of the noises generated is within the hours of 8 am in the morning and 4 pm in the evening when their learning activity is on.

2. Location (Orientation)

The inpatient and outpatient wards are facing the North South direction. But because of the proximity of the institution to a welding workshop, the fume if gases generated from their machines tends to flow easily through the hospital buildings. Also, the limited flows of air do enhance the spread of air borne infections. The entire building is a 2 story structure and therefore the nearby buildings have tended to obstruct the smooth flow of fresh air.

3. Courtyard

Even though the land is limited in size, provision is made for a lofty courtyard which is centrally placed with low rising grasses. This space does not provide any sort of hindrances to sounds from conversations. Together with clear hearing, the view from this site aids quick healing and recovery processes.

4. Unit layout and spacing units

The general land mass is not fertile which accounts for the sparsely populated gardens that are present in the hospital surroundings. Deciduous trees are present in pairs. These trees serve as wind breakers and also reduce the intensity of sunlight that falls on the structures.

5. Unit and floor plans

The wards are placed not adjacent to each other but at diagonal in that distance of about 10m exist between each ward on the same row and a spacing of the same distance from doors across hallways. The center spaces are equipped with sitting materials arranged to line the walls of the wards.

Table 3.10: Ward spaces in Princess Basma hospital

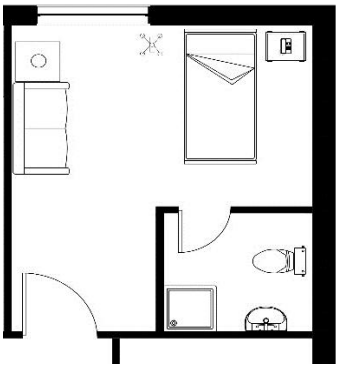
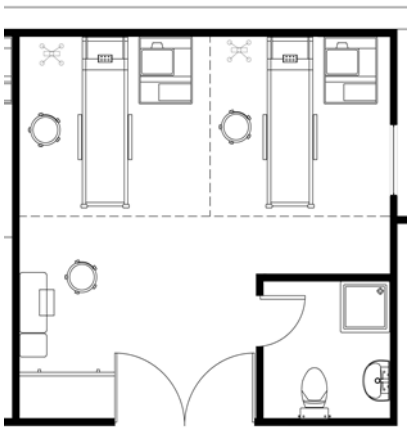
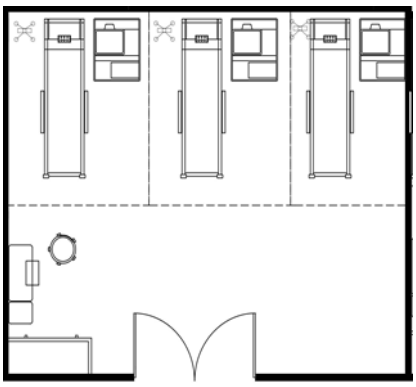
Ward	Photo	Remarks
 One bed room		- The single or private wards are designed to operate in a way that can allow for total conditioning of daytime temperature and lighting conditions.
 Two bed room		- The 2 bed wards are not really much in number but well equipped. - The windows are wide enough and at night, lighting is provided with the use of the convectional fluorescent bulbs.
 Three bed room		- This is a typical 3 bed ward for inpatients at the hospital. - The beds are arranged parallel to each other with no demarcation between any two.

Table 3.11: Comparison between sectional components of case studies

Wards	Islamic Hospital	Aljazeerah Hospital	Rahma Hospital	Basma Hospital
Treatment Room	At Islamic hospital, the treatment rooms are spacious but emphasis can be placed on proper placement and organization of other facilities there in.	At Aljazeerah hospital, the structure of the building allows the level of natural air reaching the hospital to be high and attention can Be paid to proper orientation.	The design of the treatment rooms here can be slightly improved upon. Provides enough opening with wider windows for proper cross ventilation and supplemented with fan and air conditioning.	Treatment rooms at the princess Basma Hospital are of different types and majorly determined by the number of beds. They are of 1, 2 of multiple bed wards.
Examination Room	Even though standards exist for which examination rooms are to be built, which is 36" along the length of the room. Here, it will be better off when emphasis are laid on components such HVAC system, flooring, window and lighting system.	Examination rooms at Aljazeera hospital will do well to have sustained plans for facility placement in spaces along and across rooms.	The spacing of beds at the Princess Rahma Hospital is about 24" which falls a little short of the standard recommendation Also, the idea multiple bed in a wards discouraged in this age for a maximum of 1-2 beds in a ward.	Examination rooms are located across different wings of the hospital for quick accessibility for health workers and other hospital attendants.
Reception Entrance	The entrance to Islamic Hospital is sited at the middle of the frontal part of the building. The size of this entrance can well be adjusted to meet the required standard while another of reduced size can be placed at a position where it will be visible to the hospital staff at the reception.	Much like that at the Islamic Hospital, there is a single central opening that leads to a pathway and also the reception. There exist a ramp and stairs for easy access.	A major entrance exists at the main hub of the building with clear access to people. This leads to a reception with staff to attend to patients on arrival. Another entrance however still exists to the west of the central one for specific uses.	Similar to that at the Princess Rahma Hospital, this hospital has a central entrance that makes provision for vehicle and emergency. Transportation to pull up at close proximity. The east of this main entrance is a small entrance for staff use.

3.9 Conclusion

The concept of healing goes beyond patients receiving any form of medication. The environment in which patients are posed to so that they can recuperate on a daily basis goes a long way in impacting the health of not only the inpatients, but also the out patients and staff. Previous studies have revealed the significance of humanization of spaces in the supporting activity design of architectural spaces revealing how space distribution has significantly improved health. To do this, several environmental factors needs to be considered such as noise, air quality, lighting condition, color brightness/dullness selection, furniture and fixture design in an attempt to provide an adequate health.

In this chapter, we have been able to discuss the typical health centers in Jordan using tangible case studies with respect to their structural components, high points and deficiencies. The chapter highlighted the major challenges encountered during the execution of this research is the unavailability of already published materials and even any form of online documentation as far as these specific hospitals are concerned and if any exist, we were unable to lay our hands on them during the entire course of this study. For this, all the information that was recorded in this chapter is either from the visual perception of the researcher or from personal interaction with people that are affiliated with the institutions in on capacity or the other.

CHAPTER 4
3D SOLUTIONS AND EXAMPLES FROM OTHER NATIONS

4.1 Introduction

A general wave of change is sweeping through all the important sectors of an economy and is subsequently entering into the health sector as well. The need for the use of sustainable materials in a healing center is bore of the fact that what do improve the health of patients goes beyond the services that they receive from the health practitioners. Some little components of the economy which are ordinarily over looked are usually beneficial on the long run.

This chapter focuses on the existing model of use in various health institutions of repute around the world. Some examples were selected and renovation work has taken place in the hospital over time were examined and how they tackled the problems using sustainable materials and comprehensive interior design and planning was evaluated.

4.2 Impact of Interior Design on Patient Health

From universities and hospital administrative settings to building contractors, engineers and upholstery and finishing companies, a great deal of focus was shifted towards setting up and providing a sustaining solution to the decreasing level of standard of patient rooms. The benefits of such improvement in the quality of patient rooms in hospitals which includes; reduced accidents, fewer infection rates, faster healing period and improved in and out patient satisfaction has been evident to builders/designers and architects on a daily basis.

The patient room goes beyond the place that holds beds and medical equipment's. It provides an avenue where the clinical staffs, in & out patients and visitors have virtually all they need for quicker healing. When putting in place a patient room, the first thing to be considered is safety. The safety of the people that come be contact with any part of it. It was previously documented that some of the most contagious disease sources are problems arising from medical services and diseases of hospital sources in the United States.

The hospital can easily put in place some simple measures to curb this. These include;

- A hand washing basin can be placed at the entrance of hospital bedrooms. That will contain an alcohol-based hand washer to encourage people to hide to the practice of washing their hands on a regular basis.

- When carrying out interior design of an hospital bedroom, the equipment's to be used for covering surfaces should be those that does won't retain stain and dirt, or better still, those that be easily cleaned should be used.

- Effective design should prevent falls and there should be easy access to bathrooms with non-slippery flooring materials.

Multi functionality of the patient room is also important. It should be afforded enough space. An average space of about 300sq ft (i.e. $28m^2$) is advised. Enough to allow nursing staff to move around freely around the bed when attending to patients and also engage in successful interactions with them and the visitors.

A personalized section can be created to allow patients keep hold of their personal items instead of scattering the all over the place. Objects they have attachment or emotional bonds with can also be displayed close to their bedside e.g. photo, flowers etc.

- The specifications that were actively in use in the previous era have now been outdated because of some factors which include;

- There is increased pressure on single wards/rooms because of the need to main same sex as opposed to mixed.

- Increases the transfer of transmittable diseases.

- Decreases eye contact between patients and clinicians

- The need for privacy when discussing personal medical information

- The major problems that are encountered in rooms are summarized into;

- Outdated HVAC system that does not function properly any longer
- Minimal/reduced access of wheelchair around beds, toilets and restricted movement of clinical reps around bed spaces.
- In ability of a moderate number of visitors to pay visitation to patients.
- Little ventilation spaces (windows and doors).

- A potential good design of choice should answer these questions;

- The sort of activity to be carried out in the room.
- Will it ensure maximum/optimum satisfaction of patients? What is the system of operation to be followed in number of nursing staff to patient?
- Points in the hospital where drugs and other medical supplies are distributed and stored.
- What must be put in place to assure that the safety of the patient is at the gore front of the decision making?

4.3 Sustainable Interior Hospital Design

The health sector is also experiencing the widely accepted use of sustainable materials when erecting its facilities. Architecture and builders alike are going 'green' and basically shifting away from the use of unsustainable materials to the use of the sustainable ones. According to Jeff Hull, the director of architecture at an Idaho based hospital; St. Luke's Hospital gave the methods which were followed by the building engineers in erecting the new set of structures at the center. They include;

- ***Reuse of used materials before replacement***

Tapping into the gift of nature is the clear idea which was exploited by the team. After discovering that a layer of about 5m to 7m of basalt rock existed below the first layer of soil in the site, they decide to find a befitting use for the natural resource. A reasonable idea was to use it in the filling of the landscape as opposed to transporting it elsewhere which will serve at a form of wastage and increased cost. The larger sized rocks were used for the decoration of the hospital campus while the remaining parts were used in the laying and leveling of pavements and the parking lots.

It should be noted that this way, the level of waste generated from the site is reduced, coat of construction is subsequently reduced and the natural aesthetic of the hospital is lifted.

- ***Provide garden and landscape***

The use of unsustainable materials in and around the hospital environment will reduce the negative impact which is usually associated with the use of sustainable materials. A rise structure for example will have people gain from good sight that surrounds the building from the top floors. Apart from seeing just roads, cars or even other houses, little time for sightseeing nature goes a long way to aid healing. This can be established artificially by making gardens, planting trees and even rocks. When trees for example are planted around a building, they helps get rid of the CO2 that are emitted into the environment and effectively generate O2.

St. Luke used a brilliant approach in its case. What they did was to obtain small sized trees, since large sized ones are not readily available in the entire community. They subsequently partnered with the educational institution in the neighborhood. These schools took to the caring and nurturing of these trees as an avenue to establish a learning program for their students. With time, these trees which they may not readily grow to the appreciable sizes are and not available for sale at those sizes.

- ***Higher dependency on daylight***

The healing process is supported by some components of the environment e.g. Light. Normally, when buildings are constructed haphazardly, there is reduced incidence of natural lighting in spaces and therefore necessitate for the use of artificial methods of lighting. St. Luke hospital followed this principle and ensured that windows are installed in patient wards and corridors are windowless where they link departments. When artificial light are at the level or intensity which are required, they are measured by fitted photo cells that monitors the readings of the daylight and tells the need to generate additional lighting. This way, energy is also saved as the light stays off when there is adequate natural light.

- ***Increased use of technology in regulating energy usage***

A commonly used light regulating system which is now in use in residential houses and commercial buildings are motion light sensors. With the help of motion sensors that are fitted in parts of the building make the light to only come on when there are no people within and energy is saved when they are not. As with the ventilation system because of the need to always keep the air in hospitals fresh at all times, hospitals generally install large fans which do require a large volume of energy to function. Instead of this, a ventilation system that is able to monitor and regulate the temperature in rooms to that level which is required is installed. With this, less energy is utilized.

- ***Extensive recycling program***

There was no general recycling program in the environment in which the hospital is sited. The administrative sector of the health center made efforts to convince and partner with recycling companies to create an avenue for deriving value from materials beyond cans, such as metals, plastics and even wood that come with deliveries and is incorporated into the system. Together with this, the entire staffs of the institution were sensitized on the need to have these programs in place and adequate provisions were made for these purposes.

4.4 Addressing Interior Environmental Quality (IEQ) of Hospital Bedroom Design Across the Globe

After the initial plan of a hospital building has been put in place, as time passes the increased acceptance of the use in sustainable materials in building construction and there superior advantages has always necessitated that some major or minor improvements be carried out in these buildings. Looking into how some major leading hospital in Europe has gone about these will give a good insight into how the hospitals in Jordan can warm towards. Some prominent examples are;

- ***Cleveland clinic, Ohio***

The hospital carried out a study to assess the level of noise reaching 7 bedrooms including patient rooms. With different number of beds, balconies and staff sections. From the conducted research, it was found out that the highest forms of noise that are generated are from alarms for notification, slamming of entrance doors and movement of carriages.

The designing and renovating company charged with the improvement recommended the following; addition of improved ceiling covers or tiles to absorb sound, installation of silicon coverings on windows and doors and also using quite types of shutters to replace the lousy ones. They recommended that the volume on telephones and pagers in the while building should be put off and vibration mode is recommended.

Sensitization of the extended staff on noise reduction, cancellation of late night deliveries, gathering & loitering and not keeping televisions and radio on when they are not in use.

Table 4.1: Design images of Cleveland clinic, Ohio

Cleveland clinic, Ohio	Remarks
 **South Elevation** (Google, 2019)	- The main campus of the clinic has 41 buildings in total sited on more than 170 acres of land. - It is regarded as one of the leading health institutions in the country and has staff strength of about 52,000.
 **Patient Ward** (Google, 2019)	- The hospital has a total of 1,200 beds as at 2016 and was concerned about limiting the impact of the noise reaching patient wards
 **Clinic Room** (Google, 2019)	- This is an educational medical center located in Cleveland. - Together with this clinic, 10 other regional hospitals and 19 other clinics are located in areas across the city of Ohio as well as other states. - They are all under the stewardship of the Cleveland clinic foundation.

- ***South Shore Hospital, South Weymouth, Massachusetts.***

In a new renovation that was executed in 2012, the 5th floor of the building which is the other poetic wing in question now have its nursing sections at the two ends of the floor. This way, nurses can shift ends with respect to their set of patients. They also can now monitor their patients better, hence improved patient satisfaction is ensured.

This new design also features single rooms with bed lined on a side and equipment which are installed in multiple locations within a ward and tend to hinder smooth staff - patient interaction are not stationed at a single position. The extra space afforded also prevents unnecessary stress in nurses, patients and attendants. Considering the fact that most of the patients in this wing of the hospital are usually aged and do require help a lot, they benefit from having friends and families close by always. Whenever the visitors decide to stay overnight, new couches are fitted in the rooms that are easily folded into beds for relaxation and sleep.

Finally, more lighting finds its way into the hospital since the previously fitted windows of 3sq ft. length are now modified to cover the whole length of the wall.

Table 4.2: Design images of South shore hospital, Weymouth

South Shore Hospital, Weymouth, Massachusetts	Remarks
 **South Elevation** (Google, 2019)	- At the south shore hospital, there are about 370 - beds. - The administration was concerned about the state of the hospital that was previously built in 1978.
 **Patient Room** (Google, 2019)	- A particular section of the hospital, the orthopedic section has bedroom suffering from overpopulation. - The nursing sector was stationed centrally and as a result, too distant from some bedrooms and daylight does not feature in some general spaces.

- ***Enloe Medical Centre, Chico, California.***

No sound controls and this reduce the level of noise generated; the movable equipment's that have joints are rusting away and were lubricated; notification for staffs are sent through pagers as opposed to the use of loud speakers got announcement. A new building was erected with the renovation and construction starting in 1999 and finished in 2012.

Table 4.3: Design images of Enloe medical centre, Chico

Enloe Medical Centre, Chico, California	Remarks
 **Front Elevation** (Google, 2019)	- This is a facility of about 298 – beds. - It was constructed in the early 1930's.
 **Maternity Room** (Google, 2019)	- Having lasted and standing the test of time and running into the early 20th century. - It was no brainer that major renovation was imperative. - The old building has features like small sized rooms, harsh lighting and absence of sound management system.

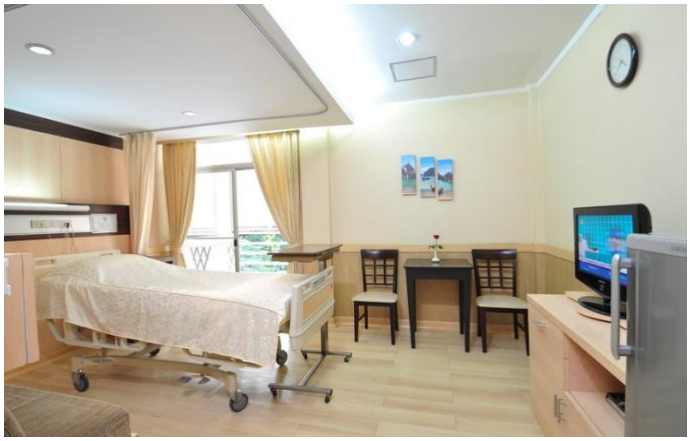
This building i.e. the Magnolia tower ensures ample spaces between hallway and rooms. This afford visitors the opportunity to stay around longer and not crowd the reception as dialogues and conversations that may arise from their interactions do not afford patients adequate rest.

The materials to be employed for use in flooring should be that with reduced noise coefficient, therefore they went for vinyl sheets as opposed to the softer vinyl composite tiles.

- ***Lee Memorial Health System: Cape Coral Hospital, Cape Coral, Florida.***

This hospital is a 291 - bed capacity hospital at the SW Florida and on a land area of about 442,000sq ft. The hospital management wanted to optimize healing in a sustainable way better the lives of the patients, staff and visitors alike, which will subsequently lead to increased satisfaction experienced by customers and speed up healing process.

Table 4.4: Design images of Lee memorial health system, Cape Coral

Lee Memorial Health System, Cape Coral, Florida	Remarks
 **Front Elevation** (Ross and Jackson, 2019)	- The environmental air became improved over the natural plant erection mounted outside the environment. - The architecture design contributes aesthetic beauty to the building.
 **Patient Ward** (Ross and Jackson, 2019)	- The interior design uses wood furnishing which is a sustainable building material. - The bright color improves eye sight brightness to the reception of the room
 **Ward Room** (Ross and Jackson, 2019)	- The interior light decoration of the ward room brightens the rooms allowing exchange of air to improve air quality impact.

In other to go about resolving this problem, the hospital management embarked on an elaborate plan to be executed in a "pathway to discovery" which will comprise the following;

- The provision of a natural garden, which stretches along a pathway that contains different lovely plants and flowers that, can be used for clinical rehabilitation sessions.
- Close to the delivery and women ward is a garden wherein people can take time out to relax and freshen up.
- A pond.
- Gymnastic exercises.

- ***St. Elizabeth Hospital, Appleton, Wisconsin***.

The St. Elizabeth hospital is one of the forefront leading hospitals in Europe. It is always conversant or paying attention of changes in the health sector around the world. When a fault was detected in the erection of the hospital building swift plans were put in place to rectify such problems.

For example, ceiling tiles were used in place of the convectional non sustainable ones. This type is known for its high noise reduction coefficient, the floor covering was changed from carpets to vinyl and the walls were plastered with a specially made sound proof material called sound acoustic. The doors in examination rooms were fitted with improved seals and blinds were used to allow for privacy.

Table 4.5: Design images of St. Elizabeth hospital, Appleton

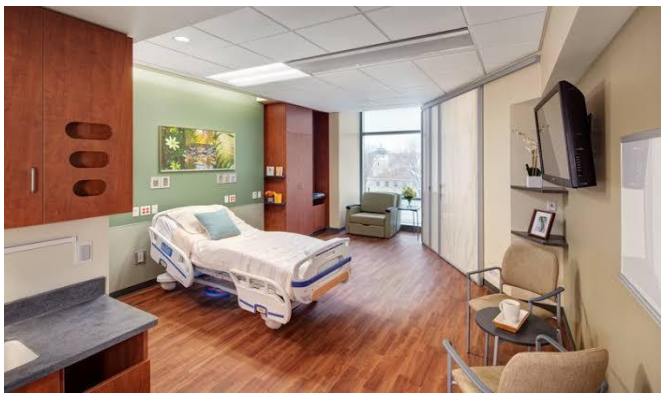
St. Elizabeth Hospital, Appleton, Wisconsin	Remarks
 **Courtyards** (Google, 2019)	- The fault in the earliest design at the hospital is in that there is usually a leak in conversations. - Noise is generated in the nursing sections that can be a perceived in the emergency wards.
 **Patient Ward** (Google, 2019)	- The management of the hospital saw a need to fix the problem by increasing the level of privacy in patient wards.
 **Patient Room** (Google, 2019)	- In other to properly find a lasting solution to the problem, the hospital looks towards changing the design by using sustainable materials.

Table 4.6: Influencing patient satisfaction through manipulation of the environment

Parameters	Remarks
Good Hygiene	• Use of impermeable surface coverings to allow for easy and effective cleaning. • Clothing materials should be avoided in places where patients are and at the diner or receptions. This way, stains can be greatly reduced. • The use of carpet tiles should be listed because of its ability to prevent sound absorption and also to reduce foot fatigue. The cleaning service providers should be taught how to go about its proper cleaning as well. • Angles where surfaces meet, to prevent the buildup of dust, it is advised to make such corners rounded. • Chairs to be used should be those that do not retain waste. Those that have gaps between the backrest and the seat are better as they allow dirt to drop to the ground for collection.
Communication	• The set of furniture to be used should not be too bogies or disjointed that it hinders the patients, staff and visitors from making direct eye contact. • Information and directives can be easily passed through the use of white boards positioned in strategic locations in the hospital instead of using written words on papers. • The general design of units should allow for effective travel of sounds between patients, staff and visitors.
Reception	• A spacious holding area should be provided for visitors so they don't feel too disjointed when they visit. • A mini pub can also be provided with meaningful gadgets like television, computer and internet.
Natural Healing Aids	• Engage the use of positive distractions, appropriate sightseeing of natural settings like gardens or other structures carved from nature e.g. rock as they create a form of calming effect on them. • Some display systems can be positioned in points in the hospital along the hallway and reception.
Staff Inclusiveness	• When implementing new designs, do endeavor to incorporate the staff of the institution both skilled and unskilled that will work there on a day-to-day basis so that they are committed and accustomed to the changes in the layout. • New installations and models that are not previously in use in ventilated areas and restrooms should have proper directives for use and staff should be a mastery of the facilities.

4.5 3D Model Designs for a Sustainable Interior Environmental Quality (IEQ) in Jordanian Hospitals

From the past, the practice that is accepted all over is the use of writings on book for documentation. But with the extent of incorporation of technology into our day-to-day activities, electronic register has been a faster, reliable and effective replacement. With this, records of patients can be accessed anywhere on the world when stored on the internet.

And even to ensure the decentralization of nurses work stations, computers are fitted at each bedside. This practice is assumed to have a great chance of evolving in the near future into the use of handheld system or mobile systems. All these processes will ensure the nursing staff is brought further closer to the patients.

The use of technological improvements in keeping track of supplies and inventory is also important. There is the need to utilize a central automated dispensing unit as opposed to storing supplies in room as there can be need for topping off a depleting stock is cared for in time. The issue of privacy is not one to be overlooked also, with increasing number of beds in a room; the level of privacy is naturally reducing. While the space afforded will conveniently take more than a bed in some 2-, 3- or 4-bed unit, the use of linen to create some kinds of partition is a welcome idea. The universal room setting basically reduces the extent at which they consider the acoustic and visual privacy of patients. This has also led to the debate of the need to initiate the use of more inboard toilets instead of outboard ones.

Most of the accidents in hospital bedrooms usually occur between the bed and the toilet. A bright idea is to introduce grab bars that will run through the length of the wall and ensure that the floor covering is not slippery at any time of the day. The distance between these two points is advised to be reduced as well.

While some hospitals allow family members of inpatients of visitors to rest or pass their time at the lounge, a better and more convenient model allows the use of sitting materials that can be suspended into bedding.

Table 4.7: 1 - Bed ward type

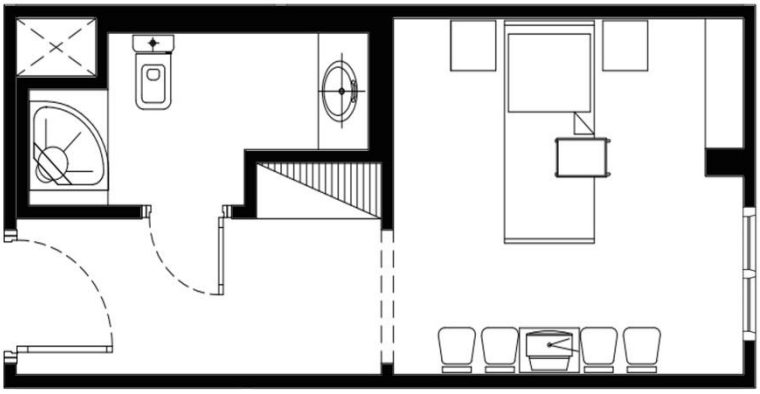
3D design (1 - bed)	Remarks
 Plan	- This shows the plans of a 1 bed ward with feature that make are installed to give it an edge over others from an unsustainable structure.
 View	- This image shows an overhead view of a typical 1 bed ward in a hospital with its restroom.
 3D- View	- This is a 3D design that shows the flow of air in and out of the room, daylight access into the room and artificial lighting.

Table 4.8: 2 - Bed ward type

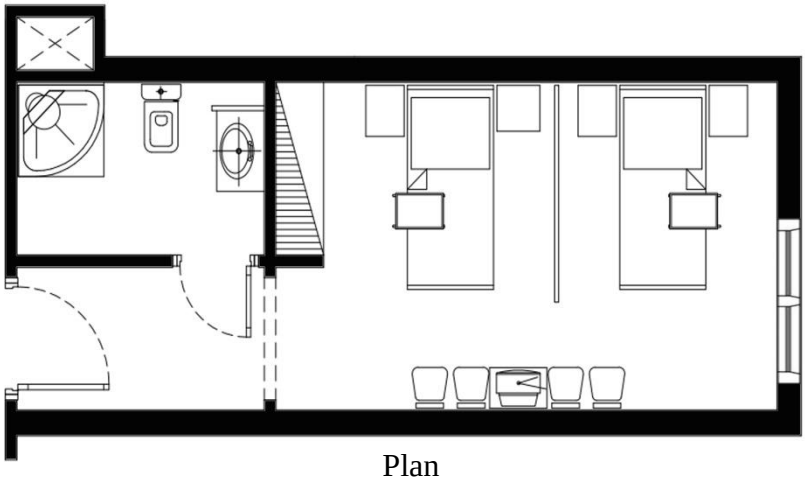
3D design (2 - bed)	Remarks
 Plan	- The image is that of a plan of a 2 bed ward with features that are installed to give it an edge over others from an unsustainable structure.
 View	- This image shows an overhead view of a typical 2 bed ward in a hospital with its restroom.
 3D- View	- This is a 3D design of a typical 2 -bed ward that shows the flow of air in and out of the room, daylight access into the room and artificial lighting. - The chairs are also arranged away from where they can hinder free movement if wheelchair of nurses.

Table 4.9: 3 - Bed ward type

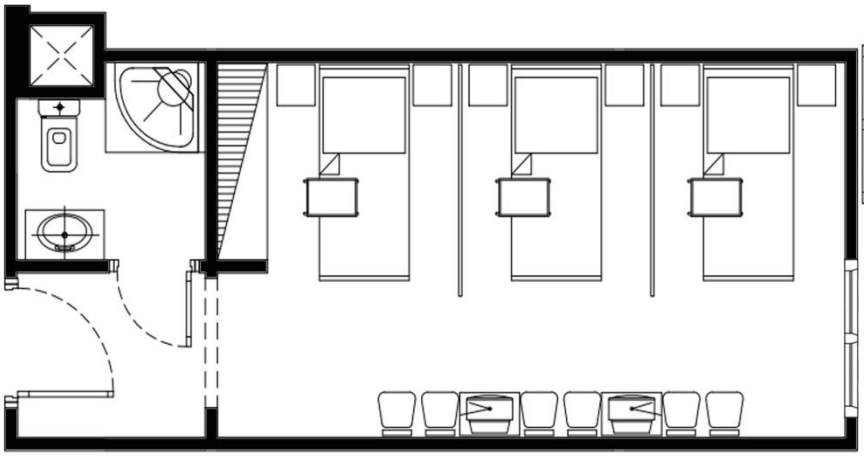
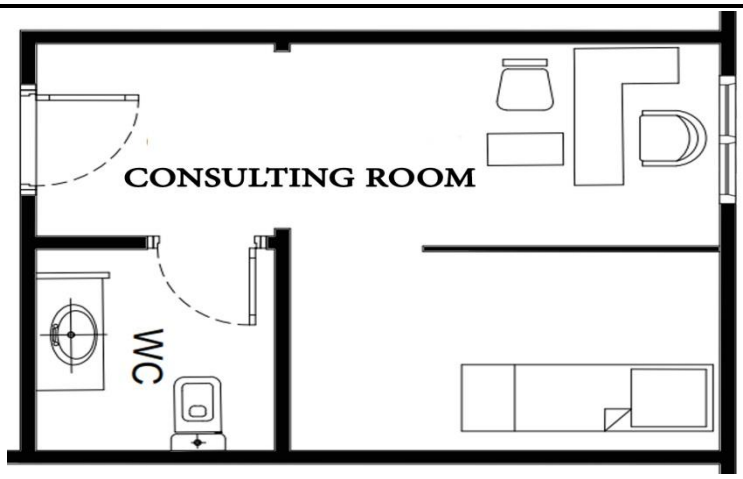
3D design (3 - bed)	Remarks
 Plan	- This image shows the architectural plan of a typical 3 - bed ward in a hospital.
 View	- This image shows an overhead view of a typical 3 bed ward in a hospital with its restroom.
 3D- View	- This is a 3D diagram of a 3 - bed ward with curtains installed to afford patients some level of privacy. - A computer system is also fitted to each bed for documentation and record keeping.

Table 4.10: 3D model design for a consultation room

3D design (Consultation room)	Remarks
 Plan	- This shows the plan of a consultation room with features that are installed to give it an edge over others from an unsustainable structure.
 View	- This image shows an overhead view of a typical consultation room in a hospital with its restroom.
 3D- View	- The image on the left is the 3D diagram of a typical consultation room showing windows fitted with movable curtain that can allow good flow of air. - A thick curtain is also placed between the bedside and the sitting furniture for privacy.

- ***Serenity in the environment***

When patients are in a hospital do not feel calm and assured in their stay in an environment, the healing process is slowed. In ensuring that they feel comfortable and unstressed, the interior design plays a major role in ensuring this. They can best accomplish this goal by having a clear sense of purpose of the institution and the profile of the patient, including have hands on information such as sight impairment, old age, mental instability or physical challenges. In ensuring serenity, the following should be phantom into the design;

- The material the patient is accustomed to should be used in designing.
- Appropriate color combination should be ensured as some colors can be offensive and can even interfere with the healing process in some people or even agitate them.
- Ensure there is adequate natural light entering into a room in daytime and artificial equivalent of such should be provided for the night time.
- View of the nature should be easy for people to sight from their rooms.

- ***Good Hygiene practices***

Some guides can be factored in the designing of hospital rooms to ensure proper hygiene and satisfaction is followed;

- The finishing of spaces where regular activities goes on should be durable.
- Points and junctions where edges/surfaces meet are better detailed in such a way that it does not hold dust.
- Teaching people on the need to ensure cleanliness and how to better operate newly adopted features.

- ***Adequate ventilation***

The hospital is usually of a big structure that contains a lot of rooms and sections. Thus, if care is not taken in the planning process, the flow and cross ventilation in the building maybe inhibited. A good interior design should follow the following guides to maximize the direct flow of air;

- Outpatients should be able to come into the hospital and leave through a path that does not necessarily make them come across inpatients in critical state of health.
- The pathway for the outpatients and visitors should not be difficult to locate.
- The route through which food, medical and clean supplies pass should not be the same as that through which waste and other disposables pass.
- Movement of dead bodies should be away from where the patients can sight them
- A stair or elevator system should be set aside for delivery and maintenance.

- ***Aesthetics***

This is not entirely different from creating a serene scene in the hospital environment. To give health institutions a facelift, it's good for its image and serves as an important marketing tool when the aesthetic value is properly managed. It also helps to improve staff morale and healing nature. The following should be carefully considered;

- Increase the use of natural/environmentally friendly materials.
- Artworks and designs should be used in fitting areas.
- Appropriate colors should be selected in different sections of the hospital.
- Spacing in each rooms and pathway should not be neglected.

- ***Other considerations to be observed may include;***

- Flooring of the entire building especially where patients have access to should not be slippery.
- In addition, floors should be easy to clean and made of durable materials.
- Outer layer of walls of paintings should be that which does not retain dust.
- Any ground openings should be closely covered in case of plumbing and wiring works.
- Doors should be either sliding or swing type, and should be lubricated when signs of rustiness are noticed.
- Curtains should be fireproof and easily maintained.
- A mini locker or side table should be provided in wards.
- A means of communication or a device for reaching the medical staff should be provided in each bedside.

4.6 Conclusion

Some people have well-argued that hospitals may be the most sophisticated forms of buildings. Moreover, since the hospital houses within itself several forms of sectors and while a lot of services are rendered theirs in. These services may range from scanning/imaging and laboratory clinical to surgery among others. This goes along with the primary function of establishment which is attending/provision of basic medical assistance to in and out patients. The diverse form of services which are offered here account for the constant need for change and upgrading in the set of buildings, design and orientation in each sections. This upgrading and renovations could be associated to their mechanical, electrical or telecommunication systems.

In a normal setting, the administration of a hospital will consist of a board of members, owners inclusive and some key members do oversee important decision making. The same applies when a decision is to be taken on adjustment and improvement on the design of rooms in a hospital, only that it is even better and effective when there is a representative from the staff, inpatients, outpatients and visitors at such meetings.

CHAPTER 5
SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1 Summary

Scientists have been carrying out research on how to new design plans in hospital environment affect health and safety patients. To eliminate the possibility of unnecessary accidents and injuries in health care centers basic changes have to be done in the traditional and physical settings of the environment, by providing the necessary aids to help align the management staff with the equipment's and technologies that will assist them in rendering their services diligently in an enabled condition. Right from time, the construction materials together with designs that are employed in part do little to cater for the impact of the set of individuals that come in contact with the facility.

Psychologists have stated the importance of the external environment to man to a large extent of effect on one's health security and performance. Before a successful and effective interior design can be implemented, it is paramount to understand the level of interaction between man and the state of its environment in which they live and work and will most likely exist peacefully when placed in an environment that is well designed and organized. On the other hand, they usually function in a negative way when the external environment components are haphazardly arranged.

If during the planning of a building, some latent factors are not accounted for, they may end up finding a suitable platform to cause havoc. These factors are usually inactive in the system for a long period of time, but will combine with other elements to carry out their destructive actions. The good news is that they can be identified and appropriate solution can be provided. These hidden factors include;

- Badly organized facilities.
- Wrongly stated procedures.
- Poor safety system.
- Wrongly placed equipment's.
- Staff inadequacies.

A good example of latent conditions interfering with proper clinical efficiency is a poor lighting model employed in a section where drugs are dispensed which can lead to error in the administration of medication. To deal with this, measures that can be taken to tackle this situation are;

- Adequate staff numbers in stations.
- Sensitization of staff and other hospital users on basic operational procedures.
- Use of evidence based design to limit distractions.
- Improved positioning of movables and other supplies.
- Ensure adequate spacing in key operational areas.

With respect to the basic components of a hospital, some templates are made which are import and can go a long way to make designer arrive at a rich outcome. They are;

- Patient Oriented design.
- Adhering to the use of 1 bed rooms.
- The rooms should be spacious enough to accommodate visitor's i.e. family and friends.
- The health profile of the patients should be considered.
- Directions and inscriptions of pathways should be created within the hospital for easy navigation.
- Safety.
- Planning of structures i.e. non slippery floors and the use of supportive installations to prevent fall.
- The HVAC system should be up and running and maximum control should be exercised on it to limit the spread of communicable diseases.
- Adopting the use of surfaces that do not absorb stains and dirt and can be easily cleaned.
- Alcohol based washer and sink should be provided at the entrance of rooms.

- Effectiveness
  - Ensure optimal the system of artificial lighting to complete daylight
  - Allow sufficient normal daylight into rooms
  - Noise control system should be installed
  - Efficiency

I. Proper sectional layout segmentation
II. Reducing potential safety

Over a long period of time, there has been an ongoing debate on either of 1 bed wards or shared privacy rooms in hospitals being the best practice. Researchers have provided clear line of view on the variables which are associated with both systems which such as cost implications, patient satisfaction and the subsequent effect on healing.

5.2 Recommendations

For parameters such as; controlling the spread of diseases and improved patient care, a 1 - bed room is superior to other forms and also when it comes to increased privacy and eliminating stress in the nursing staff. Sleep patterns in wards especially the ICU's are disrupted by abject electricity. Families and friends have always expressed some level of satisfaction when their patients are admitted into 1 bed room. They do respect privacy and a high level of comfort is usually felt, together with the additional attention they receive from the nursing staff and other members of the hospital management. For child bearing patients, a 1 bed room is also recommended. When single bed models are adopted, it is advisable to properly manage the cross ventilation with other wards or pathways so that infectious diseases can be contained and this can only be ensured if the room is usually tightly sealed.

Flexibility of design is another point that should be taken into consideration in the plan of a hospital. A sort of design that can be easily adapted to changes in the structural demand of patient is highly advised. Health care service is also improved when the medical personnel can make consultations. This is possible when the patients are increasingly satisfied and the periods of stay of patients are reduced.

For ICU's, the recommended models are those that cater for the following are advised;

- Number of beds, single bed is advised.
- The position of the bed should not prevent access by nursing staff.
- Alcohol based wash hand basin should be provided.
- Tidy waste disposal system.
- Optimum natural lighting.

In a previous research, when a sample of nurses were asked what their greatest form of distraction was, they listed, badly organized work stations, disturbances and distractions from family members and visitors, difficulty in getting drugs from pharmaceutical stores, excessive crowding in work stations, insufficient equipment's in work place, misplacing of equipment's, noises from physician alarm and announcements, problems related to documentation among others.

As it concerns organizational problems, the nurses complained about; insufficient spaces in locker room, stores, shower, foil room and other administrative sections.

Operational design specifications that can be used to tackle the problem of possible rise in activity failure include;

- Automation of important tasks.
- Installation of hardware to prevent injuries and accidents.
- Design should be scalable, flexible and adaptable.
- Lift the general standard.
- Prevent unwanted sounds.
- Limit stress level in staff.
- Carry patients and visitors along in structural designing.
- Increase visualization between patients, staff and visitors.

Noises that are generated within the premises of the hospital hinder smooth communication processes, impede learning and education processes, diminish. concentration and increase/contribute to stressors and tiredness.

When such unwanted sounds reach the bedroom of patients, it interfere with sleep time and hence, their comfort ability.

The room walls that serve as partition between subsequent rooms should be insulated with air spaces. The mechanics, plumbers and electricians should make use of materials that will generate low sounds. These materials have the ability to dampen noises whenever they are created. Carpet is conventional to rooms but may be restricted to hallways in some cases as with its advantages, they also do require regular cleaning which do generate noises when the vacuum carpet cleaner is used. Instead, rubber can be used as flooring materials in rooms. Sound absorbing ceiling materials was also installed. Paging and call alerts were received via vibrations as well.

The concept of visibility was established by Florence Nightingale as the proposed that when nurses have close observation of patients, the quality of nursing services rendered is improved. Avenue should be provided where nurses can monitor patients constantly without waking them or creating noise from door opens. Optimum lighting can be ensured by making wide window openings in rooms that can be fitted with shutters also allow for daylight penetration.

A small treatment sections can be created close to the entrance, the visitors can be seated close to the window without disturbing airflow, and a bedside desk is fitted with computer having internet connectivity.

Investing in the health care sector is important to keep the hospital

Up-to-date and in vogue at all times. Automatic systems can be employed and this can come in different forms which include; record keeping, new bed forms, bar-coding etc. the incorporation of technology into the daily activities of hospital will ensure efficient and faster delivery of services. Fatigue should be properly managed in nursing staff to minimize the effect from slipping into the result derived from man personnel. It does have a telling effect on the mood, alertness and physiological fitness of people. This can be combated by reducing the number of hours in which an individual work and also encouraging the use of technology in different practices.

5.3 Conclusion

The idea of sustainability is now being married with the concept of Evidence Based Design when renovating old buildings and erecting new ones. The health sector is picking the right to associate with the use of sustainable materials in its structures and physical environment. The impact of nurses in achieving a befitting hospital design in any form of hospital administrative setup should not be underrated. It serve all well if they are involved in the planning, testing and evaluation of wards and also in the use of new technological installations to ensure adequate usage and that the desired result is obtained in terms of rapid healing in patients.

In few years to come, hospitals are expected to adopt to the changes in the use of materials and adoption of different interior design models when they are to meet with the changing market demand. When the administration of an hospital subscribe to the idea of going 'green' in design and renovation plans, a glaring outcome will be noticed in patient satisfaction and healing in general.

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