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GUIDELINES FOR HEALTHCARE DESIGN IN MOZAMBIQUE

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ABSTRACT

The network of healthcare facilities in Mozambique is made up of facilities that are old and do not meet the current healthcare needs of the country. Many facilities have already existed well beyond their useful life of, with approximately 50 to 75 years, and continue to operate without considerable maintenance. The access to care is very low. According to the Ministry of Health, the ratio of population at the primary level of care delivery (health centers) is an average of 17,000 people per each healthcare unit and for the secondary level (district and rural hospitals) is 501,000 people per each healthcare unit. World Health Organization recommends a ratio of 10,000 inhabitants per primary health (first referral hospital and health centers).

The population is growing very fast, with projections pointing to 23,700,715 inhabitants in the year of 2012, and 29,310,474 inhabitants by the year of 2020. Basically, the population will increase 23.7 percent in less than 10 years. The population is extensively immigrating from rural to urban areas, settling in peripheral unplanned ex-urban areas which are currently unserved in terms of

access to healthcare. Because most existing healthcare facilities are old, in a state of disrepair, and do not support state of art practices in healthcare, it is evident that future interventions in will require the use of new planning and design tools. The tools proposed in this thesis, "Guidelines for Healthcare Design in Mozambique" should meet the new healthcare design challenges considering the principal country's characteristics, limitations and its stage of growth.

Currently, urban areas (urban and peripheral areas) are experiencing an exponential population growth derived from migratory factors and high birth rates. These populations are settling in fringe areas around cities without any previous urban settlement or planning. These crowded and unserved settlements require new and improved healthcare facilities to ensure equity and quality of healthcare service delivery for the entire population. Additionally, there are higher expectations for improved health care from middle class population with better income which is also permanently increasing.

The secondary and tertiary levels of healthcare service delivery, including general and provincial hospitals, both referred for urban areas, is the only way of addressing the current and future needs of the population of these urban settings.

Thus, this study aimed to compose a set of design guidelines based on universal standards and best practices in healthcare design that can be applicable and sustainable in the current Mozambican reality, with major focus in urban settings, while improving the level of healthcare services delivered to meet (i) patients, staff and family needs; (ii) to ensure health and improve safety; (iii) to improve efficiency and effectiveness; and (iv) to provide building fabric design that positively responds to the diversity of environmental and social conditions of the country.

As result, the set of proposed guidelines bring the awareness and underlines two main topics. (1) A focus on how the overall site, surrounding context and infrastructures should correlate in order to build a healthcare facility that is integrated in the natural environment. A friendly instead of harming facility; and

(2) how to plan, organize and design a building fabric to ensure the current state of art in healthcare delivery while responding the overall healthcare needs of the population underlined on the main goals of this study.

The set of guidelines includes (a) site selection criterion, (b) security, (c) outdoor space use, (d) facility growth and adjacencies, (e) wayfinding – circulation hierarchy and signage, and (f) building form and scale. The expected outcomes of the implementation of these guidelines includes but are not limited to (i) reduction of hospital-acquired infections, medical errors and other adverse events; (ii) reducing patient stress and pain; (iii) providing settings that enable social support; (iv) provide settings that enable privacy and confidentiality; (v) providing settings that improve communication; (vi) optimizing care delivery to address staff shortage; (vii) maximizing the use of natural resources; and (viii) and building facilities that allow flexibility, adaptability and expandability for accommodating change over the time.

Future studies will be needed to address and carefully adjust the physical features of overall facility spaces including patient room, patient ward, exam and treatment room, intensive care rooms, nurses' stations and core services spaces, family accommodation spaces and public realm spaces, in order to make these spaces friendly and comfortable, which role will be to reduce anxiety, frustration, fear, angry, stress and dissatisfaction of patients, staff and family while in a healthcare setting.

DEDICATION

Dedico este trabalho de defesa a toda a minha família, em especial em memória do meu falecido pai António Sitanula Dengo e a minha mãe Maria Cau, que com muito amor, sabedoria e coragem me proveram de conhecimentos e determinação necessários para que eu pudesse alcançar mais este objectivo. Especial recordação vai para meu falecido esposo Cyr Bolanzi que sempre me encorajou de forma perseverante para que eu alcançasse os meus objectivos. A minha filha Nicole Adanna Bolanzi, vai a minha carinhosa dedicatória, pelo amor, alegria, encorajamento, atenção e muita distração que ela sempre me proporcionou e continua me proporcionando nesta etapa importante de nossas vidas. Muito obrigada a toda a minha família. Muito obrigado DEUS pela proteção, iluminação e encaminhamento.

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Last, but least, I am thankful for all my family and friends for their tireless support and encouragement throughout my time at Clemson.

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CONTENTS

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ACRONYMS

- WHO: World Health Organization
- HNS: Health National System
- HSSP: Health Sector Strategic Plan
- PESS: Plano Estrategico para Sector da Saude
- HVAC: Heating, Ventilating, and Air Conditioning
- PACS: Picture Archiving and Communication System
- RIS: Radiology Information Systems
- IMACS Image Management and Communication Systems
- HER: Electronic Health Record
- CPOE: Computerized Provider Order Entry
- CDSS: Clinical Decision Support System
- RFID: Radio Frequency Identification
- ADM: Automated Dispensing Machines
- EMM: Electronic Materials Management
- D &T: Diagnosis tic and Treatment
- OP: Outpatient department
- ED: Emergency Department
- MISAU –DI: Ministerio da Saude – Departamento de Infraestruturas

COUNTRY BACKGROUND

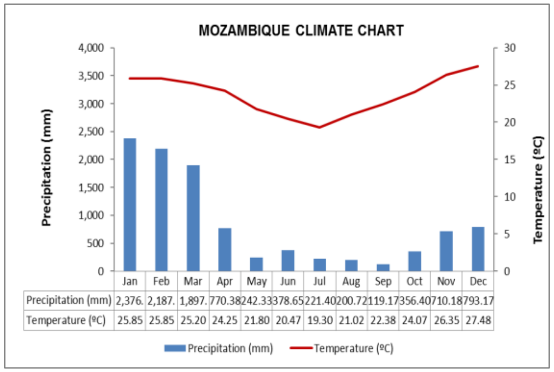


Figure 2: Mozambique Climate Chart, generated using data from 1999 to 2003

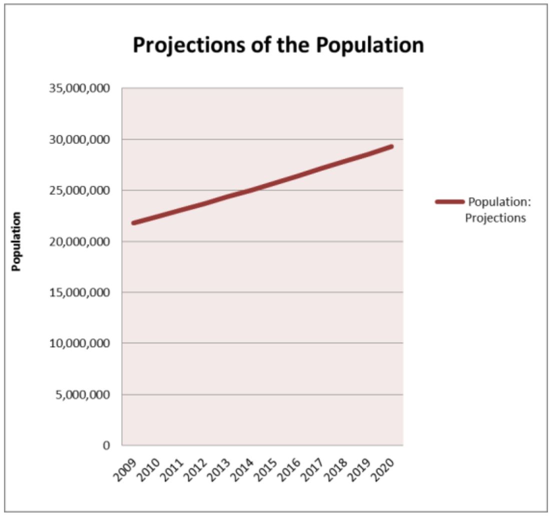


Figure 3: Projections of the Population of the years 2009 to 2020

There is a growing need for additional new healthcare facilities in Mozambique that respond to its particular climate, culture, population growth and needs. Mozambique is a developing country, located on the Southeastern coast of Africa. The East coast is along the Indian Ocean. The climate is tropical humid with two seasons: a hot wet season or summer from October to March and a dry cold season or winter from April to September. The annual average temperature is 24-25 °C (75.2 - 77° F); annual precipitation varies from 120 to 2375 mm depending on the region, with an annual average of approximately 850 mm; and 70.2 % of annual average humidity (INDE ENM 24, 25), (INE, Climate), (Kimmel). Due to its geographical location and environmental degradation, Mozambique is vulnerable to natural disasters such as cyclones, flooding and drought.

According to the projections for the year of 2012, the country has 23,700,715 inhabitants (INE - Direccao de Estatisticas Demograficas 12) and until 2020, the population will be growing to 29,310,474 inhabitants (INE - Direccao de

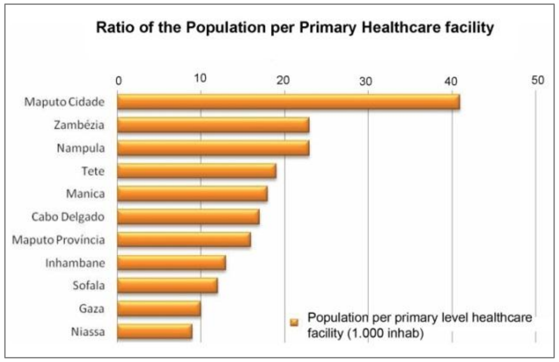


Figure 1: Ratio of the population per primary healthcare facility per province along the country

Estatisticas Demograficas 20). According to the WHO report, the ratio of the population per primary health unit (first referral hospital and health centers) is 15,800, which is still below the WHO's recommended ratio of 10,000 inhabitants per primary health (WHO 2009 3). According to the "National Inventory of Health Infrastructures, Services and Resources – Mozambique 2007 Report", the ratio of population at the primary level of the HNS is in average 17,000 people per each healthcare unit and for the secondary level it is 501,000 people per each healthcare unit (MISAU-INS 24).

Figure 2: Beira Central Hospital 750 bed-capacity, Beira Mozambique

Most existing healthcare facilities are old, in a state of disrepair, and do not support the state of the art practices in healthcare. Many facilities are almost 50 to 75 years old and continue to operate without considerable maintenance. Maputo Central Hospital, the country's largest fourth level healthcare institution was originally built in the early 1900's. It was built in two phases: the first phase was from 1900 to 1910 and the second from 1920 to 1950. From that period up to today, maintenance works, extensions, rehabilitations and adaptations have been taking place to meet the new care and technology needs and trends. The overall building archetype is characterized by colonial architecture. Based on the fact that most hospital buildings are old, some of them have exceeded their life cycle or are in an advanced state of disrepair due the lack of maintenance, it is evident that future interventions in this field will require the use of new planning and design tools. These will be needed to meet the new healthcare design challenges considering the principal characteristics and limitations of the country and its stage of growth.

Figure 3: Maputo Central Hospital, built from 1910 to 1950 – administration & outpatient block

Newer hospitals were built following up to today building design practices, characterized by colonial architecture, which includes mixed massive racetrack plans and double loaded corridors in the central hospitals; and pavilion plans such as single and double loaded corridors for provincial, rural, and district hospitals. Most of these hospitals include merely basic specialized services such as internal medicine, pediatrics, surgical, gynecology/obstetrics. The most specialized services

Figure 4: New Central Hospital at Quelimane is ongoing construction (600 bed capacity to serve 2'000'000 inhabitants)

including traumatology, infectious-contagious diseases and neurology are provided only at tertiary and quaternary level hospitals. A ambulatory care services include otorhinolaryngology, ophthalmology; dermatology and psychiatry are included in all hospital levels (MISAU 41, 42, 43).

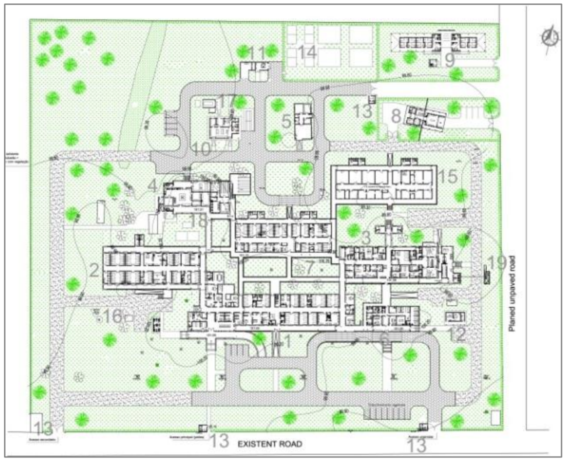


Figure 5: Rural Hospital in Chokwe. Pavilion design built in colonial epoch (1960's)

Figure 6: Woman & children population in urban and rural settings, Maputo

While newer healthcare facilities have been built in rural areas, very little attention has been paid to the design and construction of new hospitals in urban contexts. Currently there is a huge need for improved health care services to meet the population growth and higher expectations for better care services by a growing middle class population with better income. There is also increased need of specialized hospitals focused on gender specific medical practices and children.

The significant growth in the healthcare facilities network has been to date in rural areas, where a large number of small rural health centers have been built because the majority of the population is in rural areas. About 69.6% of the population lives in rural areas and 30.4% lives in urban areas (INE 9). From 1997 to 2007 the

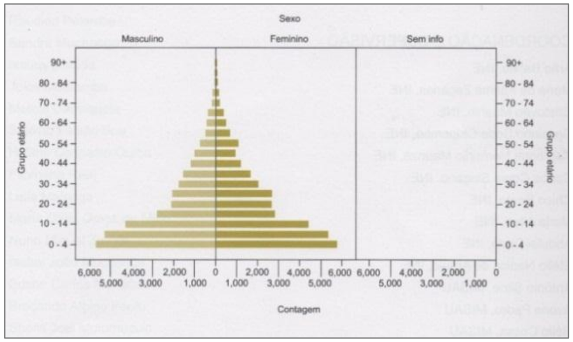


Figure 8: Population pyramid. Ages from 0 to 90+ (2008)

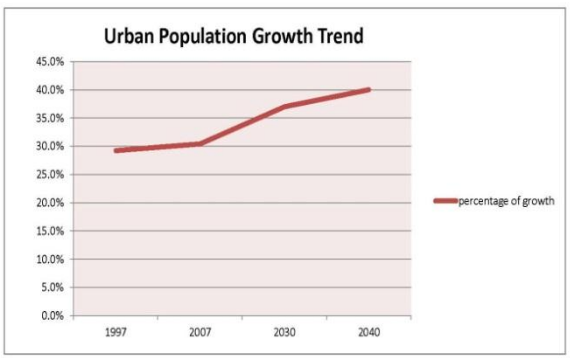


Figure 7: Urban population growth trend (from 1997 to 2040)

population of in rural areas increased 25% with an annual growth of 2.2% (INE 11).

Improvements in healthcare settings in the urban context had been less of a priority, despite a significant growth in the urban population. Migratory movements from rural to urban settings and high birth rates combined with falling death rates, represent a significant demand for expanded capacity in new facilities and improved care services delivery in urban fringe areas of the country. From 1997 to 2007 the population in urban areas increased 63.4% with an annual growth of 3.1% (INE 11). It is estimated that population in urban settings will have a growth of 37% and 40% in 2030 and 2040 respectively (INE - Direccao de Estatisticas Demograficas 6). The country is mainly characterized by young people, and a higher birth rate with exponential growth of the population as primarily consequence. To face this trend, the inclusion of Woman and Children Hospitals in the program for expansion and development of new infrastructures for care delivery and construction of these facilities through the country should be seen as a priority in the Governance program.

Future interventions in this field will require the use of new planning and design tools to supplement the regulations and standards currently in use and approved by the Government of Mozambique. The current regulation—"Caracterizacao tecnica, enuciado de funcoes especificas, criterios e mecanismos para a classificacao das instituicoes do SNS, aprovada pelo Diploma Ministerial no 127/2002"—defines the technical characteristics, functions and classification of healthcare institutions within the National Healthcare System (MISAU 3-70). It does not include guides for the technical design of facilities and infrastructures to provide healthcare. Thus, this study aims to compose a set of design guidelines based on the universal standards and best practices in healthcare design that can be applicable and sustainable in the current Mozambican reality, while improving the level of healthcare delivery.

This set of guidelines should enable designers in Mozambique to make a necessary transition toward best practice hospital design trends, to meet patients, staff and family needs, to ensure health and improve the safety of care delivery, to improve the efficiency and effectiveness in delivering care and provides a building fabric design that positively responds to the diversity of environmental and social conditions in the country.

The main goal of the NHS—sustainable health system—is conditioned by the improvement of healthcare infrastructures, which will ensure the universal access of care based on primary health care principles such as equity and quality of care for all patients, and the development of human healthcare resources capacity. The national health policy is based on principles of providing primary health care, equity and better quality of care for all patients. One of the pillars of this policy is the Health Sector Strategic Plan (HSSP/PESS), 2007–2012 in which the objectives of the health sector are laid down (WHO 2009 2). The expected main outcomes of this plan include but are not limited to (WHO 2009 2, 3):

- Increased access to health services towards universal coverage principles;
- Consolidation of the primary health care approach and integrated service delivery;
- Improved quality of services delivered at all levels of the National Health System (NHS);
- Guaranteed adequate and early response to emergencies and epidemics;
- encouraged community participation;
- Promotion of a collaborative approach with other health providers, among others.

These objectives are achievable yet depend in part on improved healthcare facilities design. New facilities need to meet the specific characteristics and needs of the potential users and their frequent diseases; the building plans should be flexible and functional for diverse circumstances such as: shortage of staff; adaptability to respond appropriately in situations of emergencies (natural disasters and epidemics such as cholera that requires large areas for patients isolation); design concepts that make possible their implementation with reduced financial resources both construction and buildings operation.

Social support should be encouraged through design that provides building space to accommodate family and patient support sessions and easy communication with staff. A collaborative approach and continuity of care are parallel goals achievable through improved information technology. Thus, health facilities should be able to accommodate changes in technology over time as well. The conceptualization of the "Guidelines for Healthcare Design in Mozambique", the main goal of this study, should take in account the goals of the HSSP and the requirements defined by the Government for Tertiary level of health care delivery services—specifically urban setting hospitals—since the country has a shortfall of specialized services (MISAU-INS 81, 82).

National Health System

In general the network of healthcare facilities is much diminished. Peripheral healthcare facilities are more disperse through the country. They provide primary care services and constitute the first contact with the patient. Thus, there is a need of enlargement and upgrading of the healthcare network to respond the most required equity level of care for the majority of the population.

Provinces	Acute Healthcare Levels						Primary Healthcare Levels						Total
	Hospitals						Urban H.C.			Rural H.C.		P.S.	
	CH	SH	PH	DH	RH	GH	T-A	T-B	T-C	T-1	T-2		
Total	3	2	7	8	27	6	25	48	31	143	612	365	1277
Niassa			1		1		1	2		9	25	98	137
Cabo Delgado			1	1	3		2	4	5	15	57	12	100
Nampula	1	1		2	4	2	2	1	5	25	76	74	193
Zambezia			1	2	4		1	9	4	16	89	53	179
Tete			1		3		2	3	1	16	58	18	102
Manica			1	3	1		1	3	1	11	58	4	83
Sofala	1				4		4	1	2	16	78	33	139
Inhambane			1		2				6	14	69	12	104
Gaza			1		4		1	14	2	10	51	45	128
Maputo Prov.					1	1	4	2	4	11	49	8	80
Maputo City	1	1				3	7	9	1		3	7	32

CH - Central Hospital DH - District Hospital HC - Health C.
SH - Specialized Hospital RH - Rural Hospital
PH - Provincial Hospital GH - General Hospital

Figure 9: The National Healthcare facilities network – I, II, III & IV Levels (2007)

The public health sector relies on a national healthcare network that is composed of 1,277 healthcare facilities of all levels (I, II, III and IV) representing 96% of healthcare facilities in the entire country; 15,877 beds distributed among the hospitals and rural health centers; and approximately 26.000 health workers (WHO 2009 3). In a total of 53 hospitals throughout the entire country, 5 are central and specialized hospitals classified as level IV of care delivery. They provide the highest level of specialized care in the country; 7 are provincial hospitals, classified as level III of care delivery and they provide the highest level of specialized service within the province; 41 are hospitals of level II which includes rural and district

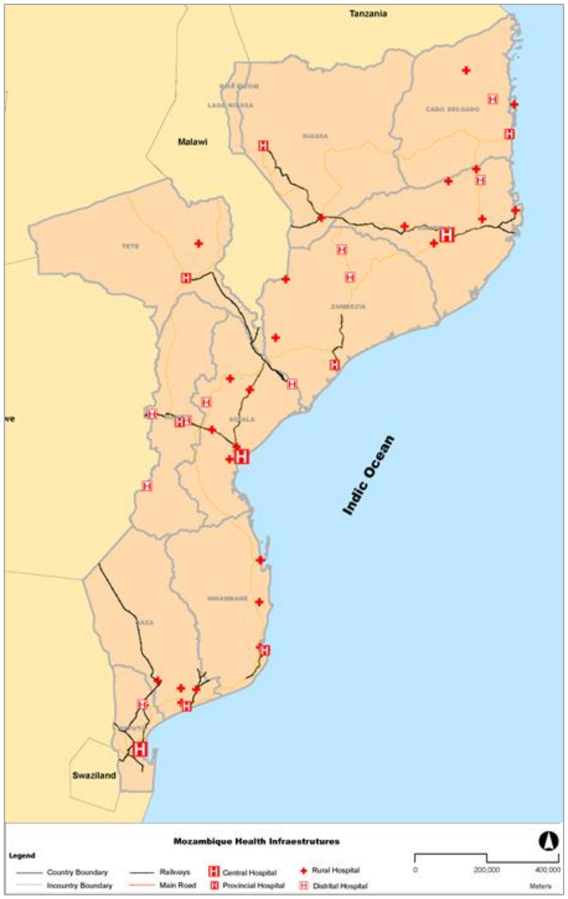


Figure 10: Distribution of Hospitals levels II, III and IV through the country

hospitals and they constitutes the first level of referral care (MISAU 36, 41, 48, 55, 60, 65) (WHO 2009 3).

The dispersion or unequal geographical distribution of first referral health care facilities contributes to a of lack access to health care mostly by rural population seeking care. Only slightly high than one third (36%) of the population has access to a health facility within 30 minutes of their homes (WHO 2009 4). Thus, the of expansion of the national network through construction of new healthcare facilities, strategically located—within the main settlements, cities, villages and peripheral neighborhoods—will help to reduce long distances that more 60% of the population has to travel to meet their needs in terms of medical care. The chart shows the quantity and distribution of the healthcare facilities according with the type and level of service delivered through all country provinces while the map illustrates the location of only the II, III and IV levels of care delivery.

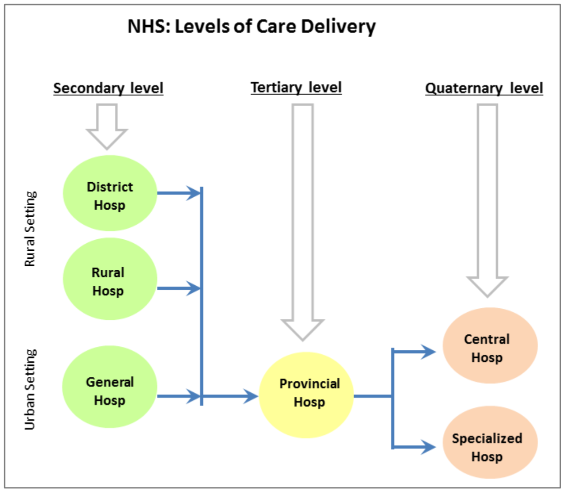


Figure 11: National Healthcare System: Levels of Health Care Delivery – II, III & III level hospitals

Health care services are delivered at four levels defined under the National Health System (NHS). These levels range from the basic primary healthcare delivered at most peripheral rural and urban areas to the more specialized care services located in urban areas. The quality of healthcare services delivered increases gradually according to the level of care and infrastructures available. Thus, the need to provide increased access and improved health services that will ensure better care equity, quality and safety for all segments of the population in urban settings—where the population is growing and the lack of specialized services has risen over the years—should be the priority of the health public sector in their national health programs. This reality should drive planners and designers to change current practices in healthcare facility design.

The **Level 1** is related to Health Centers and they serve most of peripheral regions and offers essential primary care services through 1224 health facilities, that

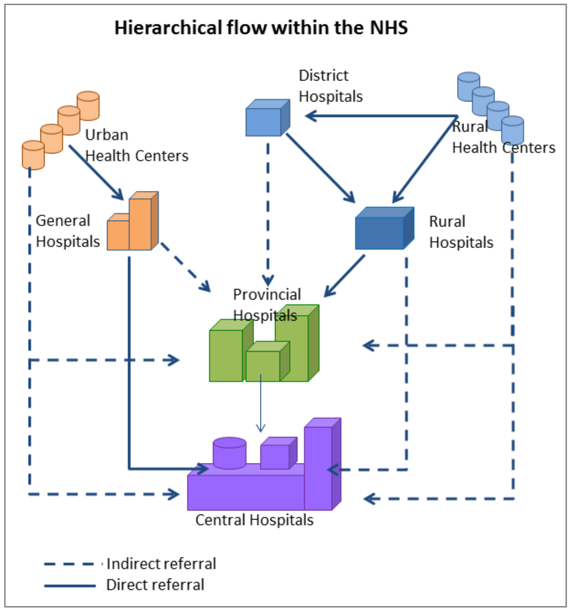


Figure 12: Hierarchical flow Conceptual diagram: Direct and indirect healthcare referral within the NHS.

comprise urban and rural health centers and health posts (WHO 2009 3) (MISAU-INS 16). They are the first contact of care for the community of the health area, which covers a territorial zone with maximum of 100.000 inhabitants (MISAU 5). In the urban settings the direct influence zone of the health center covers a maximum of 4 Km radius, while in rural settings; they cover direct influence zones of 8 Km radius maximum and 40-50 Km of radius maximum of indirect influence coverage (MISAU 6). Their responsibilities include to provide education for health, vaccinations, mother and child health & family planning, promote & control environmental sanitation, water and food sanitary inspections (hygienic), nutritional education, prevention and control of the most endemic diseases (malaria, tuberculosis, HIV/AIDS, parasitosis, among others), clinical diagnosis, first aid and emergency assistance for minor trauma, and data collection (epidemiologic & demographics), for health sector reports (MISAU 7, 8).

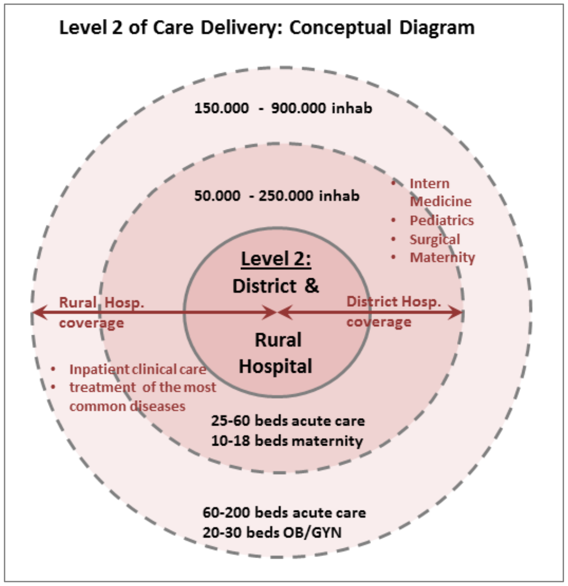


Figure 13: Size and coverage of Level 2 Care Delivery within the NHS Network

The **Level 2** includes district and rural hospitals located mostly in the rural areas, and general hospitals in urban areas, totaling 41 health care facilities (WHO 2009 3) (MISAU 36). The level 2 of care delivery constitutes the first referral level of care and these facilities are located near agglomerated population settings, on cross-ways or junctions to ensure quickly patient evacuation from health centers to upper hospital levels (MISAU 35, 36).

District hospitals cover influence areas of about 50.000 to 250.000 inhabitants and they should have a bed-capacity of 25 to 60 beds for acute and intensive care and 10 to 18 beds for the maternity. Rural hospitals cover an influence area of about 150.000 to 900.000 inhabitants mostly in rural areas; they should have a bed capacity ranging from 60 to 200 beds for acute and intensive care; and 20 to 30 beds for gynecology/obstetrics (MISAU 36, 40, 41, 46).

Both provide basically the same level of care services to patients referred from health centers and/or district hospitals located in the hospital health influence area.

Rural hospitals provide more accurate diagnostic and laboratorial exams, specialized service care and surgery procedures while the district hospitals only can provide minor surgery procedures. Services provided include prevention, treatment and control of most endemic diseases, clinical diagnostic, with support of laboratorial and radiological exams; emergency care for traumas and others diseases 24 hours per day; clinical care for inpatients; and assistance and treatment of most common diseases in the region (MISAU 36-8, 41-3, 48).

General hospitals have a maximum of 200 bed capacity. They are located at urban areas and serve as the first referred or secondary level of care delivery for the health centers located in urban and suburban neighborhoods. Their area of influence depends on the density of the neighborhoods directly assisted by the hospital and its location. They deliver the same range of care services provided in a rural hospital (MISAU 48).

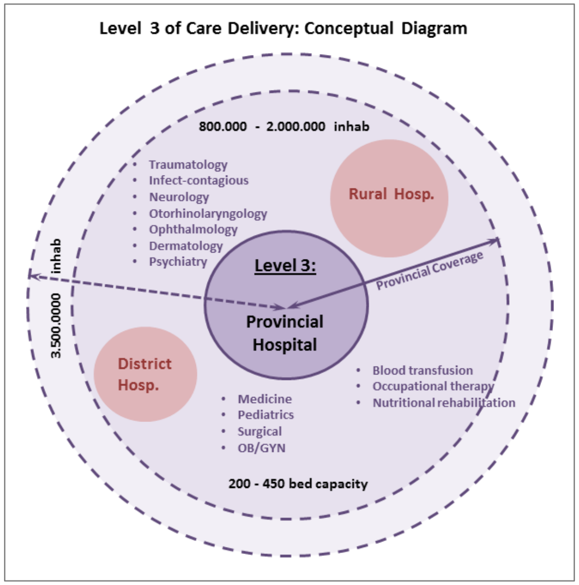


Figure 14: Size, coverage and services of Level 3 Care Delivery within the NHS Network

The **Level 3** include **provincial hospitals,** which is the focus of this study. They constitute the second referral level of care and have been typically located at capitals of provinces, but they can also be located in other cities or urbanized areas within the province. If indicated, a province may have more than one provincial hospital, depending on the quantity and geographical location of the population (MISAU 55-6). Currently there are only seven provincial hospitals for the entire country (MISAU-INS 16).

The influence area of the provincial hospital covers about 800.000 to 2.000.000 inhabitants, but if the province has high population density the hospital may have to cover up to 3.500.000 inhabitants, or it might be necessary to build another provincial hospital to ensure better healthcare service coverage (MISAU 55-6). Provincial hospitals typically have bed-capacity of 200 to 450 beds; depending of the population they serve (MISAU 56).

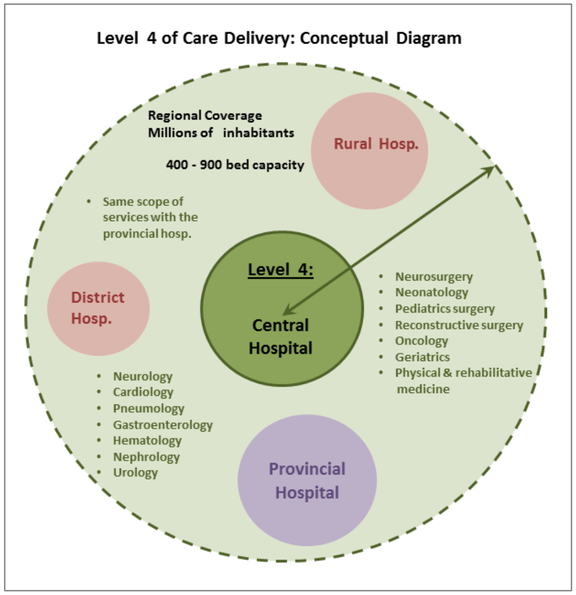


Figure 15: Size, coverage and services of Level 4 Care Delivery within the NHS Network

Level 4 includes central and specialized hospitals. Central hospitals also provide services defined as third level (MISAU 60-1). There is no predefined area of influence for the fourth level of services although these facilities should be located in urban areas. Mozambique has only three central hospitals at Maputo, Beira and Nampula, which cover South, Centre and North regions. These hospitals also serve as provincial hospitals within the provinces where they are located (MISAU 61). Central hospitals have a bed-capacity according with the population to serve and, which should include from 400 to 900 beds (MISAU 61). There are a total of three specialized hospitals in the entire country. Two in Maputo city providing care as a psychiatric hospitals. One heart institute in Maputo, and one psychiatric hospital in Nampula.

Basically the level and type of services provided at all levels (II, III and IV) of hospitals is the same. The scope of services gradually increases its specialization from the lower levels to the upper levels, as well as the conditions in terms of equipment accommodate complementary and more accurate diagnosis through specific exams and laboratorial analyzes. The sophistication of diagnostic capabilities increases accordingly with the level and type of specialization service provided. Those exams should be conducted by specialized technicians or physicians in areas of clinical practice such as imaging, biochemistry, hematology, microbiology, pathology, anatomical immunology, electromyography, electrocardiography and electroencephalography. Individualized services and more specialized staff are required for level 3 and 4 hospitals. Staff teams should be available 24 hours per day and emergency services should include intensive care units for cardiology, cardiovascular surgery, neurosurgery, traumatisms and burns. The provincial and central hospitals should include training school facilities for Medical, Law, Pharmacy, Dentistry and Nursing students and above all should include physical and environmental conditions to accommodate Postgraduate students in Medical specialized clinics (MISAU 56-9).

OUTPATIENT SERVICES PROVIDED: PROV. VERSUS CENTRAL HOSP.		
Clinical Serv. Delivered	**Central Hosp. (%)**	**Provinc. Hosp. (%)**
Outpatient Care	3 Facilities	7 Facilities
Pediatrics	100.0	100.0
Internal Medicine	100.0	100.0
Dermatology-Venereology	100.0	00.0
Cardiology	100.0	28.6
Neurology	100.0	28.6
Psychiatry	100.0	100.0
Pneumology	66.7	14.3
Gastroenterology	33.3	14.3
Oncology	66.7	00.0
Geriatrics	33.3	00.0
General surgery	100.0	85.7
Pediatrics surgery	100.0	42.9
Neurology	100.0	00.0
Reconstructive & Aesthetics	100.0	00.0
Urology	66.7	57.1
Maxillofacial Surgery	66,7	00.0
Odontostomatology	100.0	100.0
Traumatology / Orthopedics	100.0	100.0
Ophthalmology	100.0	85.7
Otorhinolaryngology	100.0	28.6
Gynecology	100.0	100.0
Obstetrics	100.0	85.7
Physical and Rehabilitative medicine	100.0	100.0

Figure 16: Facilities providing Outpatient specialized care services along the country

The incremental expansion of tertiary level facilities—provincial hospitals—will improve access to specialized care services for the majority of population, geographically dispersed throughout the country. Provincial hospitals are the highest referral level of care within the province and, they provide considerable specialized healthcare services that are also provided in central hospitals.

Given the quantity of quaternary versus tertiary levels service delivered throughout the country it concluded that there are lack of specialized services coverage in the provincial hospitals both in terms of outpatient care and inpatient care. Some examples of lack of outpatient specialized care services include dermatology/venereology, oncology, geriatrics, neurology and reconstructive and maxillofacial surgeries; and there is no neurosurgery nursing care provided by provincial hospitals for impatient segment (MISAU-INS 81).

INPATIENT SERVICES PROVIDED: PROV. VERSUS CENTRAL HOSP.		
Clinical Serv. Delivered	Central Hosp. (%)	Provinc. Hosp. (%)
Inpatient Care	3 Facilities	7 Facilities
Pediatrics	100.0	100.0
Neonatology	66.7	57.1
Dermatology	66.7	28.6
Cardiology	100.0	14.3
Psychiatry	100.0	71.4
Pneumology	66.7	28.6
Oncology	100.0	14.3
Surgery	100.0	71.4
Neurology	100.0	28.6
Urology	100.0	28.6
Traumatology/ Orthopedic.	100.0	85.7
Ophthalmology	100.0	71.4
Gynecology	100	85.7
Obstetrics	100.0	71.4
Pediatrics surgery	100.0	28.6
Neurosurgery	100.0	00.0

Figure 17: Facilities providing Inpatient specialized care services along the country

Other specialized services such as pneumology, gastroenterology, otorhinolaryngology, neurology, urology and cardiology are being provided by only one or two (14.3 and 28.6%) provincial hospitals (MISAU-INS 82), which mean that the population of 5 or 6 provinces must travel to another province to seek for specialized healthcare assistance. Thus, the program design requirement s for provincial hospitals should include the space needs for all healthcare specialties to ensure delivery off comprehensive services and minimize the costs and access issues associated with patients' travel and allowances. The charts show clearly the percentage of facilities (central versus provincial hospitals) that provide a complete set of specialized care services versus those which are not providing all specialized services for outpatient and inpatient population.

Country Context Factors and Influences

According with data available, the country is devastated by many avoidable factors that negatively impact health status of the population, which is mainly illiterate, with high birth rates. The future facilities will have to be designed with flexibility, design solutions and sized to respond and accommodate the most important issues that impact health status of the majority of people, including pandemic diseases, new noncommunicable diseases, increasing and underserved young population with more focus on children, among many others. The design approach will require attention in issues such as privacy, isolation, and the need of specialized facilities among others.

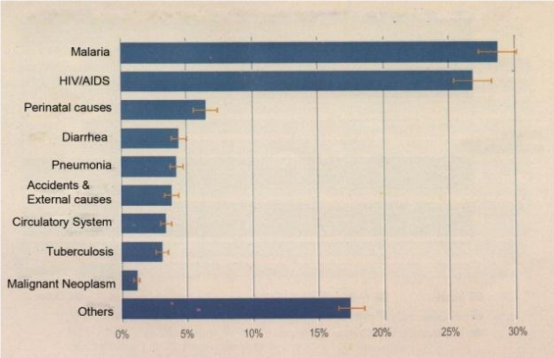


Figure 18: Causes of morbidity and mortality among the population of all ages

Frequent diseases and causes of morbidity and mortality: Many diseases would be more preventable with clear and focused educational sessions of health awareness of the population. Also the inclusion of isolation wards, building physical features for mosquito protection and provision of space to shelter plague

Figure 19: Maputo, capital of Mozambique during a flood circumstances

victims should be a priority during the planning and facility design processes, since the settlements in urban settings have been chaotically expanded without any plan. The main causes of morbidity and mortality in Mozambique are malaria (29%) and HIV/AIDS (27%), followed by perinatal causes (7%), diarrhea diseases (4%); acute respiratory infections (4%), circulatory system diseases (3%) and TB associated with AIDS (3%). Cholera as well, constitute the main epidemic-prone disease which has huge contribution to the causes of death and illness in the country (INE-INCAM 19), (WHO 2009 7)

Figure 20: Cholera treatment center at Lurio, Cuamba - Niassa province

The vulnerability of the country to various natural disasters including floods, storms and drought exposes the population to water-borne and drought-related disease outbreaks, such as cholera and dysentery, meningococcal meningitis and an increase in malnutrition (WHO 2004 16) (WHO 2009 10). Roughly 6000 cases of malaria are reported each year in Mozambique and it is estimated that around 24% of deaths among children under-five are due to malaria. This disease also has huge impact on maternal deaths rates (WHO 2009 7). Obviously, the referred figures indicate that carefully attention should be paid during the healthcare site selection, since it may impact the size and location of future health care facilities.

Figure 21: Patient ward, Institute of Heart in Maputo, Mozambique

The old building design that characterizes the national healthcare network facilities has led to an inappropriate and insufficient response of the healthcare institutions to the new Noncommunicable Diseases. These new noncommunicable diseases are rising very fast in major cities due the cultural and sedentary habits in urban population. Cardiovascular diseases, high blood pressure, diabetes, chronic respiratory tract diseases and cancers are on the rise and currently, constitute an important public health problem. Common risk factors associated to this situation include high alcohol and tobacco consumption, with a prevalence of 77.2% and 18.7% respectively in the population. High blood pressure has a prevalence of 33.2% and constitutes a major risk factor for cardiovascular incident (WHO 2009 7, 8).

Figure 22: Institute of Heart in Maputo city - exam room: imaging portable fluoroscopy

There is a need to incorporate in healthcare facilities design both clinical and preventative services that target diseases such as cardiovascular diseases, diabetes, chronic respiratory tract diseases (asthma) and malignancies (cancers). This should be the main goal of the NHS in the near future. Thus, it is important to provide design guidelines based on current best practices and procedures which can be applied on new healthcare facilities in Mozambique. Given these diseases are affecting mostly the urban population, urban healthcare facilities such as provincial and central hospitals should be the first targeted for these expanded services. Furthermore, the decisions makers will need to take the next step to build specialized hospitals such as cancer treatment centers.

The need of easy access healthcare settings—hospitals—within useful time have become more necessary due the number of deaths that still occur in home settings. Thus, there is a need of expanded construction of healthcare facilities for unserved people in urban peripheral neighborhoods. Of the mortality rate caused by sickness, 21% of deaths occur in a healthcare setting, while 74% occur at home. These figures vary according with the specific setting, cultural habits and believef. Thus, in the urban settings 41% of death has occurred in a healthcare facility while in rural areas only 13% has occurred in a healthcare setting. The most urbanized cities have higher rates (40%-57%) of deaths in a healthcare setting against (15%-18%) rates in the less urbanized cities and rural areas (INE-INCAM 7).

Figure 23: Common source of drinkable water in urban peripheral areas – public fountain

***Health determinants and environmental conditions*:** In general, a large majority of the population of Mozambique still engages in high-risk behaviors. Information and knowledge related to health and well-being is still unavailable to the majority of the population, due to illiteracy. Poor hygiene practices and sanitation, the lack of potable water, early and unsafe sex practice, unhealthy diet, lack of physical activity, high alcohol and tobacco consumption and other harmful cultural practices are some of the common high-risk behaviors that contribute to the current health status of Mozambican people (WHO 2009 6).

Selected Characteristics	Main Source of Drinking Water												Total	Improved Sources of Drinking Water	Number of Household members
	Improved Sources						Unimproved Sources								
	Indoor	Outdoor	Public Drinking Fountain	Neighbour house	Well or protected Hole with Manual Pump	Bottled or Mineral Water	Well without Manual Pump	Non-protected well	Rain Water	River or Pond Suorce	Others sources	No information			
Total (%)	2.1	5.6	9.2	6.2	19.8	0.1	4.5	36.1	0.2	16.0	0.2	0.0	100.0	43.0	64,214.0
Urban Areas (%)	6.2	16.7	19.7	17.8	9.3	0.2	6.6	20.2	0.3	2.8	0.1	0.0	100.0	69.9	20,952.0
Rural Areas (%)	0.1	0.3	4.1	0.5	25.0	0.0	3.5	43.8	0.2	22.4	0.2	0.0	100.0	30.0	43,263.0

Figure 24: Distribution of improved and unimproved sources of water

The availability of drinkable water and improved sanitation are necessary to reduce the occurrence of water borne diseases, which in turn impact the highly mortality rate in the country. Approximately 16.2% of all deaths in Mozambique are attributed to inadequate water, sanitation and hygiene practices (WHO 2009 6). Only 43% of the population had access to improved water source in the year of 2008. Within this population, 70% were located in urban areas and only 30% in rural areas (MICS 58, 59). Improved water sources typical in Mozambique include piped water—inside the house, in the backyard or at neighbor's house provided by a —public drinking fountain, protected well with manual pump and mineral water (MICS 58, 59). Around 20% of household use protected well with manual pump while, about 9% use a public fountain as a source of water, 6% use water from a neighbor's house, 6% use water from the backyard house and only 2% have piped water inside the house (MICS 59).

Selected Characteristics	Type of Sanitation used by household									Total	Population using Improved Sanitation System	Number of Household members
	Improved Sanitation				Unimproved Sanitation							
	Toilet with water closet	Toilet without water closet	Improved Latrine	Traditional Improved Latrine	Unimproved Latrine	On the Beach	On the Bush	Others places	No information			
Total (%)	**2.4**	**2.5**	**6.8**	**7.6**	38.3	1.5	40.3	0.0	0.6	100.0	**19.3**	**64,214.0**
Urban Areas (%)	**7.0**	**7.3**	**17.9**	**14.9**	37.9	2.6	11.9	0.0	0.5	100.0	**47.1**	20,952.0
Rural Areas (%)	**0.2**	**0.2**	**1.4**	**4.0**	38.5	0.9	54.1	0.0	0.6	100.0	**5.8**	43,263.0

Figure 25: Sanitation System - Distribution of improved & unimproved means in rural and urban areas

During the same period, 19.3% of population used improved sanitation, including 47.1% in urban areas and 5.8% in rural areas (MICS 65-7). Among people with access to improved sanitation, only 5% use toilet with or without water closet in the house (MICS 65). The use of unimproved sanitation or uncontrolled placement of human excrements leads to the variety of diseases—diarrhea and cholera—which represents high risk factor of the mortality and morbidity in the country. Improved sanitation infrastructures include toilet with water closet, toilet without water

Figure 26: Improved latrine for the boys and girls in Chicumbane, Gaza province

closet, improved latrine and traditional improved latrine (MICS 65). The charts show the distribution of improved and unimproved sources of water and sanitation conditions among the population in the year of 2008. Improving potable water sources and sanitation systems will reduce the need of planned space within the healthcare facilities to target the diseases caused by these conditions. Thus, the health facilities in urban settings should be planned with focus to other diseases challenges, such as the growing number of noncommunicable diseases emerging in the country.

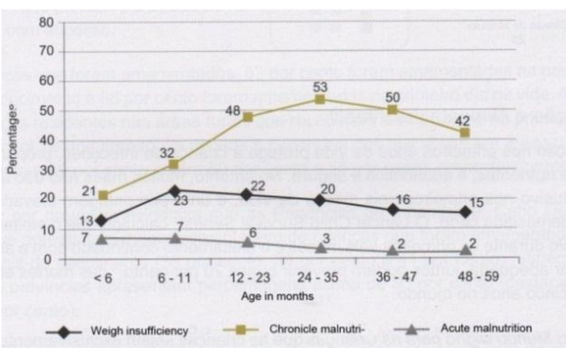


Figure 27: Malnutrition in children under five years old

Malnourished children are more likely to die of common infant diseases due to environmental degradation in urban and suburban areas and the lack of education and illiteracy among mothers who are their primary caregivers (WHO 2009 15). If surviving, they are more pre- disposed to have recurrent diseases, deficient growth and weak mental health. In Mozambique, 18% of children under five years old present too low weight for the age. Almost one out of two children under is chronically malnourished and almost 4% are acutely malnourished (MICS 13, 14). The prevalence of malnutrition in children under three (3) years old is 41% in rural areas, compared to 26% in urban areas (WHO 2009 5). Thus, the need of specialized facilities—children hospitals and woman and children hospitals—to address these particular diseases and circumstances of these populations should be urgently considered.

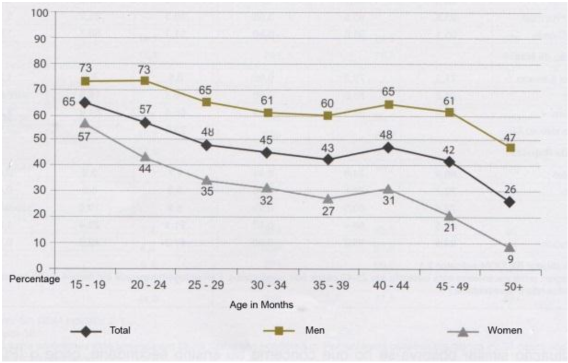


Figure 28: Literate rates are higher in young people and too low in old female population

The country has around 49.2% of illiteracy rate. Survey in this field has shown that female illiteracy is higher (64.95%) which impacts negatively on the overall social-economic stage and development of the community (MICS 83). Male Illiteracy is 35.05% (MICS 83). Thus, education of children is one for the big challenges of the country. Education helps with the elimination of poverty, women's empowerment, protection of children against child labor and sexual exploration helps more protect the environment and influences population growth (MICS 83). These factors in turn can help reduce the need for healthcare services and facilities to address preventable disease. Furthermore, more focus could be made the growing prevalence of noncommunicable diseases through including during the planning and design processes the provision of space needs to accommodate services of care for these diseases.

	Health Professional Level and Type						Total
	Physicians	Other Grad. Health workers	Middle level	Basic level	Elementary level	General support staff	
Health workers	542	266	4,207	8,051	3,176	9,794	26,036
Percent. (%)	2,1	1,0	16,2	30,9	12,2	37,6	100

Figure 29: Percentage of health workers according with the professional level type

Figure 30: Students in an internship Lab, Central Hospital Clinical laboratory, Beira

Human resources**:** The lack of human resources within health national system leads to the weakness of service and lowers the efficiency and effectiveness of those currently employed. According with data of the year 2007, the country has 26,036 employed health staff. Within those, only 542 represents physicians, 4.207 represents the middle level technicians and 8051 are basic level staff (MISAU-INS 91). These figures illustrate the constraints within the national health system in meeting the real and current population needs and in achieving its health-related international goals. This implies a significant barrier to overall health service delivery, which is already weak due the lack of infrastructures and equipment (WHO 2009 4).

To stimulate young qualified staff to work in rural and peripheral regions, where the lack of qualified human resources is greater, the Government has implemented strategic incentives, which include the construction of new houses, power and water supplies, along with the extension of telecommunication and internet networks for

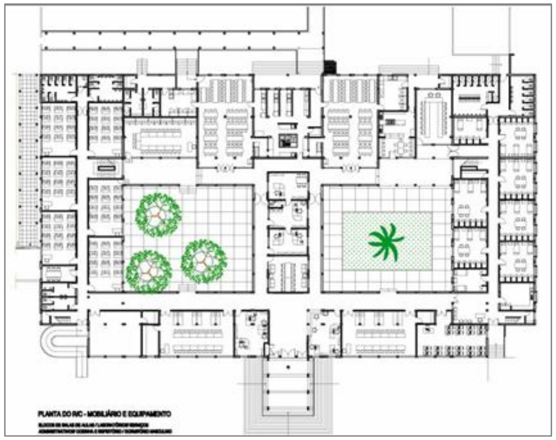


Figure 31: Health Training School for middle level technicians in Maputo. Ground floor plan

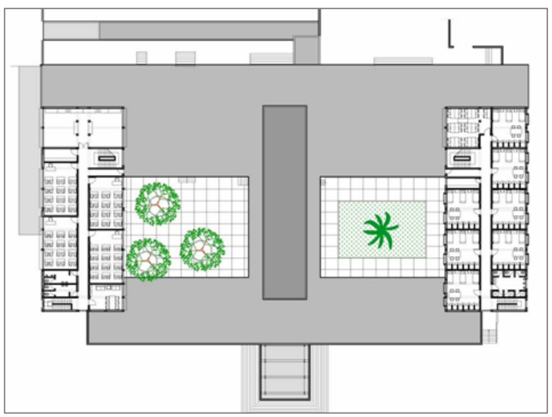


Figure 32: Health Training School for middle level technicians, Maputo. 1st Floor plan

these regions. Inadequate remuneration, limited career prospects, increased workload and a difficult working environment negatively impacts the performance and effectiveness of health workers (WHO 2009 4).

The ratio of health staff worker to the total population is very low. The density of healthcare personnel is represented by the ratio of 0.03 doctors per 1000 inhabitants, and 0.21 nurses per 1000 inhabitants (WHO 2009 4) (WHO 2004 11). The shortage of care providers is aggravated by low pre-service training and recruitment; increased attrition in the healthcare sectors; and rapidly-changing health needs. Private and public medical schools form the primary training for physicians, graduate nurses and health technicians. There are also training institutions for all levels of health professionals. All total this includes include 9 institutes of health science and 13 health training centers basically distributed through the provinces.

The lack of health works from represents one of the major limitations on delivering safe, quality and equity care. Thus, to maximize the efficiency and effectiveness of limited clinical staff, healthcare facilities should be designed with plan configurations and flexibility that leads to maximize effectiveness and efficiency of available health workers, through reducing staff fatigue, walking distances, stress and exhaustion along with other negative factors that affects care providers and users in general. The design should also approach the improvement of communication, visibility, privacy which will boost the confidence and satisfaction among the workers. The set of guidelines resulting from this study, define the design strategies and standards required to ensure a flexible and functional plan configurations for new healthcare facilities, as well as designs that minimize the need for staff in delivering care (Roger S. Ulrich 140-7) (Marberry 63-73) (Hamilton & Shepley 213-24).

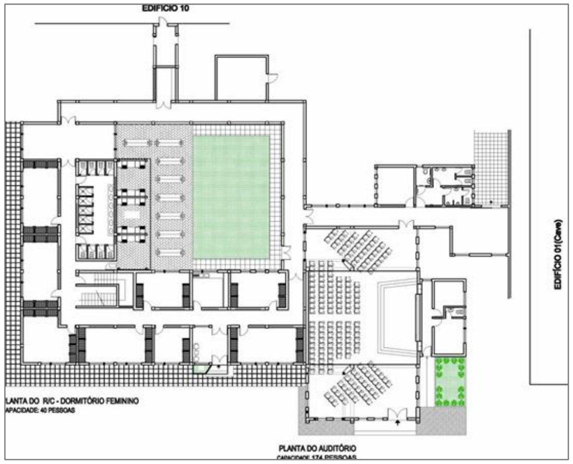


Figure 33: Health Training School, Maputo. Female dorm building – Ground Floor plan

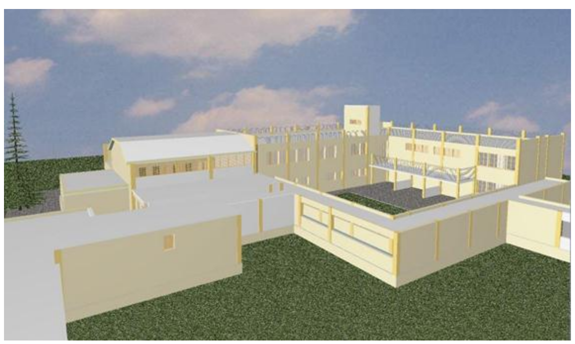


Figure 34: Rendering image of the female dorm. Health training school, Maputo

***Socio-cultural influences*:** Healthcare facilities should be planed and designed to accommodate the need of outdoors rather that indoors, to meet the most common habits of the local population. The integration of building elements as a mean of transition between interiors and external spaces should be considered at the beginning of the design process.

The country has a climate that encourages spending most of the time outdoors rather than indoors. The tropical humid climate with two clearly defined seasons: very hot and wet with high humidity rates during summer and moderate winters, enables people to live outdoors and accomplish most domestic activities under natural environment—trees, porches, patios—all integrated along within traditional and conventional facilities. Living and working outdoors is also a necessity as the financial-economic level of the majority of the population cannot afford mechanical systems to comfortable temperatures indoors. Healthcare facilities that include wide

Figure 35: Health Training School, Maputo

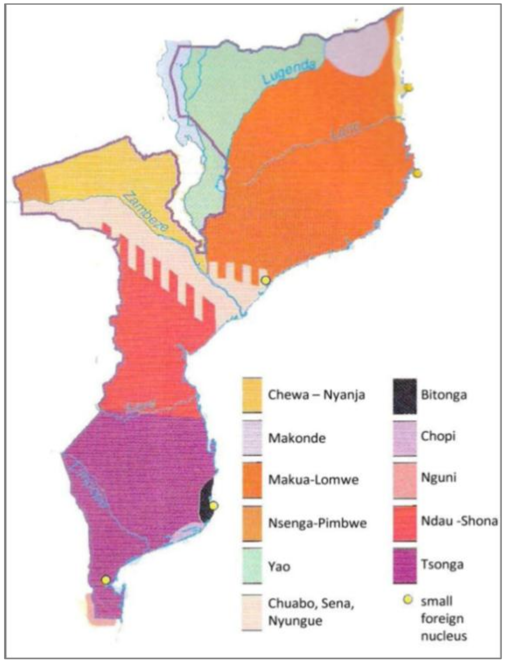


Figure 36: Ethnic-linguistic regions along the country (1880)

verandas, decks, porches, and external covered patios can allow the users of the facility, many opportunities for interaction and social support

The wide range of tribes using their native languages added to the current condition of the population which is characterized by having high rates of illiteracy alternative means or ways of communication, to allow confident use and easy navigation of the building. Portuguese is the official language of the nation, but only 40% of the population speaks this language. 33.5% of the population, mostly from tribe Bantu, speaks Portuguese as their second language and only 6.5% of the population—mostly white Mozambicans and mestiços (mixed) speak Portuguese as their first language. The remaining 60% of the population is distributed through the 16 native languages (INDE ENM 13). Thus, the design facilities for healthcare delivery should include graphical and/or pictographic signage added to building clues to meet the communication needs of all segments of users.

Conclusion

The important conclusion to draw from the health and social conditions in Mozambique is that many factors have influence on the health status of the population. Poverty and the on the high rates of illiteracy are the main and determinant factor for the solutions adopted by the Government through the national health system (NHS). Other country context factors play an important role as well and they constitute limitations for the design of best polices to meet the health needs of the majority of the population.

Greater effort needs to be made to address the rapid growth of the population, their care needs and to adjust to the permanent and global changes in health. The enlargement of healthcare facilities in urban settings targeting unserved population should focuses on peripheral areas as with high priorities to meet the principle of equity. Noncommunicable diseases as well, are an issue not less important in a country where the middle-level income population is raising, along with increasingly unhealthy habits of living in urban settings. The prevalence of high birth rates create a population of the country that is young, which requires specialized healthcare facilities to target specific diseases in these population segments. Thus, general and woman and children hospitals in urban settings through the country should be built to ensure easy access to care services, with equity and quality for all segments of the population, with greater focus on those who live under unserved health conditions.

ARCHITECTURE IN MOZAMBIQUE

Over the time, different archetypal styles shaped architecture of the buildings and finally entire cities in Mozambique. Mixed architectural styles, highly influenced by the local climate and culture lend to the majority of cities an indescribable cozy and friendly environment. From old familiar Victorian residences to imposing familiar condominiums; from the old low rise, two story commercial buildings to new high rise commercial and office buildings, from the old small apartment blocks to the new beachfront condominiums altogether provide a singular identity that characterizes local architecture up to date and provides the path for all new constructions taking place in the country.

Healthcare facilities are also characterized by the same architectural path; however fewer facilities were built up to date. The advances in construction industry, including building technology, information technology, healthcare technology, and many other factors impact the current trend of building design worldwide. Focusing on how these factors can impact healthcare design in the local context, will allow decision makers, planners and designers, to provide flexible, easy and inexpensive design solutions for the new buildings.

Contemporary issues of Architecture in Mozambique

Real state is characterized by being considerable old. Major part of the cities was built during the years 1940's to 1970's. The last two decades of this period were characterized by replacing old and low rise buildings with modern high rise buildings, at least in the main cities of the country. Lack of maintenance and lack of familiarity with urban living style and the population growth, were the major factors that speeded degradation of the cities during the last 3 decades. Although all cities were built using a conventional method with application of durable materials, the large number of years of highly demanded building use added to the expired life cycle of building systems—MEP, mechanical, electrical and plumbing systems, have driven all real state to the degradation stage that it is up to date.

Figure 37: Maputo Railway Station designed by Gustav Eiffel, opened in 1910

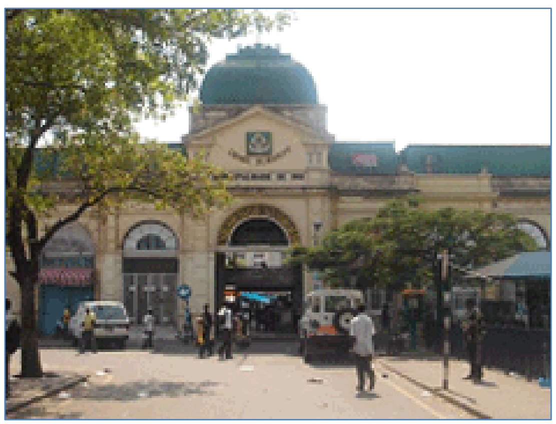


Figure 38: City Market “Mercado Central do Maputo” built in 1900

Building form and style: Like in all others colonized countries, the dominant architectural style in Mozambique was inherited from the colonizer Portugal, which was based on the architectural styles of that eras around the world. Archetypically the cities in Mozambique are characterized by a mix of architectural styles that identify different epochs. From the earliest1900’s the constructions were made with concrete, with remarkable quality (figures 41 & 42), and most of them considered historical buildings nowadays. Water and power supply were introduced in the cities during this epoch (Bruschi & Lage 88).

From the 1930’s, architectural style and influenced by Art Deco. This style lasted until the 1940’s and 1950’s and was known as “The Soft Portuguese style” or “Nationalistic style”. This type of architecture was applied to variety types of public buildings in Mozambique—small primary schools, high schools, universities in urban settings; hospitals, courts of justice, provincial government buildings, banks, blocks of flats, office and commercial buildings among others (Lad 1-7).

Figure 39: architectural buildings – balconies & deco elements, Maputo

Figure 44: The railway club, Maputo down town

The soft Portuguese style was characterized by the use of modern engineering techniques—concrete structures with a high construction quality, although the modern techniques and lines were hidden by the combination of ornamental elements from the 17th-18th centuries with the modern techniques. The typical decorative elements were among others, concrete roof plan and picked tiles roofs, rough rock, pinnacles, pilasters, balconies, concrete roof plans, prominent structural elements—columns, beams and bars—all orthogonally arranged were the remarkable elements of the public and residential buildings. Other remarkable characteristic of this epoch is the fact that designers embrace with freedom the trends of international architecture practiced around the world during that period of time (Bruschi & Lage 88), (Lad 1-7).

Figure 45: Deco & streamline modern architecture building at Inhambane

Figure 46: other building with the same architectural style

Figure 47: Municipal Council of Maputo city- Historical building

Figure 48: Two-story commercial district buildings

Figure 49: Art deco Theater building, Inhambane Mozambique

Figure 50: Maputo Railway Station – covered waiting station

Figure 51: Government Building: Provincial Directorate

From the 1940's the cities started to growth very fast due the massive migration of Portuguese colonists to Mozambique. From that period to the 1960's there was a made the transition from low rise buildings to high rise buildings. Cities in Mozambique were significantly enlarged with the construction of new and wide roads. The new style with no real stylistic denomination was introduced by the end of 1950's through the 1960's. A "false" modern style architecture was introduced (Bruschi & Lage 90-3).

Figure 52: Old airport office building

This phase last until the independence of the country in 1975, and was basically characterized by having slightly different approach on the finalization of the engineering techniques and lines. This new architectural approach was no longer hidden by ornamental elements, and this created a more dry style—rigid architectural lines, without any decorative ornament on the façades. This architectural type characterizes the majority buildings built in this period including high-rise apartment and office buildings, ranging from 7 to 33 stories, with

Figure 53: Business district from the 1960s

Figure 54: Portuguese Embassy building and other high rise buildings along Julius N. Av.

mezzanines and commercial stories below on the ground floor. The highest buildings were strategically located in expanded town areas, along the main streets and avenues.

The down town of most cities is characterized by low-rise commercial and office buildings up to 4 stories. Basically cities were planned to comprise different building typologies aggregated according with its function—residential, commercial, office, or other—and the amount of floors proposed for each buildings. Thus, the urban plans and regulations creates zones for up to three to four stories buildings; areas for residential neighborhoods with a predominance of family houses and three to four stories apartment blocks; areas for high-rise buildings of seven stories and more, among other minor type of buildings. This arrangement characterized the urban settings in Mozambique especially in the main cities such as Maputo, Beira and Nampula.

Figure 55: Maputo city view, the “25 de Setembro” Avenue

Figure 56: Office & apartment building, Maputo city

Figure 57: Headquarters of BIM Commercial Bank, Maputo

Figure 58: Catedral Church in Maputo

Figure 59: View of Nampula city

Figure 60: Hotel Polana, Maputo city

Figure 61: Victorian building

Figure 62: New beachfront condominium, Maputo

Figure 63: New hotel building under construction in Maputo

In the almost 25 years after independence, the construction industry has basically stagnated. There have been no new investments in buildings modernization and construction. Currently, the country is welcoming the most contemporary architecture of the late 20th century up to today, reflecting state of art design and building practices. New construction includes hotels, offices, malls and other commercial buildings. New residential neighborhoods have been rapidly developed in the more expensive areas of the city, with views to the ocean, and in the peripheral areas of the main cities. These new developments are characterized by a contemporary architectural style and they constitute the highest standard of residential buildings ever built in Mozambique.

Figure 64: Verandah of the Central Rail way station in Maputo

Figure 65: Block of apartments in Maputo - verandahs

As referred previously in the chapter 1 of this report, the climate of Mozambique is Tropical Humid with, annual average temperature of 24-25 °C (75.2 - 77o F); an annual average precipitation of 850 mm; and 70.2 % of annual average humidity. To accommodate these climate features, careful consideration must be taken to account including the impact of solar radiation, high temperatures and the predominance of rainfall. The common building characteristics include:

- Large covered balconies surrounding the entire perimeter of the building, mostly in residential houses to protect from direct incidence of Northeast and Northwest solar radiation and the most predominant and heavy rainfall, in which the prevailing direction is from South to North. In turn these balconies provide an intermediate microclimate transition between internal and external environments.
- The orientation of the buildings on their site, are most predominantly with the major façades exposed = north and south, which ensure that the major façade area is exposed to less aggressiveness of direct overhead sun incidence on the norte side and complete shadow (absence of direct sun incidence) on the South side. If this

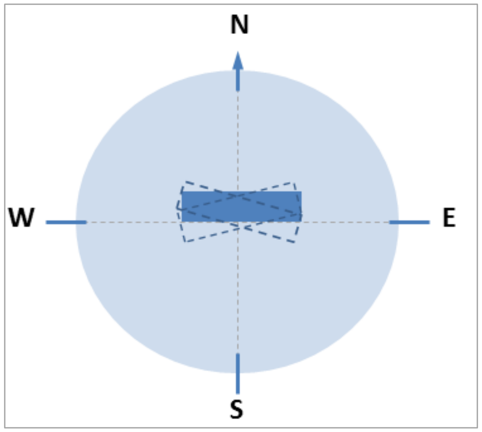


Figure 66: Building orientation (N-S): advantage of the sun path protection

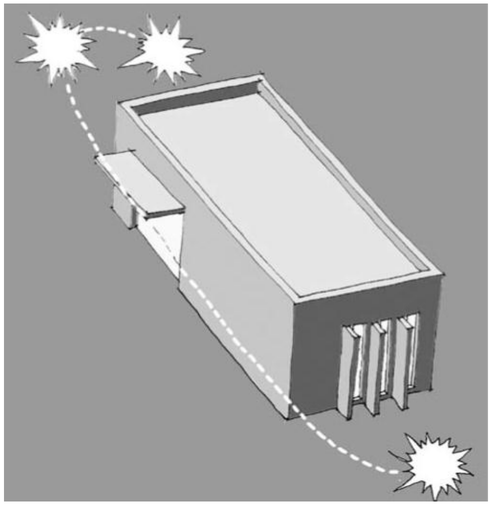


Figure 67: Sun path diagram: building orientation (N-S) maxim sun protection

parameter is not covered, then the building openings (windows, clerestories and balconies) may be protected by sun control systems screens, sun cladding systems, and so on);

- Insulated roofs. Almost always the roofs are thermally insulated through aluminum foil radiation barriers and/or glass wool insulation which create thermally comfortable indoor environments. Some of these materials also have dust-proofing and water-proofing proprieties. When concrete flat roofs, completely exposed to the harsh environments have—direct sun incidence, bituminous waterproofing is applied and glass wool is used as thermal insulation;

- High to medium pitched roofs allows the air chamber (airspace) between the roof and the ceiling (concrete, gypsum boards or any other board ceiling material) which minimizes the transmission of temperatures between internal and external environments. These air chambers are ventilated for permanent air circulation;

- Narrow footprint building plans with strategically placed windows and doors allow greater natural ventilation between the different interior compartments, and

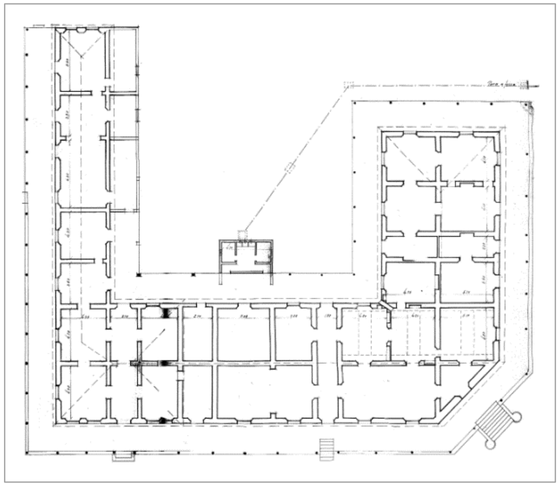


Figure 68: Financial building (1930's) Pemba, Mozambique

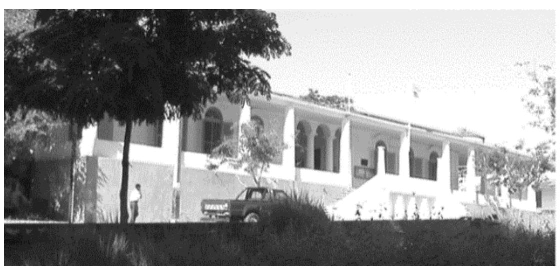


Figure 69: View of the financial department building, Pemba

good access to daylight. Natural air flow within the building ensures that the hot air is drawn out of the building and replaced by fresh air;

- Building rain water collection is accomplished through guttering and downspouts to absorbent drains, if there are no underground water cisterns. Drainage ditches, large green areas are other techniques used to address rain during the wet seasons.

In conclusion, given the fact that healthcare facilities should not be a source of harm, rather should provide comfort and habitableness for the users in means of temperature, humidity, air quality, natural light and natural cross ventilation, to ensure health and wellbeing, therapeutic and restorative effects on patients and staff, the listed design response to environmental conditions should be taken in account from the beginning of the plan and design process.

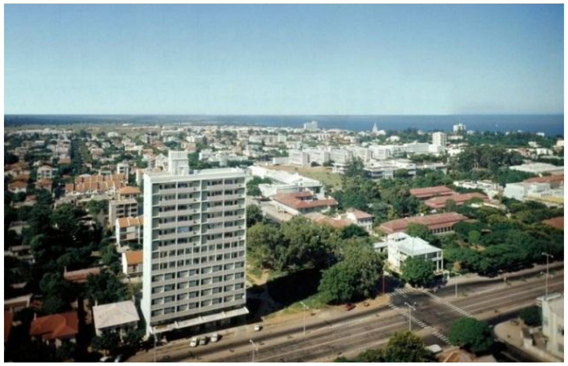


Figure 70: View of Maputo city on 1960's, Mozambique

The main economic factor that contributed to the stagnation of the construction industry over the past twenty five years was directly related to the non-existence of clear and flexible financial policy in country, which inhibited the private sector from investing more consistently in the construction. In turn financial institutions (banks), applied prohibitive interest rates which had a huge negative impact the banking credit lines, and greatly inhibited the engagement in credits or loans by private sector investors or individuals.

Figure 71: View of the city Beira, Mozambique' second largest city

With independence, the government nationalized all existing real state (immovable property) and allowed the population to access these properties through renting them at very low prices. The majority of the population migrating from peripheral neighborhoods and rural areas under the advent of the independence were not prepared to live in urban settings; the population was mostly illiterate and with no financial resources—employment and income, occupied the cities. Since then, urban settlements have been challenged by overcrowded neighborhoods, people

Figure 72: Housing block decline period after independence, Beira Mozambique

Figure 73: Building block at Bagamoyo Avenue after independence, Beira Mozambique

Figure 74: Grande Hotel – period after independence, Beira Mozambique

continuously learning how to dwell and maintain urban infrastructures, in ways that were sustainable. These existent infrastructures is no longer capable of respond the current social-economic-cultural changes that have been taking place in urban settings throughout the country.

The consequences of these political decisions were basically the overwhelming of the entire infrastructure including hospitals, houses, apartments, stores, offices, among others. Rents remained very low compared to the real cost of the buildings. After a decade, the government did not have the resources to manage and maintain the amount of real estate under its control and they made and passed a law to allow the population to buy their rented apartments, houses, commercial and office spaces at very low symbolic prices. Currently, approximately 80% of urban real estate is private. People who bought do not have the financial capacity to operate and maintain their properties, resulting practically the stagnation in the improvement of basically all real estate.


Figure 75: Two-story mixed commercial and apartment building, Maputo

In conclusion, all these factors together have produced a significant decline in the state of contemporary architecture in the country in general. Particular attention should be paid to the need of providing less expensive design solutions for healthcare buildings since the government faces serious constraints in financing healthcare design and construction projects.

Materials and construction methods: Cement, steel, sand, stone, water, cement blocks and bricks are the basic rough materials used in construction in Mozambique. Wooden or steel framing are used for formwork. The country is a producer of cement and steel, however these industries have experienced periods of low production or even stagnation. Wood is also largely available, since the country has considerable forests, and exports a large amount of wood. Processed materials are mostly imported from South Africa, Brazil, Portugal, Argentina, Italy, Spain, and China. These materials include all finishing materials such as floor and wall tiles, paints and polishes, ceiling boards, concrete roof tiles, steel roof sheets, hardware, locks, faucets, sanitaryware, stainless steel equipment, hydraulic pipes, and electric wires, among others.

The common materials used in construction process, ensure durability and long life-cycle buildings, and they include:

- Sand or clay, mostly extracted from a river depending on what it is used for;

Figure 76: Walls construction: placement of hollowed cement blocks, Maputo Mozambique

Figure 77: Construction materials: Cement sack, Mozambique

- Stone is mainly extracted from rock quarries through an excavations process;
- Reinforced concrete is used for the structural elements of the building. They define the durability and life-cycle of the buildings;
- Hollowed cement blocks are used for walls. External walls are made by 200 mm wide blocks, while internal walls are made by of 100 and 150 mm wide blocks. Alternatively hollowed clay bricks are also employed to lower the construction costs. Bricks were used more than six decades ago in industry of construction in Mozambique. Over the time they have proven to be a weak material, however they are cheaper. Using hollowed clay bricks makes it difficult to integrate electrical and plumbing in the walls, because the brick is too fragile or breakable, comparing with the cement blocks. Both materials have the propriety of slowing the heat transmission from the exterior to interior environment, due the holes and the material density;
- Wood is mostly used for roof structures, floor finishes, framework and joinery—timber doors, window frames, furniture, closets and cabinets;

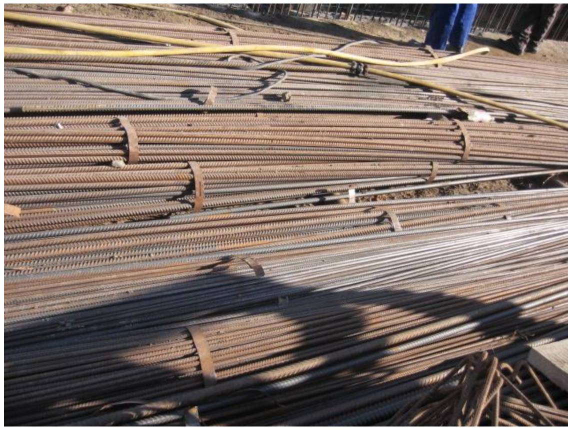


Figure 78: Construction materials – construction steel, Mozambique

Figure 79: Conventional construction method, Mozambique

- Steel is basically used for reinforced concrete, frameworks and infrequently for the building structure as structural element. It is also used for iron works such as, railing and roof structures among others;
- Plasters, cement for floors, and overall all finishers are basically durable materials.

In Mozambique, conventional construction and place-in-situ construction methods are usually combined by contractors during the construction process to ensure maxim productivity, speed and accuracy of pre-fabricated construction elements even with non-skilled workforce. Conventional building methods are defined as components of the building that are assembled on site through the processes of timber or steel formwork installation, steel reinforcement, and cast in place concrete. Conventional buildings are mostly built of reinforced concrete structure elements—continuous and isolated footings, columns, beams and slabs—filled in with blocks or brick walls.

Figure 80: concrete elements reinforced and framework installation, site construction

Cast-in-place concrete construction is more suitable for countries where skilled labour is limited. This method does not use heavy machinery or high technology. The system is technically applicable to almost all types of building. The advantages of both methods over the traditional construction method include, low skill requirement, speedy construction, low maintenance, and durable structure at reduced cost. Local labor and construction companies were traditionally employed in the construction industry, but currently with China overtaking construction works in the country; it has driven the national construction industry to a stage of readjustment given the uneven competition imposed by the low costs practiced by Chinese companies.

In conclusion, there is a need of have available skilled labor force to ensure higher quality and speed in construction, important requirements for the construction of healthcare facilities. New challenges in maximizing the use of local rapidly replenishable materials should be taken including account to lower the construction costs and reduce the need for imported materials while at the same time, it can reduce the embodied energy in construction process and construction materials production.

***Technology and/or service*:** Systems that provide required amenities to ensure habitability and comfortableness for the users include MEP (mechanical, electrical and plumbing) systems; Electronic security (CCTV – TV closed circuit, access control, intrusion and fire) systems; and Telecommunications systems (telephone, intercom, data computing, and internet).

Most high-rise buildings have central HVAC systems however the heating part of system are not typically included since the country is basically very hot. The most predominant systems are ventilating and cooling. As with elevators, these systems in many buildings have reached their state of obsolescence and are not working in almost all buildings where they were included. To ensure habitability and comfortableness of the indoor environments, considering the high temperatures reached during the hot season in the country, these obsolete centralized systems have been individually replaced by wall mounted air conditioning units—split and window equipment. These solutions have many problems, from low energy efficiency to the negative impact created on the façades due the external units placed without any design consideration and water infiltrations caused by the improper placement of drainage pipes. It is important to note as well, that the obsolete installations—conduit pipes, engine equipment, among others was not removed from the building, which has also caused damage to the buildings and probably represent a huge source of infection for the users (Roger S. Ulrich 105-8).

Elevators: All buildings with more than 4 floors are required to have a mechanical vertical system of circulation. Due lack of maintenance that characterized the period after independence, many high-rise buildings have no elevators functioning. Alternatively, stairways originally designed for emergency exit re used as the only means of vertical circulation though these buildings.

Electrical power is distributed through the public electrical supply network, which delivers 220/380V low voltage energy, as monophasic and triphasic systems respectively. All the buildings in urban settings have electrical system built-in (embedded) into the walls, which makes expensive to replace. The new constructions have been designed to meet the current practices and standards worldwide, and to allow easy replacements and maintenance. Even though, many elements of the electrical supply system are in a state of obsolescence, most electrical installations are still functioning. They are in very poor condition, representing a huge life risk for the users, since sporadic electrically caused fires have been common in the oldest buildings.

Gradually the owners of the buildings or part of the buildings—apartments, offices, stores, among others, are beginning to engage rehabilitations works which almost always includes the replacement of the entire MEP systems. It is common within the same building, to have parts of it which were renewed, rehabilitated or remodeled while others remain completely obsolete. The implications of these partial interventions are very clear: The building MEP systems are not working in their plenitude.

Basically all buildings in the urban settings are equipped with water supply systems that include water reservoirs—lower and upper reservoirs, electrical pumps [usually two units of pumps to operate alternatively], and finally an embedded water piping network for hot and cold water. Water recycling process in buildings has to yet to be introduced in the country. The only water recycle process implemented is the rainwater collection systems, mostly from the roof buildings of public services such as hospitals, health centers and schools. Expired materials life-cycle and, lack of maintenance aggravated by discontinuity of the material production in the market, led to the obsolescence of overall water supply systems in many buildings, with serious consequences such as problems of leaks, damage of steel embedded into the concrete structure elements due the humidity, buildings settlement due soil siltation, among others.

In old buildings, the replacement of plumbing systems has been made in the same manner as others services systems. Partial replacement of old plumbing systems is made by the owners of buildings in the process of rehabilitation and renovations. Sewerage systems are generally in the same conditions as the water supply systems. There has been a lack of maintenance and discontinuity of materials production.

The majority of buildings does not include television closed circuit, access control, and intrusion and fire detection systems. These systems are being included in the design and construction of new buildings. They are mainly applied in offices, commercial, banks, courts and industrial buildings.

Telephone and intercom systems or networks constitute the most obsolete part of older buildings nowadays. All high-rise building apartments were built with intercom networks, to enable communication between upper floors and ground floor. All these systems are obsolete due lack of maintenance, and they have not been replaced yet. Landline networks were common until the introduction of mobile phone systems, when they became less used.

With the advent of informatics technology, building design and construction process started to include data and internet networks. These are applied basically in the all types of buildings. The actual stage of building fabric in Mozambique reflects the economic and socio-cultural levels of the population and above all the countries' building policies. This situation can also be extended to healthcare buildings which leads to the need for new design approach as a means of reducing a reliance on mechanical systems.

Architecture of Hospital Buildings

Pavilion buildings characterize most hospitals in Mozambique. They were most built in rural areas than in urban areas, given their concept which is favorable for reduced reliance in mechanical systems to keep the buildings operating. Exceptions are in urban hospitals, central hospitals where the architectonic approach was based on integrating the hospital building in an overall architecture contextual style of the epoch. Hospitals have been running in very critical circumstances. Facilities are considerable old, added to lack of resources to run adequately these facilities, drive to the current situation of lack of maintenance, chaotic and overcrowded environment making it a challenge in running hospitals settings in Mozambique.

Considerable effort in extending healthcare network and rebuilt the existent ones have been made by Government and ONG's through the Ministry of Health, but much still to be done. New facilities design should enable to accommodate new healthcare technologies, health information technologies, and reduced reliance in mechanical systems, maximization of natural resources among others.

Figure 81: Maputo Central hospital: the main building façade (1960's**)**

Building Form and Style of Healthcare Facilities: Hospitals in the colonial era were designed and built following the trends in hospital design found around the world. Nightingale ward typologies and the Hill-Burton guidelines were the most predominant influences during the early 1910's to 1940's and 1950's to 1960's. The specificity in hospital design practices during that period was embedded within the Portuguese colony architecture style by 1950's to 1960's.

Figure 82: Maputo Central Hospital: private room (1929**)**

Basically hospital buildings were characterized by the use of modern engineering techniques—concrete structures with a high building quality. Hill-Burton design guidelines influenced double-loaded corridors plans for hospital buildings which consisted of a central corridor that was flanked by rooms open to it, from both corridors sides (Verderber 26). In most old hospitals, for example the Miguel Bombarda Hospital, currently known as Maputo Central Hospital, was built in phases from 1900's to 1940's. The typical ward was a Nightingale ward and private patient rooms were provided for isolation.

Figure 83: Maputo Central Hospital: ward (1929)

Figure 84: Double-loaded corridor plans: Lichinga Prov. Hosp & Chokwe Rural Hosp. Moz

The most common design plan is the double-loaded corridor typically arranged as room-corridor-support space or ward-corridor-support space. The double-loaded corridor plan has significant advantages to the race-track plan because it is basically a narrow and long footprint plan with operable windows in both façades which ensures natural ventilation and daylight within the building. The support services and doctors' offices are distributed along the building block, which is typically rectangular shaped. The support area linearly arranged enables the related services to be close to the patient treatment area or to the patient wards, which reduces staff travel distances, and ensures better proximity between the physicians and the patients.

The drawback of this plan typology includes limitation in defining and/or distinguish clear circulation hierarchy such as of back of the house/clinical traffic versus secondary circulation—the central corridors are mixed circulation; location of nurse's station is not suitable for minimal staffing situations; depending of the site

Figure 85: 3-stories building at Maputo Central Hosp

Figure 86: Single-story building, Chokwe rural hospital

plan arrangement and organization, the location of these units may promote long travel distances for staff, among others. Infection control is another issue that must be addressed when the natural ventilation is the main source of fresh air within the facility. These issues should be carefully addressed for the future of design facilities in Mozambique.

Other dominant characteristic of hospital buildings in Mozambique is that they are typically low-rise rather than high-rise, and their plans extend horizontally. Basically in the urban settings hospitals are typically a maximum of 5 floors while in the rural areas they are not more than 2 floors high. The reasons for these options are basically related to the cultural habits of the population, the lack of the reliability in mechanical lift systems and the need to minimize energy consumption. This approach is commonly implemented in developing countries, given scarce resources lead to sustainable design by default, through avoidance of wastefulness and unnecessary energy consumption.

Figure 87: Women and children Wellness Center, Nairobi Kenya

Figure 88: Shaded courtyard at Women and children Wellness Center Kenya

Figure 89: Ophthalmic surgical training center, Accra Ghana

More recent strategies for low technology dependent healthcare facilities were recently applied in a couple of hospitals in Africa including “Kenya Women and Children Wellness Centre in Nairobi” designed by Perkins+Will and “Ophthalmic Surgical Training Center, Korle Bu Teaching Hospital in Accra, Ghana” by Broadway Malyan. The designers of these facilities adopted low-rise buildings with multiple courtyards—covered and non-covered, playing that serve different roles from the opportunity of providing views, daylight and natural ventilation to the use of the covered courtyards as “external rooms” to allow the population to develop their activities and interact outdoors, which is linked to cultural practices. Other strategies such as a 2 meters overhang throughout the buildings perimeter provide fixed level control from the sunlight, and the incorporation of renewable energy system—solar panels along the roofs took the maximum advantage of local climate and building location—on the equator which reduces drastically the need for electrical energy in Kenya women and children’s’ hospital. (Brooks, Market Report:

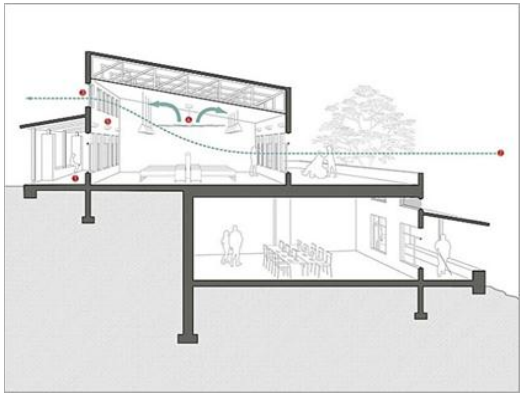


Figure 90: Cross ventilation and access to daylight: Butaro Hospital, Rwanda

Figure 91: Women's ward- access to daylight & ventilation

Figure 92: Large opened window & skylight, outpatient area, Butaro Hosp.

Africa - Emerging Hope & Tools to Succeed 27, 31) (Knutson:Perkins + Will 21-31).

"Butaro hospital in Rwanda", designed by MASS Design Group, had a similar approach to the design conception. Wide and natural cross-ventilated wards were designed with the aim of mitigating and reducing the transmission of airborne diseases in a contextual situation where it is difficult to afford and maintain central mechanical ventilation systems. The strategies applied include elimination of tiny corridors through single loaded corridor plans to facilitate patient and staff flow; placement of several operable windows and the strategically located low-speed fans to move air from the wards to outside, that produce the necessary air changes the wards, and ensure the removal of potentially harmful microbes without the needing for mechanical ventilation. At the same time, access to daylight reduces electrical lighting. [(Brooks, Market Report: Africa - Emerging Hope & Tools to Succeed 25) and (Fallon)].

Figure 93: Outpatient waiting area, Beira Central Hospital

Figure 94: Inpatient ward, Beira central Hospital

As all other buildings in Mozambique, hospitals have been designed to fit the same requirements for the tropical humid climate context. Hospitals in Mozambique traditionally house large number of ill people, in wards for 6 to 8 people each. The increasing population growth and sporadic disease outbreaks caused by flood and others natural disasters has placed demands on these facilities which were not sized for the large number of patients seeking care. Thus, chaotic environments such as overcrowded wards, waiting areas, and outpatient services lead to lack of privacy and confidentiality; decrease speech legibility and patient sleep; decrease infection control and increase overall stress in patients and staff. These factors represent a tremendous threat for terms of health, safety and wellbeing.

Specific design parameters to meet the local climatic and ensure healthy and safety in healthcare facilities include:

- Hospitals buildings are mostly oriented North – South (figures 66 and 67), with special attention for the rising east and setting west sunlight. North and

Figure 95: Double-loaded corridor- NICU, Maputo Central Hospital

east façades are basically shadowed by horizontal sun-shade while south façades are naturally non-exposed to direct incidence of sunlight. The west façades are usually blank façades without windows. The combination of all these principles, added to the use of roof insulation solutions, hollowed blocks or bricks walls and the placement of operable windows throughout the building provide an opportunity for good ambience in means of indoor temperature, humidity and air quality, which in turn trend to promote health and well-being;

- Plan typology—single and double loaded corridors, and narrow building footprints respond to the specificities of local climate. Hospital building footprints are basically narrow and extended, with operable windows and clerestory in both façades which makes it more likely for buildings to take advantage of natural ventilation and daylight;
- Windows that provide daylight and sunlight also serve as a link between nature landscape (outdoors) and indoors, providing for building occupants the sense of time and position within the daily cycle (Bourbekri 2). As known, the

Figure 96: Operable windows: ventilation & daylight, Beira Central Hosp.

Figure 97: Windows panel: Daylight and visibility Clinical Lab, Beira Central Hosp.

absence of natural light causes a lack of vitamin D, which in turn is the major cause of various illnesses such as bone disease, seasonal affective disorder, heart disease, multiple sclerosis, cancer and diabetes (Bourbekri 68-77). In Mozambique it is a traditional practice to provide windows in basically all portions of the building, however the size and the quantity of the windows is still not being clearly specified. It is still necessary to determine the amount of sunlight and daylight captured inside the buildings versus the required need of these natural resources to ensure health and safety of the patients and staff, above all in the crowded wards and outpatient services (Bourbekri 2,4,5);

- Well-designed natural ventilation strategies provide healthy air for breathing by both diluting and removing the pollutants originating in the building. Local hospitals include operable windows in all compartmentalized areas, strategically located to ensure cross ventilation above all in the patients' wards, and waiting areas. Three basic steps should be taken during the design process to evaluate, namely: (a) "*ventilation rate which is the amount and quality of*

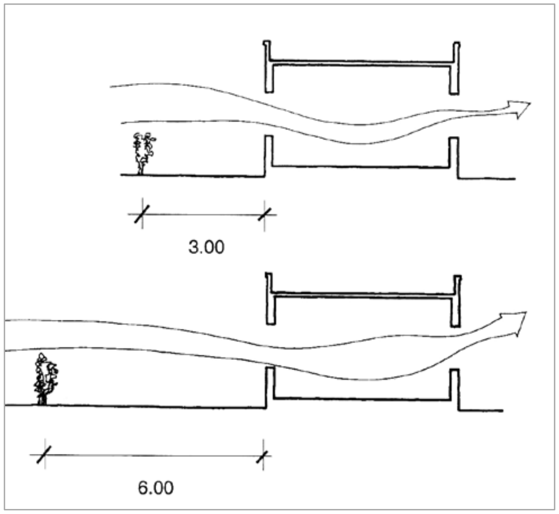


Figure 98: Cross ventilation: Conceptual diagram – vegetation close to the windows obstruct air flow

outdoors air provided into the building"; (b) "*airflow direction in the building, which should be from clean to dirty building zones*"; (c) *air distribution which related to the way in which the external air is delivered to each space within the building as well as, the way in which the indoor air is removed from the building*" (P. G. WHO 7).

The healthcare system in Mozambique relies in funding from governmental and NGO international partners, and is still struggling to meet the basic health needs of almost 24 million people, in which almost 70% lives in rural areas with lack provision of healthcare assistance and facilities people (INE - Direccao de Estatisticas Demograficas 12). International donors play an important role on determining how to use the donated financial resources.

During the design process, through many years, decision makers and designers have debated two important variables to balance what decision or solution may benefit the majority of the population, namely: To build fewer but higher standard healthcare facilities that would ensure the best health care service for people versus to lower the standard and built more facilities that would provide coverage for more of the population? Certainly the decision makers—government, ONG donors and international partners—decide how and where to provide primary health care to the majority of the population, which lies over the NHS—public healthcare system—and also it meets the main goal of the health sector in Mozambique. However, these political decisions have driven the health building design practices to the low road approach. The state of art practices in health facilities has been disregarded for the second rate. Now it is the time to make a shift to developing the right tools that will help to improve current design practices to meet a higher standard of healthcare needs, while at the same time, these tools are developed to accommodate variation to universal standardized design through design principles applicable and achievable for the current Mozambican context.

Materials applied on healthcare facilities: Basically the rough materials applied on building construction process of hospitals and other health care facilities are the same used for the common building construction process, as outlined previously.

Important differences are related to the finishes materials. It is required that the finishing materials for the healthcare facilities provide a safe environment for all users, however due financial and cultural reasons; it is common practice in Mozambique to employ medium level standard materials that are durable and require less maintenance. Finish materials usually applied on healthcare buildings in Mozambique include:

Figure 99: Tiles and vinyl floors: Clinical Lab, Beira Central Hosp.

- Floors and walls are mostly covered by ceramic tiles to ensure easy cleanliness even with fewer resources. Floor and wall tiles have the disadvantage of having grout joints that tend to be porous, which represents a huge source for nosocomial infectors' microorganisms (Fallon 4). On the other hand, tiles are durable and cheaper in Mozambique than non-permeable, continuous floor finishes such as vinyl sheets. Vinyl sheets are applied on floors and walls of the areas only where required for the avoidance of infections risk, such as operating theaters, intensive care units, clinical laboratories, and sterilization departments among others;

Figure 100: gypsum board ceiling: Clinical Lab, Beira Central Hospital

- Ceilings are usually made of gypsum boards or reinforced cement slabs. The need for noise absorbent materials on ceilings still needs to be carefully addressed. Little attention is paid to the in Mozambique choice of absorbent ceiling tiles, since research studies are not being conducted in the country and there is limited access to information sources and publications to keep track of the latest findings and solutions on the field of health care and design facilities;

Figure 101: Stainless steel equipment: Clinical Lab, Beira Central Hops

- Fixed equipment and sanitaryware include non-movable equipment, mounted on the work areas, while sanitaryware are plumbing features mounted in rest rooms. Healthcare facilities typically employ stainless steel equipment and sanitaryware because it ensures cleanliness, durability, does not break easily, and is light weight;

Figure 102: Wall mounted fixtures, Clinical Lab, Beira Central Hosp.

- Locks and hardware may be considered as another main vector for nosocomial infection diseases. In Mozambique access through doorway sensor systems or code systems has yet to be widely employed. That fact enlarges the opportunity for infection transmission by opening the doors with non-washed hands or even infected hands.

***Technology and services specific in healthcare facilities*:** Comparatively with other regular buildings, healthcare should accommodate specific technologies and services that meet its aim. Communication technology systems to ensure operativeness of the medical equipment—gases network and specific wireless to allow specific medical software to run efficiently constitute a requirement when planning a healthcare facility.

Healthcare facilities in Mozambique use typically natural ventilation, which is the "*access of natural forces—e.g. winds—driving outdoor air, into the building through the openings such as windows, doors, solar chimneys, wind towers and trickle ventilators. This system relies on the climate, building design and human behavior*" (P. G. WHO 7). Exceptions to this practice include spaces such as operating suites, sterilization departments, clinical laboratories and all other sensitive spaces in which it is universal practices and mandatory not to have openings within the room, to ensure good air quality and infection control. In these areas ventilation is provided through a mechanical ventilation system—HVAC.

Currently, none of the central mechanical ventilation systems—in all hospitals—are in use due to the lack of maintenance. These obsolete systems were individually replaced by wall mounted air conditioning units—split and window. This solution provides cooling air where there is not any windows to allow natural ventilation. At the same time, these practices raise the issue of infection control.

Hospitals with more than two floors have provision for elevators and alternatively, provide a ramp to accommodate the needs for easy circulation, if for instance the elevators are not working properly. Thus, the hospital buildings are designed to operate with or without reliance in mechanical systems for circulation. Security staircases are also provided in each building, to ensure security exit in case of emergency in each building.

before it occurs" (Rostenberg 14-5). "*Imaging techniques, medical health records, physical examination and laboratorial information, all together play an important role in healthcare, and are used in diagnosis and treatment procedures to confirm the presence or absence of disease, control the effectiveness and progress of the medication in administration, as tool for diagnostic and therapeutic procedures, provide information about patient's condition and provide evidence in medico-legal events*" (Rostenberg 83).

The exponential growth of modern and high-tech hospital equipment over the last several decades has enhanced the quality of care delivered to the patients, thus saving their lives. Recognized growth in imaging technology, life support systems and electronic information management is cited in a large body of research as being a huge achievement in means of delivering care with quality and safety. These achievements have a notable impact on disease prevention and patient safety since they are most focused on preventive medicine, identifying the potential for disease

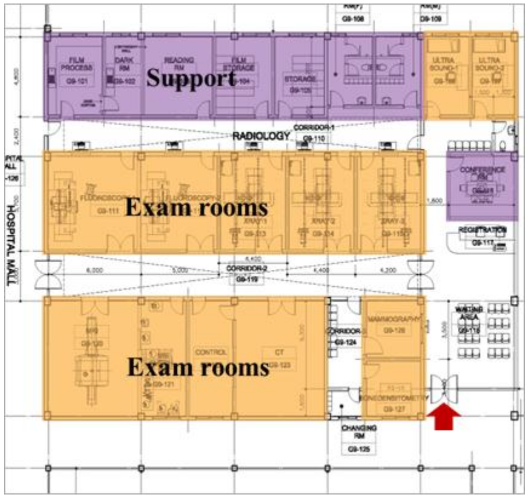


Figure 103: Imaging depart plan: Quelimane Central Hosp. (new facility)

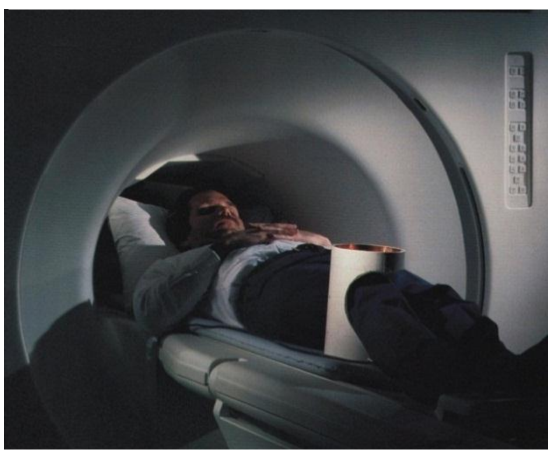


Figure 104: MRI scanner equipment

Healthcare technology in Mozambique needs to be largely expanded, as is happening in other developing countries in the same region. The first MRI (magnetic resonance imaging) equipment was introduced in Mozambique only 5 to 10 years ago. Older hospitals are not designed to support new healthcare technology. The installation of new healthcare equipment typically requires changes and adaptations of the facilities to fit the functional requirements of the equipment.

The new fourth level central hospital—Quelimane Central Hospital at Zambezia province, was designed with space for extended imaging services, however the plan seems not to meet the requirements and principles to fit some of these technologies. The facility as planned to be built in 2012, foresees a radiology department, designed as double corridor layout in which the support services' area is not centralized for easy access from both areas. The zonings for public, semi-restricted and restricted areas are not clearly defined. The department includes two fluoroscopy rooms, three x-ray rooms, one MRI (magnetic resonance imaging) room, one CT (computer-tomography) room, one mammography room, one bone densitometry room, and two ultrasound rooms. The support area basically includes space for film processing dark room, reading room and film storage, which implies that the medical imaging will still be processed in a traditional way, recorded in films for display.

Radiology information system (RIS), picture archiving and communication systems (PACS), and image management and communications systems (IMACS) are not being implemented in the health sector yet. Constrains such as cost, complexity of the implementation of healthcare information technology (IT), and the need of sophisticated changing of the culture in health institutions, may be the major barriers for the extended use and implementation of healthcare technology.

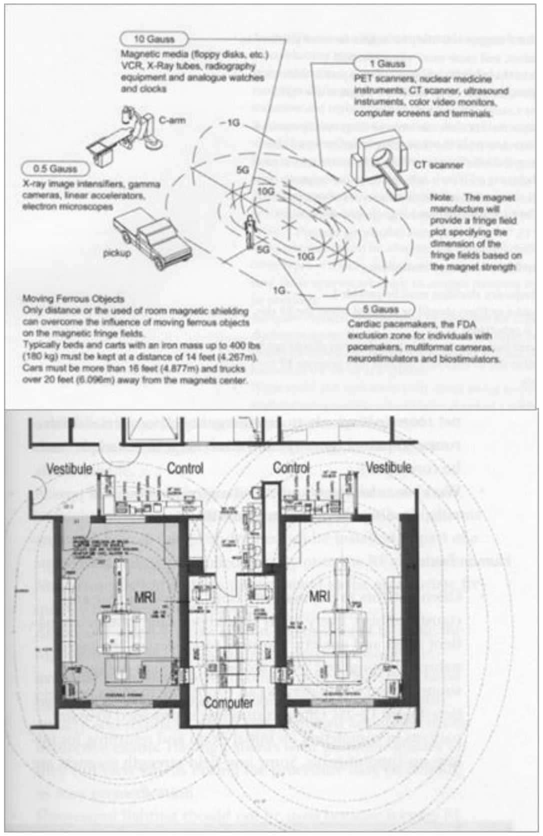


Figure 105: Minimal distances to be kept away from the center of magnet field and MRI rooms: Magnetic field radius

Imaging facility design should take in account the specific planning and design considerations required for each imaging technique planned for the facility. Above all, more attention is required for those that have considerable magnetic field that may impact and harm people and goods moving close to the magnetic center field. Important considerations should also be taken in account on the interference of metal objects and other imaging equipment emitting magnetic fields that may negatively interfere in the quality of diagnostic performed (Rostenberg 280-94).

Space need requirements have been changing over the time, along with the changes of the technology. Thus, facilities should careful address space needs and zoning requirements, technical issues and human factor aspects for current and long-term programs.

The national health system relies on a Health Information System (HIS) or hospital information system (HIS), which does not meet the entire needs of National Health Service in the current context. The aim of this information system is to gather, analyze/ produce and disseminate information to quantify and monitor the state of health of the population in Mozambique. Limitations of resources characterize the current stage of health information technology in the country. The need to provide innovative yet affordable electronic information technology in healthcare, with a focus on new medical imaging techniques is rising permanently along with patient needs.

Information technology in healthcare facilities has the potential to improve quality, safety and efficiency of healthcare, through collecting, storing, retrieving and transferring electronic health information on patients at the same time that it reduces the risk of handwriting or other staff communication errors (Abt Associates 157, 159). Electronic information management aims to reduce time for patients and staff by reducing the number of process-steps in a ordering, processing and evaluating a service provided, while at the same time enables the access of the medical information across the physicians, hospital departments and between different healthcare institutions across the country (Rostenberg 14, 15). Implementation of healthcare IT when properly employed can leads to the reduction staff while at the same time increase patient satisfaction and staff productivity.

Currently, new private and public healthcare facilities have been implementing and use IT as a passive tool to store patient information and drugs prescription. More complex using of these tools including x-rays and other imaging orders; laboratorial exam orders; exams reporting results; consultations report; patient transfers; clinical decisions support systems; error alert systems; among others, are still not being widely employed (Abt Associates 159). Additionally, weak access to communication systems such as internet and wireless, and electrical energy in more peripheral areas—villages and small towns—constitute a huge limitation to implementing these technologies in all healthcare settings. Thus, healthcare facilities should be planned and designed to fit both systems: the use of Electronic Information Management or Health Information Technology; and the traditional

Paper and Pencil-based systems. The importance of maintaining both systems ensures care delivery and building operativeness even though the resources and qualified staff to run high-tech systems remain scarce.

During the planning and facility design processes, the gradual implementation of IT applications for administrative and financial, clinical and infrastructures uses should be considered. The most indispensable include computerized provider order entry (CPOE), electronic health record (EHR), picture archiving and communication systems, clinical decision support system (CDSS), bar coding technology for drugs, medical devices and inventory, automated dispensing machines (ADMs) and electronic materials management (EMM).

Conclusion

Many factors influence the planning, design and construction of facilities in general. Given the function of healthcare facilities, much attention should be paid during the design process. Form and scale of buildings must be addressed accordingly with climate, culture and economic factors. Materials and construction methods currently applied in the country had proven to be the most adequate in a context where skilled workforce is scarce. Additionally, these methods ensure durability and resistance of materials which in turn impact on the building life cycle. However, more should be done in terms of use of maximizing the use of local resources.

Solutions that include building technology that is not relying so much in high sophisticated mechanical systems should be the new approach. Solutions such as hybrid ventilation systems and low-rise buildings should be welcomed to minimize building operational costs and thus beneficiate as much as possible patients' population.

The current challenge is the introduction of healthcare technology and health information technology in new healthcare facilities. Decision makers and healthcare designers should together embrace this goal and provide building solutions to improve overall the quality of care provided. The most important goals of ensuring quality, equity, and punctual healthcare for the population, based on the principle of patient-centered care, underlined on the next chapter. These goals should be gradually achieved along with the improvements of healthcare facilities, in a means of planning, design and construction.

FUTURE OF HEALTHCARE DESIGN IN MOZAMBIQUE

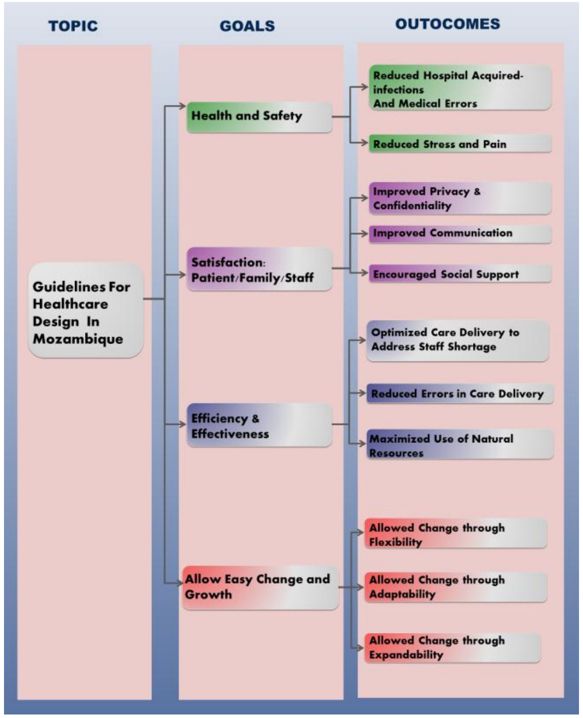


Figure 106: Goals and related outcomes: Conceptual diagram

The first three chapters of this study identify the facts and arguments that support the need for improvement of the overall design of healthcare facilities and infrastructures in Mozambique. As result was defined four main goals in which this new design approach should address. These goals are the backbone of a set of guidelines which aim to make available knowledge and tools that support state of the art practices in healthcare and that can be applied to improving healthcare design in the context of the country. The goals include:

- (1) Ensure health and safety for patients, staff and family
- (2) Create patients and family centered environments to ensure satisfaction
- (3) Ensure efficiency and effectiveness
- (4) Plan facilities to allow easy changes and growth.

Ensure Health and Safety for Patients, Staff and Family

The state stage of healthcare facilities in Mozambique promotes unhealthy and unsafely care delivery. A weak healthcare network and shortage of staff to cover and provide care for the majority of populations in need are the main constraints. Additionally, the poor social and economic conditions of the population make an ideal platform for poor healthcare service provided.

Figure 107: Driscoll Children's Hospital Pediatric Sub-Specialty Clinics, Texas

Health and safety should be high priority in all healthcare settings. Patients, staff and family should have access to universal standards of health care delivery through the adequate design of physical environment that considers diverse factors such as infections, air quality, noise level, light pollution, natural light, nature views and positive distractions, among others (Joseph 3). These factors play an important role in promoting health and safety through (A) reducing the risk of hospital acquired-infections, medical errors and other adverse events; and (B) reducing patient stress and pain, which in turn will ensure overall satisfaction and productivity for patients, staff and visitors.

Figure 108: Corridor, Driscoll Children's Hospital Pediatric Sub-Specialty Clinics, Texas

Figure 109: St. Elizabeth's Hospital Enumclaw, WA. By Mahlum

Reduce hospital-acquired infections, medical errors and other adverse events: Reduce hospital acquired infections through controlling and/or avoiding facility design solutions that enable poor ventilation and/or fungal contamination of the central mechanical ventilation system, poor access to daylight in large and frequently overcrowded wards, patient rooms and other hospital areas, easy contamination of surfaces—walls, floors and furniture, lack or wrong placement of sinks and hand washing soap dispensers, opportunity for stagnated water and/or lack of maintenance of water fountains, and poor selection of water fixtures. These are the most common pathogen sources of nosocomial infections (Roger S. Ulrich 106-9).

Nosocomial infections are not present in patients when they are admitted in hospitals, but many patients develop these infections during their length of stay in healthcare settings (WHO, 14: Hospital Hygiene and Infection Control 148). Staff as well is exposed to high risk of developing hospital-acquired infections (Joseph 3). Patients develop infections while housed in the hospital due their weak and

Figure 110: Building façade - windows to access daylight Butaro Hospital

Figure 111: Infection control: cross ventilation women's ward Butaro Hospital

altered resistance. In healthcare facilities the sources of infection and precedent contamination are defined as being staff, patients, visitors or the inanimate environment (WHO, 14: Hospital Hygiene and Infection Control 148).

From the point of view of physical environment, infection transmission may occur in three manners: *(i) contact, (ii) air and (iii) water* (Roger S. Ulrich 105). Reducing and controlling the main sources of nosocomial infections will make healthcare environments more safe and healthy. Patients and staff will be less exposed to new diseases and will spend fewer resources for cure and in length of stay in healthcare facilities. On the other hand, staff will increase productivity and quality of care delivery, due the health status which in turn benefits directly the patient and the institution. Design solutions to reduce nosocomial infections include providing isolation capacity through reduced ward bed-capacity; maximization of the use of air filtration (HEPA) in appropriate hospital areas; careful placement of operable windows to enable high ventilation rates, adequate air flow direction and air distribution (P. G. WHO 7); strategic placement of sinks, liquid dispensers & alcohol rubs to support hand washing; appropriated selection of materials that are easy to clean; elimination of solutions favorable to water stagnation, back flows & dead pipes in the water supply system; appropriate choosing of fixtures – preferably wall mounted; avoid decorative water fountains in high-risk patient areas and designs that helps to maintain recommended temperature cold (below 68^{o}F) and hot (above 140^{o}F) and adequate pressure of water in the tank/reservoirs (Roger S. Ulrich 106-9).

The next goal should be to reduce Medical errors and adverse events through design solutions that eliminate the opportunity for occurrence of high noise levels, poor communication systems, light pollution, lack of work space, lack outdoor views, unit configuration in means of inadequate location of nursing core or support area which leads to the need of travel long distances to fetcher supplies for patient needs, mainly in a shortage of staff circumstances (Roger S. Ulrich 118). Medical errors and adverse events may occur due to failures of the healthcare systems or inadequate design facility. The more the caregiver is close to the patient fewer opportunities for errors are likely to occur.

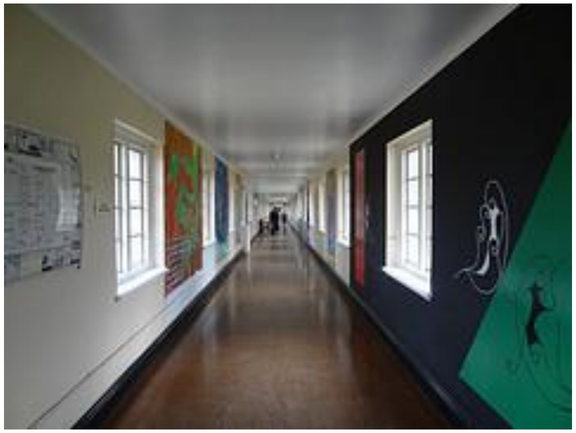


Figure 112: Very long corridor, 235m long. St. Georges Hospital in Horn church

In Mozambique, healthcare environments are likely to have poor lighting sources and high levels of noise due permanent overcrowded spaces. On other hand, the facilities are designed with long travel distances, which further compromises care when there is a shortage of staff. Altogether promote staff distractions when they are performing their tasks, fatigue, exhaustion, stress, resulting in reduced productivity, chronic effects on performance, These conditions promote overload, fatigue and medical errors and in worst scenario, it leads to staff burn out and long term negative effects on staff well-being (Roger S. Ulrich 118) (Joseph 10).

Medical errors and adverse events represent high rate of death in healthcare settings all over the world. They are basically the failure of performing a planned action

Figure 113: Operation room, Heart Institute, Maputo Mozambique

Figure 114: staff work space connected with nature, Cancer Center Univ. of Wisconsin

"error of execution", or the use of wrong plan to achieve a defined aim "error of planning". Both events are strongly correlated to injuries caused by medical management rather than the undergoing condition of the patient (Linda T. Kohn 28).

Reducing or controlling noise sources to meet the standardized noise levels recommended by WHO—35 dB or less for continuous background noise in inpatient units, with peaks during the night not exceeding 40 dB (Marberry, 2006)—will allow staff to perform their tasks in a quiet environment being less distracted and interrupted. The level of stress and exhaustion will decrease and ultimately fewer errors will occur. Design solutions to ensure reduction of medical errors and other adverse events should include installation of high performance sound absorbent materials (ceiling, walls & floors) to reduce noise, above all in chaotic environments; provide quiet and restrictive work spaces to be less interrupted and distracted, harnessing all work spaces with outdoor views, daylight and natural ventilation has impact of reducing stress (Roger S. Ulrich 117) (Joseph 10).

Figure 115: St. Elizabeth's Hospital Enumclaw, WA, by Mahlum

On other hand, low illumination levels—200 to 500 lux and 450 to 1,000 lux—found in large number of healthcare settings, impacts for the occurrence of errors in dispensing medication and in pharmacies (Marberry 72-3). Providing adequate bright lighting levels—1500 lux—recommended in staff work areas will ensure accuracy in performing critical tasks (Roger S. Ulrich 118) (Joseph 10).

Reduce patient stress and pain: Stress and pain experienced by patients and staff in healthcare settings have relevant negative outcome and they negatively impact all other health outcomes. There are many causes that can lead to negative impact on the health and wellbeing of patients, staff and visitors in general. A large body of research had shown evidences of negative effects of stress and pain on health and well-being (Marberry 37, 51) (Roger S. Ulrich 125).

Stress may be caused by infinite factors from fear of undergoing medical and surgical procedures, and painful medications to the disturbance of social relationship. These causations are directly associated to the state of illness, medical procedures, and the organizational culture of the institution. They are unavoidable (Marberry 37). Noise is the most critical source of stress, and the design of physical environment should carefully address the issues related to noise.

Physical environment features play a huge role in overall stage of stress of the healthcare users. Poorly designed facilities may worsen the condition of stress due weak opportunity for privacy, noisy environments, spatial disorientation, lack access to nature features including daylight, ventilation, outdoor views, lack of green spaces—gardens, courtyards, playgrounds, lack of healing and spiritual spaces (Marberry 37) (Roger S. Ulrich 125).

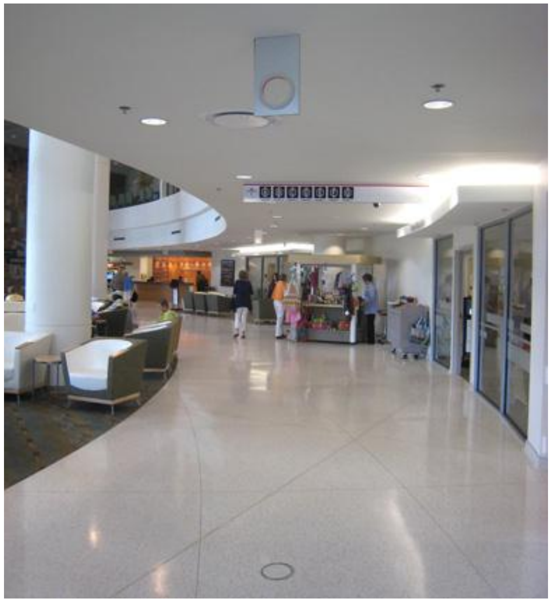


Figure 116: University of Arkansas for Medical Sciences in Little Rock

These conditions also affect directly the staff which is usual undergoing stress due overworking, long shift turns and sleepless (Marberry 37). For patients, these unhealthy physical environment features have direct effect on psychological, physiological, neuroendocrine and behavioral changes. The stress response, suppression of the immune system which in turn, decreases bodies' resistance to infections and worsens the recovery process and outcomes (Roger S. Ulrich 126).

Figure 117: Patient Room, Community Hospital of Monterey the Peninsula, California

Pain is strongly correlated to lack of exposure to bright light,—both daylight and artificial light—nature views and is also correlated to the exposure to noisy environments (Roger S. Ulrich 120). According to distraction theory "*pain requires considerable conscious attention. The theory predicts the more engrossing an environmental distraction, the greater the pain reduction*" (Roger S. Ulrich 121). Thus, when patients experiment pain, they use all available amount of conscious attention, which turns the sense of pain more heavily (Marberry 47). Planning and designing healthcare facilities that provide opportunities to access all pleasant distractions above described, namely: abundant daylight and sunlight, views of nature, positive distractions such as nature themes TV programs, and objects of artwork among others, will boost patient and staff mood and satisfaction; enhance therapeutic and restorative effects on patients, increase staff productivity, reduce length of stay, pain and stress, will increase physiological, psychological and emotional patient changes achieving in that way health quality, wellbeing and safety for patients, staff and family in all healthcare settings.

Create Patients-Family Centered Environments to Ensure Satisfaction

Figure 118: The Hansen Oncology Center (Margaret Mary Community Hospital), IN

One of the major benefits of patient and family centered models such as “Planetree Model Hospital” is because it enables the prevention of many problems before they get out of control. Patient and family centered care foresees the direct participation of the patient and family in the care process, through providing physical environmental spaces to support social support (McCullough 89) (Malkin 23).

Social support provided to patients by their family members and friends positively has an impact in reducing stress, anxiety and overall improving patient outcomes (Marberry 53). Respect for each families culture, values and believes, access to patient information by family members, an appropriate environment that promotes trust for sharing information, and that promotes confidential communication between staff and families are the principles that may be established to ensure this correlation (McCullough 88-9). Designing improved facilities to promote and enable (A) social support; (B) privacy and confidentiality; (C) communication through speech illegibility, will ensure satisfaction and confidentiality for patients, staff and family (Roger S. Ulrich 134, 136, 137).

Figure 119: Hospital of Sant Joan Despi Doctor Moises Broggi, Spain

Provide settings that enable social support: Promoting social support, physical environment design and features should encourage social interaction. Buildings should be designed to facilitate access to information, access to patients through proximity, clear way findings for better navigation and reduction of spatial disorientation, opportunities for privacy, confidentiality and speech legibility among others (Hamilton & Shepley 161).

Figure 120: Patient room with extra bed/seat, Legacy Salmon Creek Hospital, Vancouver

Mozambique has traditionally had a culture of "social support"; however its healthcare facilities are not designed to address this need. A shortage of staff in the national health system, makes it desirable that family members are welcomed in healthcare facilities to support—bringing food, helping to shower, to eat, to walk, etc—their sick relatives. Because the support provided is not based on international principles, the expected patient outcome is still far from being achieved. Patients and family are not actively participating in decision process of the care provided; the facilities are not allowing privacy and speech legibility; and the most important, the patient is not considered and respected as an individual with unique emotional and medical needs (Malkin 23).

Figure 121: Providence Newberg Medical center, by Mahlum

For patients, social support received from family members, friends and staff reduce patient stress and patients' psychological negative outcomes which in turn has positive impact on both patients and families. Family members also need social support to face, for example, a long-term illness or the death of their relative. A family members' long-term illness affects the entire family's well-being and health (Roger S. Ulrich 138). Social support is perceived as "emotional, informational support or caring obtained through interpersonal relationships, and tangible care delivered by others", healthcare design should enable the occurrence of this support. However much attention should be paid to avoid designs that boost social support through providing space for family in wards and patient rooms, because this situation can make these spaces high populated and noisy, taking away the sense of privacy and confidentiality needed for patients recovery process (Hamilton

& Shepley 161). The design process should carefully balance the advantages and disadvantages of each need versus each design solution to ensure patients, families and staff well-being and ultimately satisfaction.

Figure 122: Corian Hospital, ICU patient rooms

Provide settings that enable privacy and confidentiality: The lack of financial resources is the major limitation to achieve the goal of privacy, in terms of how it is internationally stated. The ability of having privacy is an important matter in care delivery, and it plays an important role on patient satisfaction and furthermore on patients' health outcome. Lack of privacy has direct consequence of compromising the level of care provided, if patients deny sharing personal information with caregivers to due speech privacy concern or any other visual privacy concern (Roger S. Ulrich 134-5).

Thus, healthcare facilities should be designed with physical environmental features that provide opportunity for speech and visual privacy, and confidentiality which includes high performance sound absorbent materials, and hard-walls, compartmentalization instead of curtains. Conference, report and education rooms should be provided to allow family-patient, patient-caregiver, and caregiver-family conferences and sharing of private information. Additionally design approaches

Figure 123: Speech eligibility - alcove or waiting area Legacy ER in Frisco, Texas

that separate patients' rooms or wards from hallways, nurses' stations and other potentially noisy areas should be carefully balanced and considered as solution to ensure privacy (Marberry 54) (Roger S. Ulrich 136). Not less important is the provision of waiting and lounge areas with flexible furniture layouts to provide opportunities for privacy. Day rooms for socialization located in-between patient wards and patient rooms will enable visitors—family members and friends—to have an opportunity for choice of space to stay during the visit time.

Figure 124: Seating arranged to support communication, Metro Health Hospital

Provide settings that improve communication: Staff-family communication facilitates the involvement of family members in patients' care decision, which helps to meet family needs and reduces patient and family anxiety, fear, and stress (Roger S. Ulrich 137). Communication among staff members is essential to meet the medical care for patients. Communication between patients and their families reduces stress levels and anxiety further more ensuring satisfaction (Hamilton & Shepley 226). All these three stages of communication encourage social support which is the platform for patient, family and staff satisfaction.

Physical environments that enable speech legibility and improve communication should be designed in order to reduce noise propagation, shorten reverberation times, diminish propagation of voices & lessen sound pressure intensity through placement of high-performance absorbing materials—ceilings, walls and floors; through lower ceilings; providing appropriate space for staff-family conversation and alcoves for more private conversations; waiting areas with flexible furniture layout to provide opportunity of privacy and speak legibility.

The use of private and semi-private rooms is an approach the NHS cannot afford its implementation in a public health sector context. However, it should be seen as an achievable goal in a long term period.

Patients satisfaction if will be improved all points mentioned above combine with each other in order to provide as much as possible facilities that are friendly, do not harm, not harming, and are easy to copy. The facilities should enable and positively respond to patients, staff and family concerns related to their staying in healthcare facility; insensitivity regarding health problems and hospitalization that the patients maybe incurring while in healthcare facility; patients and family inclusion in care decisions; satisfaction of patients' emotional needs; and continuous information or interaction between nurses–patients-family (Roger S. Ulrich 137).

Ensure Efficiency and Effectiveness

Figure 125: Banner Health Medical Center Banner, Arizona

Designing facilities to ensure efficiency and effectiveness for better care delivery should take in account resources limitations—human and finances resources—users' expectation, space needs for work flows and process of the services to be delivered, incorporation and adaptability of healthcare technology and information technology to support an efficient and effective care delivery models for present needs and future programs (McCullough 119-20). Currently, for Mozambique, the most important reasons to approach healthcare design that ensure efficiency and effectiveness include (A) Optimize care delivery to address staff shortage and (B) Maximize the use of natural resources (McCullough 152) (Roger S. Ulrich 147). Designs resulting from this approach should enable maximum efficiency and effectiveness in care delivery, even with limitations of resources.

Optimize care delivery to address staff shortage: The shortage of healthcare workers is a global problem, due the fact that the average nursing staff is becoming older. Thus an active healthcare staff should be able to deliver more work without spending more effort (McCullough 120) (Roger Zimring et al 5, 6). Staff (nurses), should spend more time providing care and assisting patients than performing peripheral tasks such as travelling through facilities to fetch supplies, documentation consuming, and care coordination activities (McCullough 120).

For the actual context of Mozambique, staff shortage is one of the major limitations that prevent the NHS from providing a better quality of care. Thus to fit the limitation of nurses and other health staff, nursing unit design should enable observation from a centralized nursing station to the different wards. The location of support services close to nursing station is an ideal approach, although it will negatively impact travel distances. In a linear unit configuration—double loaded-corridor, race-track plan, courtyard and articulated building plans, nursing work

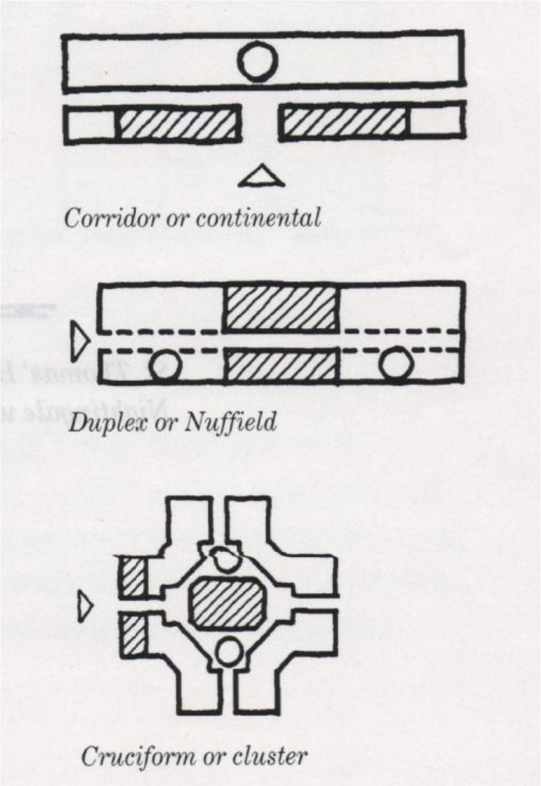


Figure 126: Nursing Unit: Typical Configurations

core is distributed along the building. This represents the best solution because it allow reduced movements of staff to fetch supplies—if provided duplication of work core area—which in turn ensures more time spent delivering care to patients. These plan configurations however are not optionally addressing others important measures including the need of visibility between staff teams for more efficiency; visibility between nursing stations and patient wards/rooms to ensure efficiency and effectiveness (Hamilton 103-4; 116-7; 193-6) (Roger S. Ulrich 145). In a double-loaded corridor and race-track units, patients and staff satisfaction is considerable less although in terms of availability of human resources, the linear shaped unit can work perfectly with less staff. The location of staff support areas and amenities such as lockers and others in linear unit configuration, are usually far from the core service area. In this configuration, the visual accessibility to patients from the nurses' stations is more limited, which causes overall dissatisfaction (Hamilton 116-7). Articulation of linear configured plans—double-loaded plan, can provide more flexibility in optional solutions that better addresses, visibility and limited staff. These options include courtyard and articulated building plans.

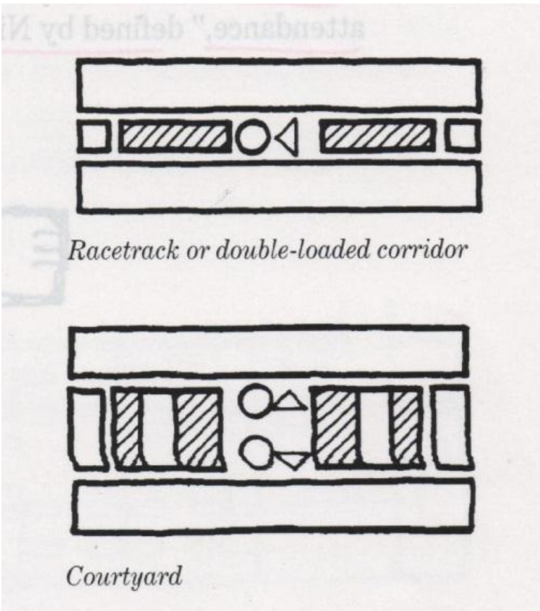


Figure 127: Nursing Unit Configurations

Racetrack plan, which consist in 2 corridors flanked by patient rooms, with staff work core located between both corridors—in a central area, is considered a good solution for having large number of patient rooms or wards in the same floor. The drawback of this plan configuration is to have limited space for support area which unable to have duplication of utilities rooms. Additionally, the central location of staff and work core area are not allowing access to daylight, views and natural ventilation required for improve staff efficiency and effectiveness. Introducing courtyards in a central area of a race track plan for allow access to ventilation and daylight, may result in a courtyard building plan, which also will require additional nursing stations and may slightly increase travel distances (Hamilton 193-6).

Figure 128: Salam Cardiac Surgery Centre, Soba (Khartoum), Sudan

Figure 129: CBF Women's Health Center, Burkina Faso

Maximize the use of natural resources: Natural resources should be used more efficiently in healthcare settings in Mozambique, in order to enable facilities to deliver care with the fewest human and natural resources. Buildings should be sustainable and address the social, environmental and economic realities in which they are built, yet maintain required standards necessary to meet the state of art in care delivery. During the planning and design processes clear decisions should be made about where the building should be sited, its orientation on site, building scale—footprint and building envelope, materials and systems to apply and how the building will be operating and maintained through its life cycle with the lowest consumption of resources.

Maximizing the use of natural resources provides innumerous advantages including: generating less waste, less carbon dioxide (CO_2) emissions, avoid loss of energy and maximize use of daylight and natural ventilation which in turn reduces energy costs for artificial lighting, mechanical ventilation (heating and cooling).

Figure 130: CBF Women's Health Center, Burkina Faso

The benefits expand to the optimization of indoor air quality (IAQ), providing opportunities for outdoor views and connections with nature. The use of recycled materials with low volatile organic compound (VOC's) emissions also ensures indoor air quality. Maximum use of natural resources implies less consumption of public water maximizing rainwater collection and storage for self-consumption (Guenther & Vittori xiii, 9, 10).

The measurable outcomes generated by the use of natural resources may be achievable if carefully studied and addressed in all the design requirements related to each sustainable technique included in the building program from the beginning. All these factors together ensure efficient and effective building functionality, by "protecting the immediate health of building occupants, protecting the health of the surrounding communities and protecting the health of global community" (Marberry 88, 90, 96).

Water and energy consumptions represent the major costs in healthcare settings worldwide. The hospital bed consumes about 300-550 liters of water daily, and hospital energy consumption is an average of two times more than the energy consumption of an office building (Guenther & Vittori xiii, 272). Reusing these resources mean savings of money for healthcare facilities. The planet has been threatened by global warming, which major cause is the production of energy that generate carbon dioxide, added to the increasing rise of energy prices worldwide; and on other hand, the threat of water scarcity on the planet constitute the top reasons to address sustainable design strategies for water and energy savings.

Plan Facilities to Allow Easy Change and Growth


Figure 131: St. Elizabeth's Hospital Enumclaw, WA, by Mahlum

The permanent growth of the population drives to the need for changes and enlargement of many healthcare facilities. Constant change and advance in medical diagnostic and treatment modalities and health information technology have driven the need of plan and design facilities to accommodate both current and future programs. Thus, from the beginning, the planning and design process should include approaches to allow facilities Flexibility adaptability; and expandability. All these changes should be accommodated and adapted efficiently, with minimum disruption of buildings operability and functionality, and minimal investment incurred (McCullough 57). Planning and designing in flexibility, adaptability and expandability enables buildings to adapt new design trends and health needs over the time.

Figure 132: Site selection: Vryburg Hospital, Norte Province SA

Figure 133: Façades and available space: Vryburg Hospital, Norte Province SA

Allow flexibility, adaptability and expandability: The site is defined by the contextual surrounding characteristics, and it is eternal (Brand 190). Site should be selected in order to allow growth of hospital buildings in an orderly manner as well as expansion of the main path systems to make easy wayfinding for all users as the building grows. The site should also allow space for exterior circulation system including parking lots and roads (Huelat 10).

To meet the main purpose of providing a healthcare facility, the site should be located near or within settlements and neighborhoods of populations in need—in cities, small towns and villages; should be easily accessible by walking, public transportation and automobile, through its location near main roads, junctions and other considerable means of communication; and should be able to accommodate current and long term projected programs (MISAU 35-6). Access to water, power, sewage and waste treatment services are other primary requisites to drive the decision of locating any healthcare facility. Utilities may be easily accessed along main roads. In order to ensure health and safety within the healthcare setting, if networks for utilities supply are not available, then the site should be able to accommodate alternative sources of drinkable water, power generation and sewage treatment systems.

Adequate adjacencies are required to ensure better care delivery for patients. Ideally interdependent departments should be grouped together to facilitate services flow for outpatient and inpatient segments, respecting as well the movement of people and goods within the facility. This is an important matter for time saving for all users. Basically, ancillary departments should be grouped together as well as inpatient departments should be located to be easy accessible from/to ancillary departments. The planning process in the early phase should develop a departmental evaluation relationship to ensure the appropriate and required service adjacencies (Kobus et al 23).

Universal Space Field

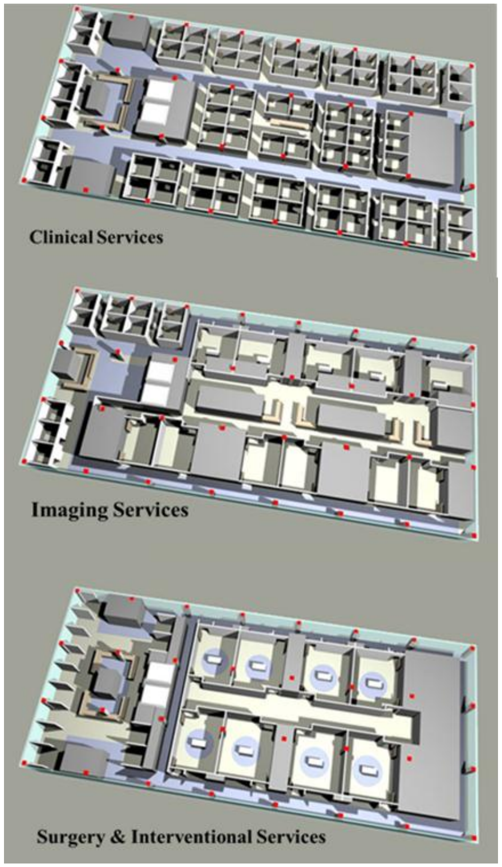


Figure 134: Planning space for long-term changes, by Martin NBBJ

The planning process should enable each department to be adequately sized to accommodate its functions. Functional planning should determine general operations concepts, identify the critical ones, determine space needs and required room relationship, considering the need for change and expansion within the time.

To allow for easy growth, departments should be planned in order to support independent open-ended growth. Thus, strategic location of soft spaces—administrative offices, conference rooms, storage rooms, etc—adjacent to spaces with high technology equipment and functions, is required. This approach is based on the fact that soft spaces are easy to change, eliminate, adapt, and are free of extensive and expensive infrastructure and technology (Kobus et al 23). Adequate planning of long-term changes—space departments, imaging, surgical and clinical offices; require the open-ended growth approach (NBBJ Martin).

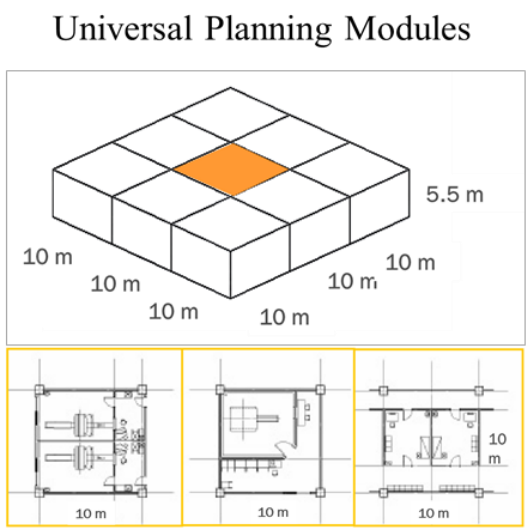


Figure 135: Planning space for short -term change, by Martin NBBJ

More flexibility may be achieved through the proper use of modularity, multiuse space, changeable and movable walls and systems within the facility. Modularity enables the planning of spaces for short term change—exam rooms, patient rooms or wards among other similar functions (NBBJ Martin). On other hand, healthcare buildings should be planned and deigned to accommodate evolutionary changes in care delivery—medical technology, and health information technology without recurring to expensive investments. Flexible and adaptable facilities are these facilities designed to easy respond future changes and needs. Universal planning modules and open-ended growth the principal approaches to be implemented during the planning and designing processes. Additionally, adequate floor heights, universally configured and same-handed rooms, patient bathrooms on exterior walls are other requirements to enable enhanced flexibility and adaptability (McCullough 230-1).

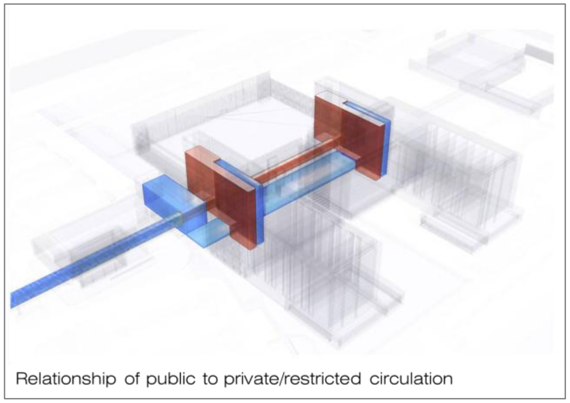


Figure 136: Circulation Diagram: Relationship of public to private/restricted circulation, NBBJ

If the circulation system is not clearly defined, all other facility components will fall down in a complex and maze-like environment. Circulation system should focus on separation of pubic traffic, service traffic and movement of goods. In other words, within the healthcare facility, the circulation system should clearly define primary, secondary and tertiary circulations; territoriality, departmental boundaries and departmental gateways, as well as well identified points of ingress and egress (Lion, Dubin and Furtell 238-46).

Overall the circulation patterns should be easy to expand in basically the main levels: primary and secondary levels. Particular attention should be paid during the planning and design process to ensure that the circulation path for movement of goods—back of the house is not easily obstructed, since it enable the distribution of supplies through the entire facility.

Conclusion

The level of healthcare that needs to be delivered in Mozambique is huge and impacted by the state of existing facilities. Existent facilities are not supporting the actual state of practices in healthcare due their extended life cycle and lack of maintenance. The goals to improve the level of service delivered in the national health system define the universal planning and design tools for healthcare facilities which will ensure health, safety, efficiency and effectiveness which in turn will ensure patient, staff and family satisfaction.

If carefully addressed during the planning and design processes all strategies defined through these goals, the expected outcomes will be a fact. The resources available should be applied and maximized in order to achieve optimal results—better hospitals, better services and better health and wellbeing. The government, NGO's, planners and designers should be aware of the state of the art practices in healthcare; recognize the need for change, and together move toward better serving the populations in need and respond to the increasing demand of better care service in Mozambique.

GUIDELINES

The purpose of Design Guidelines is to provide designers, planners and other design decision makers—Government and NGO's—with specific guidance tool for better understanding how healthcare facilities should be planned and designed to achieve best practices and achievable state of the art in healthcare design. The Guidelines cover two broad areas which were defined based on the specific state of healthcare facilities in the country, which is characterized by being mostly old and, diminished to the point that do not support state of art the practices in healthcare.

The design of these guidelines took in to consideration the social, cultural and economic aspects of Mozambique in the current context. The proposed set of Guidelines is composed by of two general areas of concern, Master Planning and Landscape, and Facility Organization and Design, each with a subset of guidelines as follows:

1: Master Planning and Landscape

Site Selection Criterion

Security

Outdoor Use Space

2: Facility Organization and Design

Growth and Adjacencies

Wayfinding: Circulation Hierarchy and Signage

Building Form and Scale

Each guideline covers the guideline definition; facility type and spaces; problem statement; related objectives; strategies of how to achieve the guideline and case-studies. Issues related to the site context and facilities 'design, if addressed accordingly with the guidelines strategies and objectives, will respond to the main goals of care delivery through achieving the expected outcomes in terms of (i) reduction of hospital-acquired infections and medical errors; (ii) reduction of patient stress and pain; (iii) providing settings that enable social support; (iv) providing settings that enable privacy and confidentiality; (v) providing settings that improve communication; (vi) optimizing care delivery to address staff shortage; (vii) maximizing the use of natural resources; and (viii) and building facilities that allow flexibility, adaptability and expandability for ease of change and growth over the time.

Site Selection Criterion

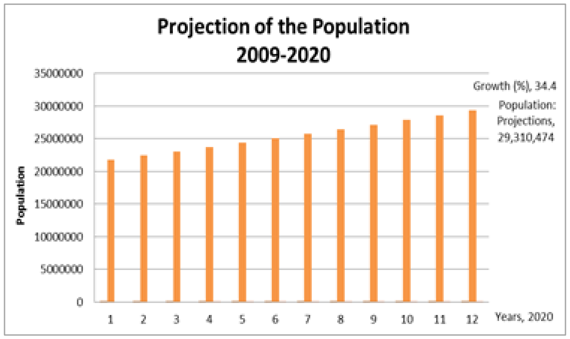
137: Surroundings of the site, Matola General Hosp. Moz.

138: Utilities & settlements / site under construction, Matola General Hosp. Moz.

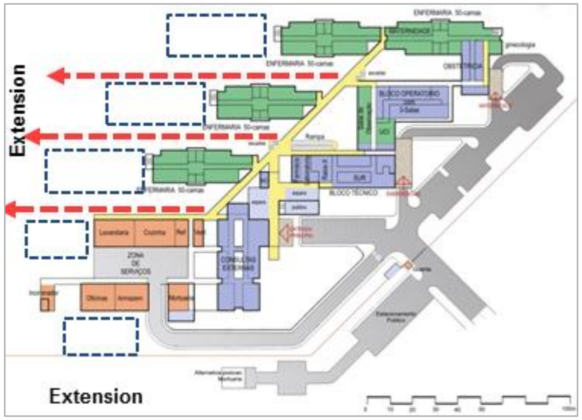
Site is the eternal geographical space where the building—healthcare facility is sited. The surrounding physical features—buildings, infrastructures, vegetation, and landscape, define its contextual environment. Adequate sites should be located near or within settlements and populations in need, easy to access by foot, public transportation or automobile and should have free space to allow growth, ability to accommodate current programs and projected 50-100 year’s needs.

Utilities including water, power, sewage and waste treatment plan are important key factors to provide healthcare with quality. Thus, site should have easy access to water, power, sewage and waste treatment plan. Avoid site located on flood plains and other areas prone to natural hazards.

This guideline should be applied for all healthcare facilities, particularly in central, provincial, general, district and rural hospitals.



139: Trends of population growth 2009 to 2020



140: Free space for facility growth Matola General Hospital Layout, Mozambique

Problem statement: Adequate selection of site for the construction of a healthcare facility is major key tool for successfully providing care quality care for people, in a country where the population is growing rapidly, in urban areas due migration factors. Available data indicates that the population will increase around 34.4% in 12 years, growing from 21,802,866 inhabitants in 2009 to 29,310,474 inhabitants in 2020. It is estimated that the population in urban areas will increase almost 10% from 30, 4% in 2007 to 40% in 2040. High birth rates combined with falling death rates and people returning from overseas the recent after war are other important facts that impact the growth of the population. (INE: Projeccoes Anuais da Populacao Total, Urbana e rural 2007-2040. 2010; Gaspar, et al. 2010; Carrilho, et al. 2006). These populations are settling in unplanned suburban areas, surrounding cities and are currently underserved in terms of access to healthcare. (Carrilho, et al. 2006; Sollien, Andersen, Costa, & Jekins. 2009). The health needs and expectations of the population will change constantly. As the country develops the capability to deliver increasingly sophisticated healthcare service.


141: Well with manual pump, Mozambique

It will require expanded programs and facilities. Limited access to clean drinking water and limited public sewage system are other main problems to be addressed during the site selection process. 57% of the population use unimproved sources of water and 80.7% of the population use unimproved sanitation system (MICS 2008. 2009; INE: Indicadores Socio-Demograficos 2010. 2010). Almost 16.2% of all deaths in Mozambique are caused by inadequate water consumption, bad sanitation and hygiene practices. Sources of drinking water contribute to 18% of childhood malnutrition (WHO 2009. 2009).


142: Tattered Street in urban area, Mozambique

The public transportation system is also weak. Limited coverage and lack of maintenance are the main problems of this sector. Additionally, the roads are in poor condition. The national road network comprises 30.056 Km of road. Only 21% of the entire national road network is paved, and most need to be repaired. Because of these constrains, only 36% of people have access to a healthcare facility within 30 minutes walking. (WHO 2009. 2009; ANE AN. 2010).

143: Flood Scenery in a City of Mozambique

Mozambique is susceptible to natural disasters and other hazards. Flooding and cyclones are prevalent in the country and they are the cause of various diseases' outbreak. Flooding added to weak sewage system are the main sources of mosquito that causes malaria, and also are the main causes of cholera and diarrhea. Malaria and diarrhea are the most common causes of death and illness in the country.

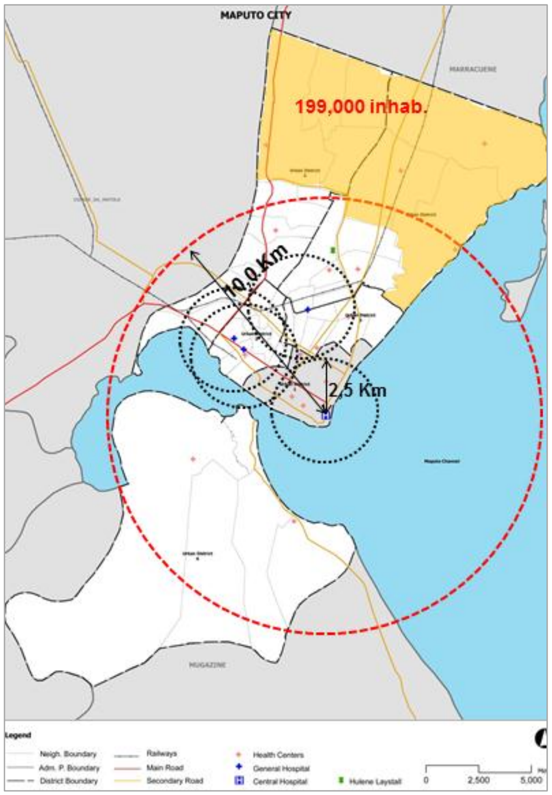
Malaria kills six thousand people in which about 24% are children under-five years each year.

144: Red Cross volunteers at Lurio Colera Treatment Center of Cuamba, Niassa Province

The main epidemic-prone disease in Mozambique is Cholera, which also account for the high rate of death. Cholera, diarrhea, dysentery & malnutrition are result of waterborne diseases outbreaks that occurs during the hot season, characterized by high period of rain and flood. The national institute of statistics cited that malaria mortality rate contributes to 26% of hospital deaths. (WHO 2009. 2009; INE-INCAM 2009. 2009).

Related objectives:

- Ensure access to health care for everyone in need
- Ensure access to healthcare setting in useful time
- Ensure availability of power, water and sewage on hospital setting
- Maximize safety in care delivery through reduction of waterborne pathogens sources and waterborne infection transmissions
- Provide world class settings for care delivery
- Maximize the use of water resource through (re)use of wastewater in the facility
- Reduce building operational costs, through maximizing the use of natural resources—renewable energy and well pumping water
- Enable facilities to serve increased needs and population
- Maximize overall satisfaction, efficiency and effectiveness.



145: Access to healthcare in Maputo City: Unserved Population

Provide accessibility to settlements and transportation: Locate site to ensure its access is within 30 min distance walking for all the settlements surrounding. Human being walks in average 2.5 - 3.0 Km in 30 minutes. Public transportation covers a distance of approximately 8.0 - 10.0 Km in 30 minutes. The site should cover settlements at least within a radius of 10 Km approximately. Provide public bus stop close or within the site for easy access to the facility. Locate the site within high density settlements: urban peripheral neighborhoods, high populated villages, capitals of provinces and capital of districts.

If in a rural setting, locate the site close to main roads, junctions and train stations.

The analysis for Maputo city shows the ideal coverage of the existing hospitals—one central hospital and three general hospitals. People living in a radius of 10 Km, can access any of these facilities in useful time. There is a need for secondary level of care services delivery for approximately 190.000 inhabitants living in expanded areas—peripheral neighborhoods in Maputo.

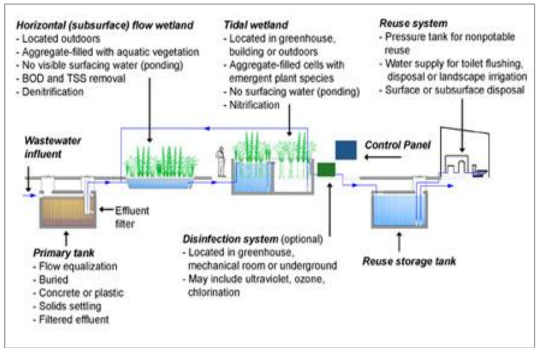
146: Pumping system

147: Solar Panels Plant at SALAM Surgery Cardiac Center, Sudan

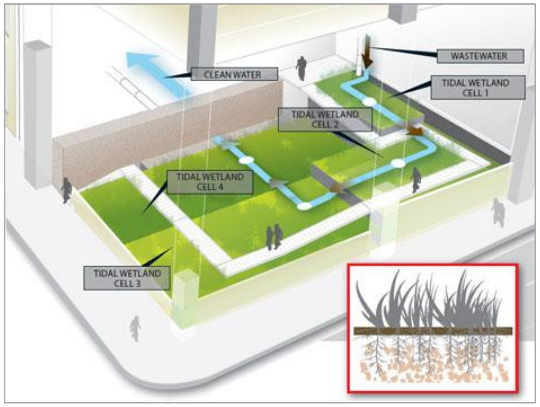
Access to utilities: The reason of locating a site near or along the main roads is to ensure access to utilities: Power and Water. Power and water supply is made through public network supply system, which goes along the roads in urban areas.

If access to a public water supply system is not available, from the site the site should be able to accommodate a well equipped with pumping system or protected well with manual pump to provide safe and drinkable water. Attention should be paid to evaluating the availability and quality of ground water to ensure its safe consumption.

If access to public power supply is not available, the site must be able to accommodate alternative renewable energy and power generation systems. Renewable energy systems include photovoltaic panels, systems that use light from the sun to create electricity; wind turbines, a turbine with vanes that are rotated by the wind to generate electricity; and active solar water heating system which consists of storage tank horizontally mounted immediately above the solar collectors on the roof . Generators have the limitation of needing fuel to operate.



148: Living machine diagram: Outdoor system



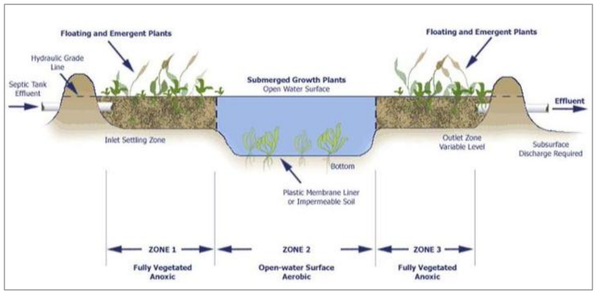
149: Living machine diagram: Indoor system

If access to a public sewage system not available, the site must be able to accommodate on-site sewage treatment systems that can accommodate current and projected facility needs. Provide free outdoor space to build on-site sewage systems such as:

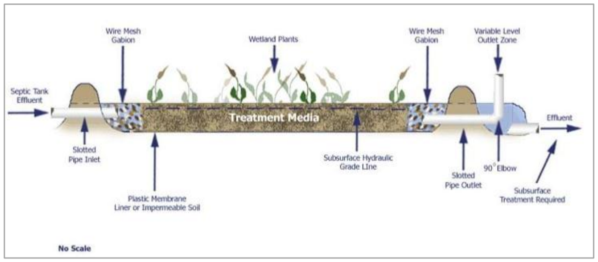
Living machine: provide outdoor on site to install a form of ecological wastewater treatment that uses tidal process that operates outdoors in tropical and temperate climates. Aquatic and wetland plants, bacteria, algae, protozoa, plankton, snails and other organisms are used in the system to provide specific cleansing or trophic functions. Its intensive bioremediation system allows production of beneficial byproducts, such as reuse quality water, ornamental plants and plant products for building material, energy biomass, animal feed.

Constructed wetlands: are systems consisting of one or more shallow treatment cells, with herbaceous vegetation that flourish in saturated or flooded cells. There are two basic types of constructed wetlands, Free Water Surface constructed wetlands (FWS) and Vegetated Submerged Bed constructed wetlands (VSB).

FWS wetlands are usually more suitable to warmer climates, because biological decomposition rates are temperature dependent, decreasing with decreasing water temperature. In these systems wastewater is treated by the processes of sedimentation, filtration, digestion, oxidation, reduction, adsorption and precipitation. VSB constructed wetlands, also known as subsurface flow wetlands, consist of gravel soil beds planted with wetland vegetation. The wastewater stays beneath the surface, flows in contact with the roots and rhizomes of the plants and is invisible or unavailable to animals ("Understanding Onsite Systems“).

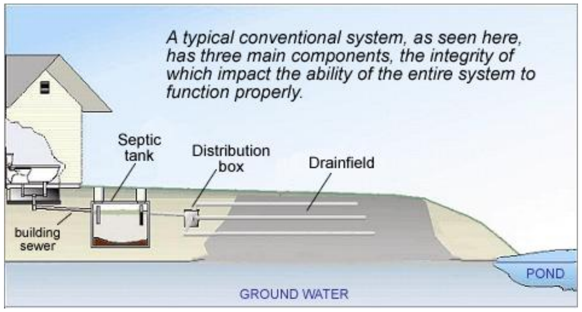


150: FWS Constructed Wetland System

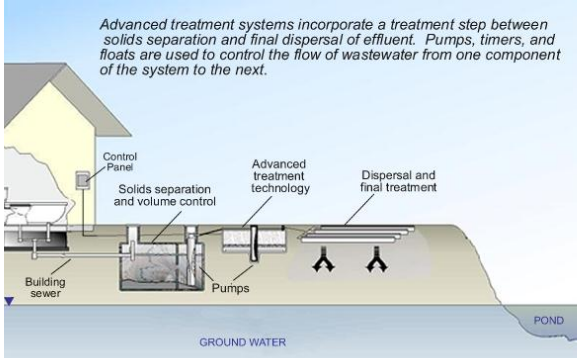


151: VSB Constructed Wetland System

Onsite sewage treatment facility: This is the most viable choice when possible for wastewater treatment in terms of public health, environmental & economic standpoints. This system replenishes local groundwater supplies; can be shared with community; and needs large extension of land to implant.



152: Conventional Treatment System



153: Advanced Treatment System

The conventional treatment system, is based on the following steps

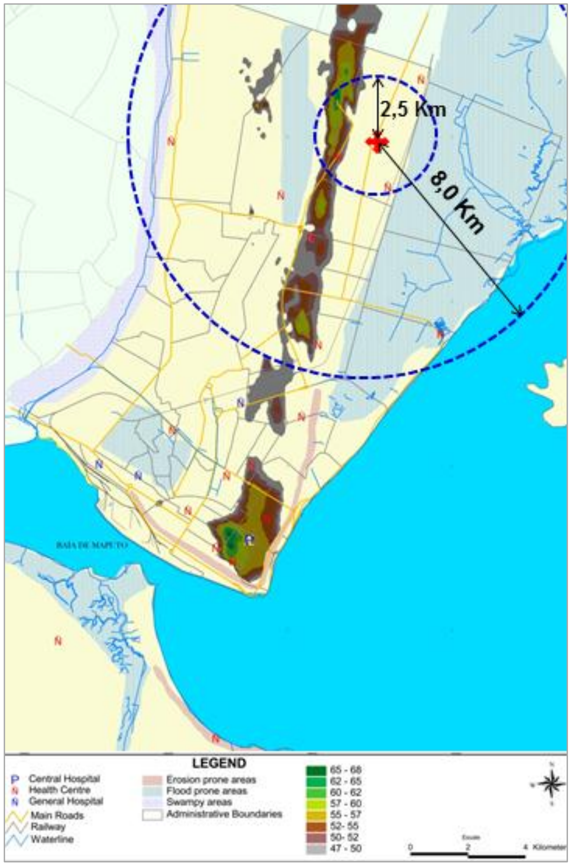
- Primary Treatment - the septic tank
- Distribution Box
- Drainfield (different options)

The advanced treatment system is based on the following steps

- Primary Treatment
- Advanced Treatment Technologies
  - Aerobic Treatment Units
  - Media Filters
  - Sequencing Batch Reactors

Final Dispersal/Drainfield Technologies

("Understanding Onsite Systems")



154: Hypothetical General Hosp Site, located away from hazards areas, Maputo city

Outside of hazardous prone areas: Analyzing the relief characteristics of Maputo city, several hazard prone areas including flood plain areas where identified, erosion prone areas, swampy areas and very sloped areas. In the map it is indicated the ideal location for the healthcare facility site, to serve 190.000 unserved inhabitants in these peripheral neighborhoods.

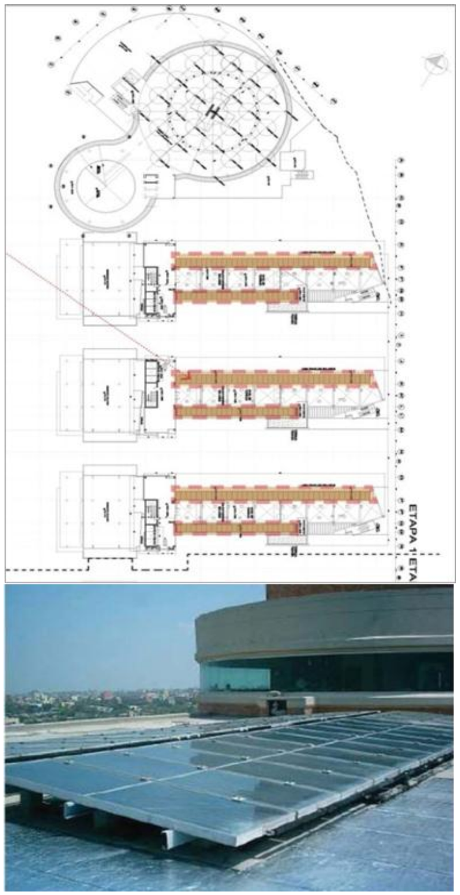
- Locate the site on high ground, with no record of flood event at least during the last 100 years.
- Locate the site away from coastal areas subject to tsunami.
- Locate the site away from swampy areas, they are high susceptible to mosquitos.
- Locate the site on stable level ground away from threats of mudslides. Slopes are highly susceptible to mudslides.
- Avoid erosion prone areas, and
- Avoid locating the site on known earthquake fault lines. The extension in length of Great Rift Valley reaches Mozambique, and it extends from the north to central zone of the country.

Case studies:

01: Onsite renewable energy: Hospital Univeritario San Vicente de Paul in Rio Negro, Colombia. Designed by Perkins + will and Condisegno, SA (local associate architect), is a 260 bed capacity hospital with 50.168 sqm. The project was completed on 2011. The facility harnesses state-of-the-art technology, was well planned to ensure energy efficiency. It employed renewable energy system onsite as well as other technics to ensure energy efficiency, namely:

- Solar photovoltaic panels on roof of each patient ward unit;
- Vegetated roof areas
- High reflectance roofing membrane
- Approximately 80% of building's gross area is ventilated
- Daylight is achieved in 75% of the spaces.

(Brooks, Emily. Market Report: South America "Southern Symmetry". World Health Design Magazine. October 2009; Design Firm: Perkins + Will)



156: Photovoltaic panels installed on the roof of each nursing unit, Hop, Univ. Sao Vicente de Paul

157: Wastewater treatment by a tidal flow wetland living machine system, RAC Las Vegas

158: Living installed indoor at Port of Portland headquarters building

(02) Living machine - outdoor system: The Animal Foundation in Las Vegas Nevada, is an example of a facility that employs an outdoor living machine. It installed an onsite wastewater treatment system that can clean up to 10,000 gallons per day (gpd) of wastewater and reuse it to wash down the kennels and runs for the dogs and other appropriate uses at the Regional Animal Campus facilitiy (RAC). The wastewater is treated by a Tidal Flow Wetland. This system was chosen for its low energy usage and low operating and maintenance requirements. The project won a Top Ten Green Projects award in 2006 from the AI A and is LEED Platinum-certified.

(03) Living machine - indoor system: The indoor living machine system installed in Port of Portland is sustainable, cost-effective, and attractive. It provides advanced wastewater treatment for reuse, including treatment up to 5,000 gallons per day. The system meets the low operational costs and ensures a 75% of reduction in water use in the facility. It produces ornamental foliage that is

integrated into public space and the water is reused to flush toilets & supply the cooling towers in the building.

159: Constructed wetland, El Salvador

(04) Constructed wetland: A constructed wetland in El Salvador, designed and installed by Florida International University's Applied Research Center, is a system composed of both: a subsurface and surface constructed wetlands, in which the native plants' root systems eliminate waste and purify the water. The system enables treatment of 44,000 gallons of sewage per day. Wastewater entering the constructed wetland completes the purification cycle in just 16 days. It was the first project to test native tropical plants in a tropical environment for waste water treatment. The system can be used to complement a Biomass gasifier, as the water can be used to irrigate crops.


160: Onsite sewage treatment facility, Huntingburg IN

(05) On-site sewage treatment facility: Cool Springs Corporate Education Center (LEED), Huntingburg IN, designed by OFS, has an on-site sewage system that protects the environment for an indefinite lifetime through its environmentally sensitive & sustainable treatment manner with low costs. The system allows growth of the facilities. It has a flow rate of 5000 gallons per day based on a maximum daily capacity of 100 people.

161: Vryburg Hospital, Northeast Province, SA

(06) Accessibility to settlements and transportation: In terms of demonstrating good practices in accessibility, Vryburg District Hospital, North West Province SA, is horizontal single-story building, sized for 120 bed capacity by Bartsch Consult/Leap Specialist Strategic and Planning Solutions. A single site access is provided and it gives access to all buildings, which are within the perimeter fence. The overall plan and design characteristics include:

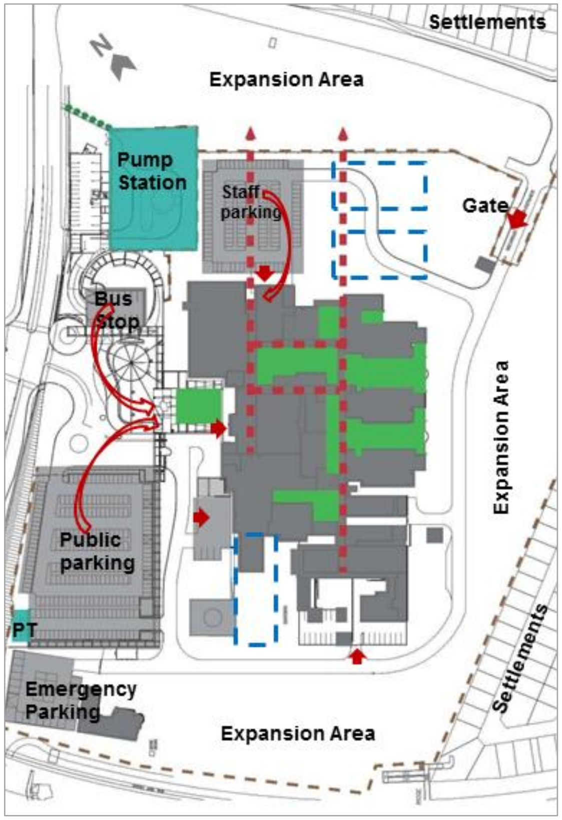
- Located along the main road;
- Close to the settlements;
- On stable level ground away from threats of mudslides;
- Away from coastal areas subject to tsunami;
- Public transportation drop-off and pick-up bus stop is available outside the secure fence;
- Taxi and outpatient parking lot is also available outside of the security fence;
- Utilities network available along the main roads.

(Brooks. January 2011), (Bartsch Consult (Pty) Ltd./Leap Specialist Strategic)

162: Main entrance, Vryburg Hospital, Northeast Province, SA

163: Building façade, Vryburg Hospital, Northeast Province, SA

164: Close up image: View of Vryburg Hospital, Northeast Province, SA



165: Khayelistsha District Hospital, Cape Town, SA

(06) Accessibility to settlements and transportation**:** Another case study that demonstrates good accessibility is Khayelitsha District Hospital, Cape Town SA, planned and designed by ACG Architects and Ngonyama Okpanum & Associates, is a 230 bed capacity facility with capacity for future extension up to 300 beds. The facility has three floors and is sized to serve the 500,000 people of the second largest township of South Africa, characterized by having high incidence of HIV/AIDS, high birth rate and high incidence of road accidents and violence. The main plan and design features include:

- Site located near the junction of the two main roads;
- Site surrounded by high population density settlements;
- Has available public transportation drop-off and pick up bus stop;
- Are provided parking lots for staff, public and emergency services;
- Available within the secure fence pump station and electricity substation;
- Available free space for potential expansion toward N-E, NW & S-E sides.

(Brooks. January 2012), (ACG Architects/ Ngonyama Okpanum & Associates)

166: Building façade, Khayelistsha District Hospital, Cape Town, SA

167: Inpatient blocks, Khayelistsha District Hospital, Cape Town, SA

168: Site location Khayelistsha District Hospital, Cape Town, SA

Security

169: Public realm: ample corridor, large windows improve security in a Hospital setting

170: Reception area in a pediatric ward, Vryburg Hospital, Northeast Province, SA

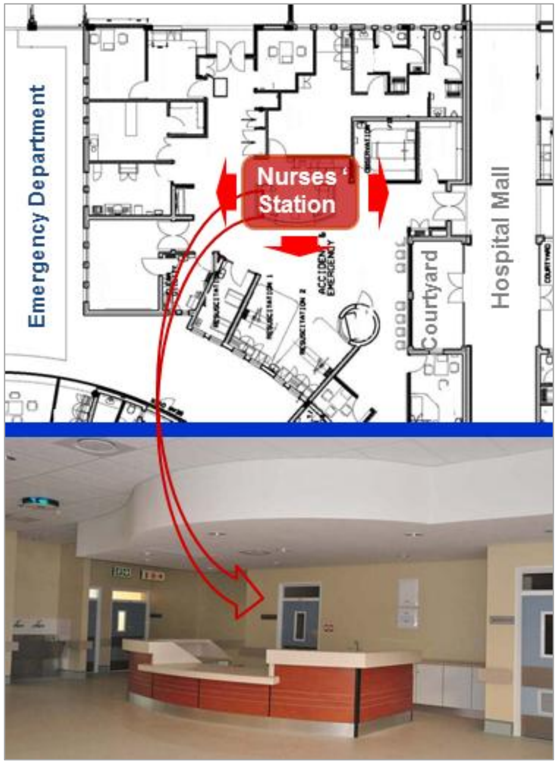
Healthcare settings are always prone to the occurrence of violence and crime due in part to their maze-like and unpredictable environment. Hospitals and other healthcare settings should provide security for all segments of their population with a major focus on children, women and elderly people who are already deprived from their personal identity, sensorial and cognitive abilities. The safety of medical information is an important issue as well in an era of high information technology usage.

The nature of the setting, a complex, stressful, traumatic and at many times chaotic contributes to the potential abuse destruction of the facility and misuse of equipment and goods. Due to people undergoing health and mental problems, stress, pain, anxiety and drug problems, these facts can increase the occurrence of violent outbreaks. Thus, security and safety should be required in all hospital settings to minimize the risk to injury, death and other adverse events of those who seek safe and quality care.

Facility type and spaces: Provide security, especially in Emergency departments, Pharmacy and drug store, Cashiers payment areas, Obstetric, Pediatric and Psychiatric. Provide security in overall healthcare facility enclosure including parking lots, and hospital grounds. (Lion, Dubin, & Futrell. 1996).

171: Departmental corridor: psychiatric & female medical wards, Vryburg Hospital, SA

Problem statement: While hospitals were created to delivery and provide health and well-being, they carry many negative aspects. Many environmental stressors impact on patients, family members and staff who are already undergoing a hard stressful time in their lives. The typically limited number of staff, almost always overwhelmed, is unable to control security issues. The population is predominantly women and children, which makes the setting more vulnerable. The facility, accessed 24 hours a day by people from different origins, carrying different cultures, languages, and with different socio-economic levels seeking for healthcare, becomes prone to violent actions. The inability of self-control and to control surrounding spaces leads to the loss of personal identity which in turn may



172: ED/Accident: Visibility from nurses' station to waiting, Vryburg Hospital, SA

contribute to violent actions and bad behaviors of those who are depersonalized, stressed, and anxious with fear and anger. Generally, insecure environments highlight the sense of victimization and violent behavior. Additionally there are permanent threats of infant kidnapping, drug theft and tampering, common theft and protests. In general, 60% of crime in hospital settings occurs in Emergency Departments (ED), where most people arrive under effect of drug and alcohol, with sense of dying or be wounded.

Unauthorized access to medical information, medical records and other sensitive information, given the vulnerability of the settings is another main concern that should be carefully addressed in planning. Thus, protection of people, property and goods in hospitals should be guaranteed by security departments to ensure safe and secure environments which in turn, will improve the quality of care delivered for all users. From the beginning of the design process, planners and designers should evaluate all the subjective risks that lead to violence and carefully address them through a well-designed security plan, specific for the facility. (Lion, Dubin, & Futrell. 1996).

173: Windows & glazed doors along the waiting area – Passive Surveillance, Vryburg Hospital, SA

Related objectives:

- Ensure security and safety for patients, staff and visitors
- Minimize patient and staff stress and anxiety
- Minimize patient and staff confusion, frustration, fear and anger
- Ensure security of medical information and medical records
- Maximize security in all vulnerable points, opened 24 hours a day
- Minimize violent outbreaks and peoples' bad behavior
- Eliminate misrepresentation of medical staff
- Eliminate the occurrence of infant kidnaping
- Eliminate the occurrence of drug theft and tempering
- Minimize destruction of the facility
- Minimize misuse of equipment
- Maximize the control of movements through the facility
- Improve security through control by staff of their area of influence
- Eliminate useless spaces such as lightly corridors, tunnels, stairwells.

174: Controlled access - Fence & Main gate: Control access point, Vryburg Hospital, SA

175: Defensive space - building façades, Hosp. Asilo of Granollers, Barcelona, Spain

Provide controlled access to enclosed site: Controlled access to an enclosed site is important for security in Mozambique. This can be accomplished through a perimeter fence or wall with controlled access points, control gates, in all access points thought the enclosure perimeter. The gates should require identity badges and/or passes to authorized staff and patient in order to circulate inside the facility perimeter. Each access point should have an automatic control gate.

If a fence or wall is not available, the facility should be designed as a series of defensible spaces. Provide building fabrics that enable latent territoriality and surveillance, through design of vivid buildings' façades and placement of windows, doors, balconies, bright artificial light that can be used to maximize passive surveillance. Provide minimal buildings' access points. [Lion, Dubin, & Futrell .1996]

176: ED Security office, Vryburg Hospital


177: ED entry lobby/waiting, Vryburg Hosp.


178: Security office, Doylestown Hospital

Provide security in entry points opened 24 hours a day: Provide security office at Emergency departments' entries that enable visual and electronic control over all emergency department territory. Provide a number of separated seating clusters for individualized groups within the ED waiting area to avoided friction between different groups of people. Limit the number of entries in an ED and provide a control system in each entry point. Provide access from the waiting area to an outdoor space such as courtyard or garden to relieve the sense of anxiety, anger and stress. Security monitors, CCTV systems, silent alarms on ingress and egress doors, bulletproof reception windows on and visual access from security office to the main space realms and circulation are other main measures to ensure security in Emergency Departments and other vulnerable spaces such as pharmacies and cashiers payment points. Provide staff workstations or desks in all other entry points within the facility, not susceptible to be opened 24 hours a day.

(Freeman White, Inc. 2011; Lion, Dubin, and Futrell .1996).

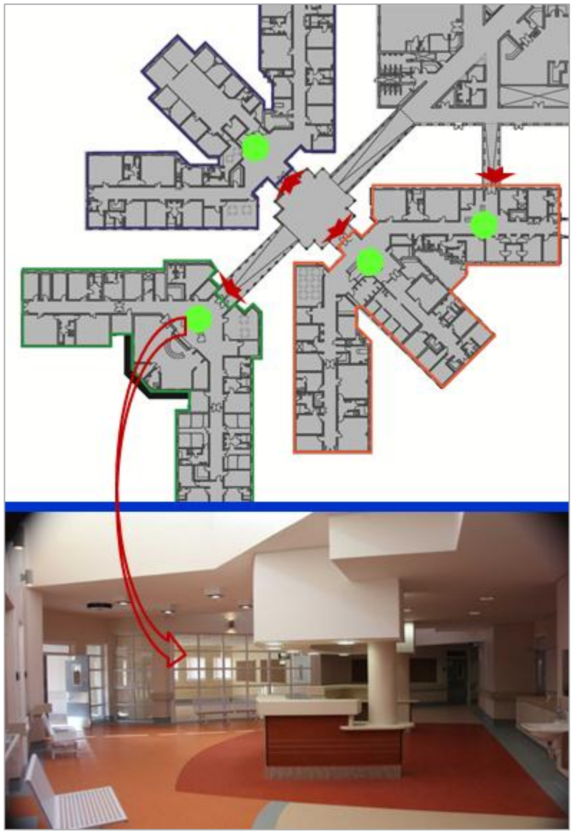
179: Site lines & circulation hierarchy, Vryburg Hospital, SA

Provide clear access and site lines to waiting and circulation areas: Provide clear access and site lines (visibility) to waiting and circulation areas from staff workstations, desk stations, nurses' stations and other staff working points. These physical features can be achieved through design spaces and forms shaped to avoid areas blocking from view and use window walls to allow visual control.

Provide clear circulation hierarchy and ample corridors to limit, control and direct movements through the facility. (Lion, Dubin, & Futrell .1996)

180: Reception desk –visual control to a public realm, Khayelistsha Hospital, SA

Provide visibility to waiting area and clear circulation within the departments with a focus to those that are more favorable to the occurrence of crime such as, obstetric, pediatric and psychiatric clinics and wards. Locate nurseries and post-partum rooms or wards away from unit entry/exit points, but for easy visual monitoring from staffed points. (Lion, Dubin, & Futrell .1996).



181: Control reinforcement – territoriality & controlled boundaries & control points, Vryburg Hospital, SA

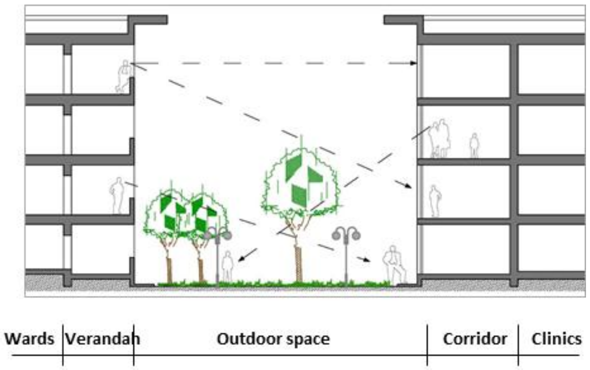
Provide workstations and reception desks at clinic &wards entry points: Provide staffed work and reception places at entry points into clinics and wards for control reinforcement. Configure nursing unit with single public access/egress a part of the required fire escape exits. Locate and configure nursing stations for easy observation of sub-waiting areas and department corridors.

Define clear territorial through: (Lion, Dubin, & Futrell .1996)

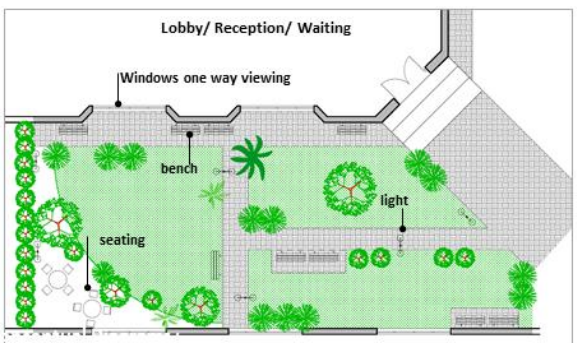
- Creation of well-defined boundaries, that are easy to control, between circulation realms that connect specific department or clinic service.
- Within each department subdivide clearly public areas and staff areas or public areas and private areas.

Define controlled boundaries through:

- Barriers to limit movement into the boundary from one area to another. These may include symbolic barriers: visual and remarkable features statues, glazed walls, arranged seating; or physical barriers: nurses 'stations and reception desks between circulation realms.
- Well defined Portals and Access points: strong visual and sequential portals or getaway, crossed-corridors portals were necessary.



182: Passive natural surveillance from indoor to outdoor: Conceptual Diagram



183: Passive natural surveillance – strategic placement of outdoor seating: Conceptual Diag.

Provide passive and natural surveillance of exterior areas: Provide natural and passive surveillance through strategic physical design features to ensure informal observation. This can be achieved through:

- Placing balconies or verandahs along building's façades, overlooking outdoor spaces
- Concentrating public movement—hospital mall—overlooking outdoor grounds through large windows or glazed walls
- Placing windows (one way viewing glass) along building façades to ensure privacy for insiders while enabling them to overlook outdoors
- Placing strategic outdoor seating arrangements in gardens, courtyards and hospital grounds in general to allow latent surveillance from the public
- Placing strategic outdoor bright lighting along the paths, within the gardens, courtyards and main entries.

(Lion, Dubin, & Futrell .1996).

Outdoor Use Space

184: Nature views, Hospital St Johann Nepomuk, by TMK.

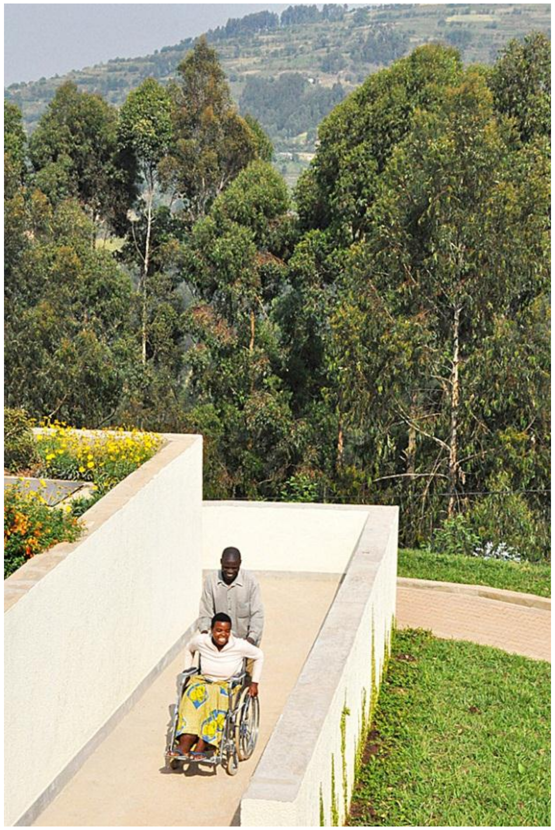
Outdoor spaces provide several opportunities for the health and wellbeing of patients, staff and visitors using healthcare facilities. The integration of outdoor spaces within a building complex enhances patients return into the real world and removes the sense of being hospitalized away from home. The diversity of outdoor spaces may include but is not limited to courtyards, building terraces, plazas and patios, green garden, among others. Each of these spaces if carefully integrated in a healthcare building complex can address specific heath needs in order to maximize patient and staff outcomes. Thus, better healthcare facilities are those that take advantage of their existing green environment and landscape providing opportunity for choice through a variety of outdoor spaces and nature features including natural air, daylight, water features, local native vegetation, grass, stone, rocks, wooded areas, and mountain views among others.

Facility type and spaces: Provide outdoor spaces hospital grounds, specifically close to cafeteria or dining areas, main entrances, lobbies and main corridors, waiting areas and pharmacies, staff offices, inpatient and therapeutic areas.


185: Nature views, Thunder Bay Health Sciences Center


186: Integration of outdoor space with facility, Hospital St Johann Nepomuk, (TMK)

Problem Statement: The proximity of nature and outdoor recreation spaces are important aspects for the quality of people's living environment. In greener environments people experience less symptoms and have better perceived quality health. People's mental health is also better when they are surrounded by greener environments (Sjerp, Verheij & Spreeuwenberg. 2003). Thus, the integration of positive outdoor spaces within a hospital building complex has the potential of speeding the healing and improving process of patient insertion to the real world. Through access to variety of outdoor elements including natural air, daylight, water features, local native vegetation, birds, threes, flowers, grass, stone, rocks, wooded areas, clouds, sunset and mountains among others, patients and staff increase their therapeutic and restorative effects, which in turn, are responsible for the reduction of stress, pain, anxiety, length of stay and depression. The beneficial effects of nature views extends to lower patients' blood pressure and heart rate, increase psychological, physiological and emotional positive changes, including feelings of pleasantness, calm and mood, while eliminating negative feelings such as anxiety,


187: Views to nature, Butaro Hospital, Rwanda

anger, worrisome and stressful thoughts. These benefits increase patients and family satisfaction, and staff effectiveness and efficiency. (Ulrich, Zimring, Zhu, DuBose, Seo, Choi, Quan & Joseph. 2008) (Marberry.2006).

Well-designed gardens, courtyards and patios are not only sources of restorative nature views, but also improve many patient outcomes and foster social support, restorative escape and self-control with respect of clinical environments. Depending of which indoor space they are directly related to, they may be used as place for gathering, interacting, eating, waiting, respite, smoking, viewing, and enhance spatial orientation. Quiet spots within green gardens and courtyards can be used for private conversations and meditation.

Related objectives: The design of patios, courtyards and gardens should be well addressed to ensure the benefic usage accordingly with local climate, culture and practices of the majority of the population.

188: Building terrace, space to gather, interacting, Gravesham Community Hospital

- Maximize health quality and wellbeing for all users
- Minimize hospital-acquired infections and medical errors
- Maximize connections with nature
- Enhance patients' therapeutic and restorative effects
- Lower patients' blood pressure and improve circadian rhythms
- Reduce patients' stress, pain and anxiety
- Reduce length of stay in a healthcare setting
- Increase psychological, physiological and emotional positive changes
- Increase staff productivity (efficiently and effectively)
- Boost patient and staff mood and satisfaction
- Optimize exposure to natural light and ventilation for all users
- Reduce medical errors and adverse events
- Provide variety of opportunities for respite and positive distraction
- Provide opportunities
- Provide opportunities for therapeutic walking and boost family support.

189: Cafeteria/dining are integrated with outdoor space, Mount Zion Cancer Center, S. Francisco

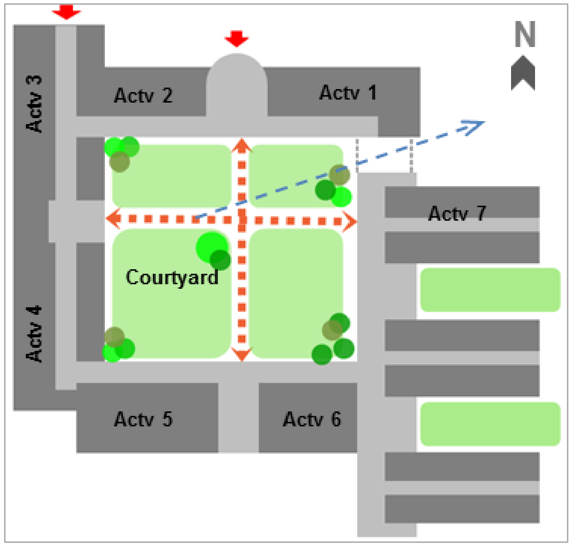
190: Kids play garden, Institute of Rehabilitative Medicine, NY

Define location, orientation and usage: Provide variety of positive outdoor spaces and opportunity for choice, through:

- Defining its location and orientation, and provide direct access to it:
    - Close to cafeteria or dining areas
    - Close to main entrances, lobbies, & main corridors
    - Close to waiting areas and pharmacies
    - Close to staff offices or inpatient and therapeutic areas
- Defining the type of outdoor spaces
    - Courtyards
    - Building terrace or Balcony
    - Patios or Plazas (exterior waiting)
    - Green garden
- Defining potential users and its usage
    - Children or adults
    - Staff, patients, visitors or both
    - Therapeutic walking, kids play garden
    - Quiet spots for private conversations

Provide courtyard as a core space of a hospital facility: Ensure visibility of the courtyard upon entering the hospital complex, through:

- Placement of glazed walls near elevators and along main corridors, entries and lobbies
- Placement of large windows and glazed doors in staff, patient and waiting areas
- Providing access to it, from at least two opposite sides with paths connecting them



191: Courtyard – Conceptual diagram


192: Covered path through garden, SALAM Surgery Cardiac Center, Sudan

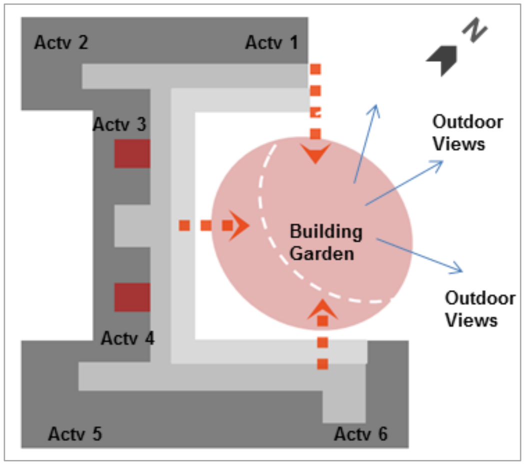
Create a sense of enclosure, security and privacy, through:

- Space surrounded by buildings, but with loopholes to allow seeing beyond it/them
- Roofed verandah or porch continuous between indoor and courtyard
- Surround seating areas with shrubs to create a sense of enclosure

Ensure comfort and sense of relaxation while in the courtyard, through:

- Organize variety of (wooden) seating and picnic tables
- Nature features: water fountain, stone/rocks
- Variety of plantation (trees, flowers, lawn area)

(Marcus and Barnes. 1999), (Christopher, Ishikawa, Silverstein. 1977).



193: Building terrace – conceptual diagram


194: Building terraces overlooking nature views, Butaro Hospital, Rwanda

Provide building terraces that take advantage of the surrounding landscape: The nature of these spaces is to capture building spaces that a likely to be unused, while at the same enables capturing expansive views. Designers should provide:

- Building terraces or verandahs maximizing the view of the landscape nature
- Locate semi-roofed verandahs overlooking the nature scenario such as water features, mountains, natural vegetation, wooded areas

Provide garden elements for relaxation and respite

- Native plants, flowers, stones, artwork sculptures, and movable furniture

If the terrace is contiguous to the patient areas or staff offices limit the public access to it

- Locate doors & windows opening directly to the terrace directly from the related indoor spaces

If the terrace is located on a neutral space, make it accessible to the public

- Locate accesses from lobbies, waiting areas, cafeterias or main corridors.

(Marcus and Barnes. 1999), (Christopher, Ishikawa, Silverstein. 1977).

195: Yards/patios as extension of waiting area on OP Dept., Vryburg Hospital

Provide hospital plazas or patios as an extension of waiting areas: In an overcrowded circumstance in a healthcare facility in Mozambique plazas or patios can be used as extension of waiting areas. Climate and culture predetermine the need for outdoor space to accommodate patients and visitors while waiting for an appointment or to have a prescribed medication in the pharmacy, during patient' visit hours or in many more occasions. These spaces should be planned in order to provide:

- Hard surfaced pavement, that facilitates walking movement and fixed furniture spaces for heavy use;
- Overhang or roofed spaces for rain or sun protection within the patio;
- Trees, shrubs or flowers to lend the sense of freshness, restfulness and relaxation to the space;
- Engraved artworks, colored and textured surfaces on walls and floors, and water features to ensure sense of relaxation.

(Marcus and Barnes. 1999), (Christopher, Ishikawa, Silverstein. 1977).

196: Woodland Rock Garden with variety of native and non-native perennials

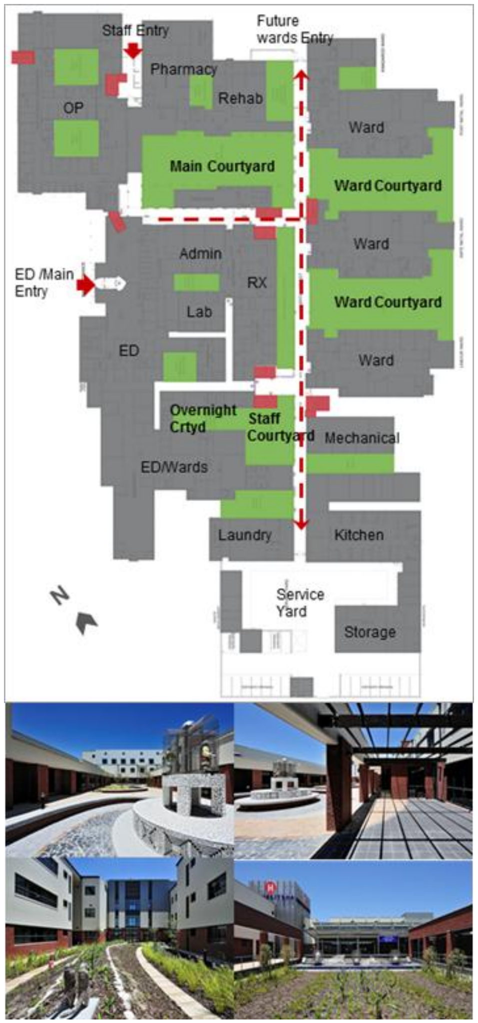
197: Living garden, at the family life center – patients with Alzheimer's, Michigan

Provide green garden that requires low maintenance: Garden that grows wild requires limited human labor due plantation of native and indigenous plants, use of elements such as stones, wood and others easy to twist in the natural environment. Designers should provide:

- Native vegetation and garden features that grows wild and requires low operational costs, through saving existing vegetation on site and integrate the garden on it;

If vegetation on site is not available, arrange garden features to allow planting growth in a natural process such as stones, wooden edges, natural pathways, grass crete paving:

- Plant vegetation in way that it interacts with the garden boundaries;
- Chose native species to reduce the need of irrigation and fill up the gapes;
- Create a sense of enclosure and security in the garden by providing fence or building boundaries and garden entry element such as gate, trellis or porch. (Marcus and Barnes. 1999), (Christopher, Ishikawa, Silverstein. 1977)



198: Location & views of the courtyards through the facility, Khayelitsha Hosp.SA

Case studies:

(01): The design approach of Khayelitsha District Hospital in Cape Town SA, according to the designers is to reduce stress, increase patient safety, improve overall healthcare quality, meeting as well the local culture and climate. The design is focused on providing a large number of sequential courtyards connected to each indoor department or service to allow patients opportunity for choice, since in developing countries with favorable climate, a lot of activities such as cooking, washing, and social interaction happen outdoors. Thus people should have an opportunity for choice while waiting. Khayelistha hospital was designed as following:

- Huge emphases in natural light and natural ventilation
- Large amount of operable and protected windows, from rain since the climate is severe
- Several courtyards featured with craved arts work and seating to encourage social interaction and relaxation. (Brooks. January 2012).

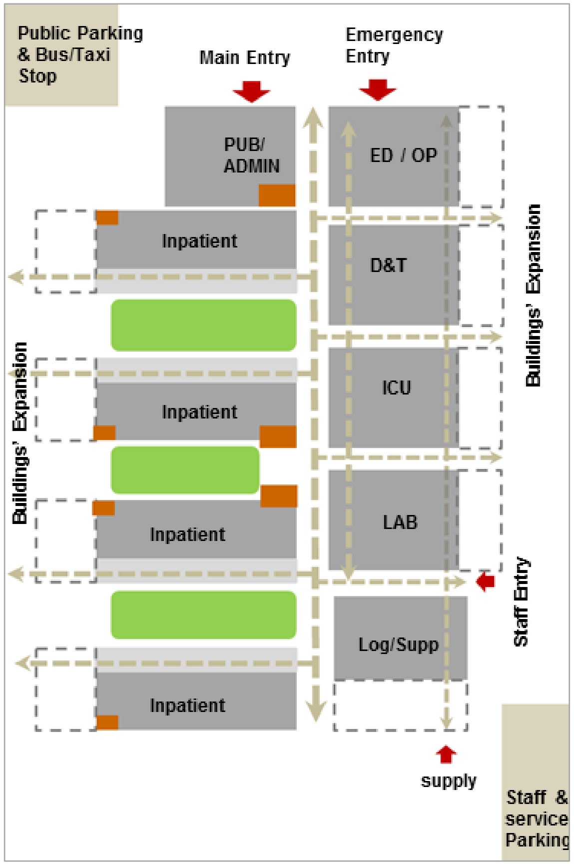
199: Inner courtyard, Hellios District Hospital, Gotha Ohrdruf, German

(02) Hellios District Hospital located in Gotha Ohrdruf, German, by Woerner and Partners designers, is a 311.373 SF facility, with 350 bed capacity. A double cross-shaped building plan horizontally extended as it rises to three stories high and it takes maximum advantage of the terrain.

The double cross-shaped building complex forms for an articulated format which converge for the main central glazed-roof hall, located in the middle of the hospital. The inner courtyard is located in the main entrance hall and explores its maximum meaning, through plantation of tropical trees and indigenous vegetation under a transparent glazed roof which lends to this space a sense of Mediterranean landscape. The insertion of cafeteria and shopping stores makes this space the most important place for socializing and recreation as well as lending the hospital a sense of a hotel lobby, place for rest, relaxation and holidays - a marketplace restaurant.

It provides a social meeting place for patients, staff and family and, above the courtyard welcomes all the visitors. (Weller and Nickl. 2007), (Schirmer and Meuser.2006).

Growth and Adjacencies



200: Hospital Growth - Conceptual Diagram

The nature of healthcare facility requires planners and designers to evaluate all constraints and strengths to provide design solutions that will ensure extended life-cycle of the facility, thus accommodating current programs and future needs. Early definition of all operations, services, functions, bed capacity, work and patient flow, and circulation system will allow better design solutions and will ensure easy growth and adequate adjacencies. Clear, hierarchical and adequate circulation systems enable good building organization which in turn makes easy navigation through the entire facility.

The overall hospital complex, should provide health and safety, minimize stress, anxiety and disorientation, and improve satisfaction, effectiveness and efficiency for all users. This is achievable through grouping all ancillary department types together; locating inpatient departments to allow support from ancillary and logistic support departments to facilitate services delivery for inpatient and outpatient segments.

Stable site and free space on site are the major and indispensable requirements for the flexible growth of any facility. Thus easy expansion and adequate adjacencies depend upon on availability of free space relies on good master planning; and well defined spaces for short-term changes and long-term changes.

201: Community Hospital of the Monterey Peninsula, California, US

202: Community Hospital Chemnitzer Land, Hartmannsdorf, Germany

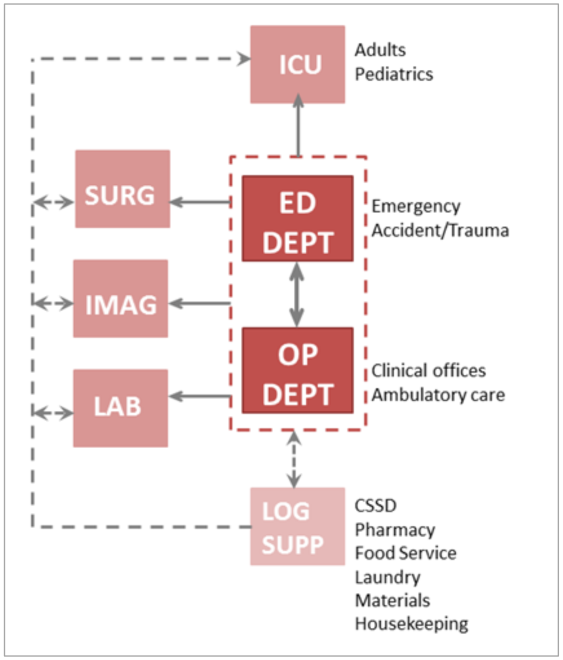
Problem statement: Unplanned growth due lack of master planning is a common problem in healthcare facilities. The permanent need to adjust buildings for new technology, the need to incorporate new services that respond patients' permanent needs, the adjustment of existing facilities to meet staff shortage, global healthcare problem, and the need to adjust current healthcare practices are some of the causes that turn hospital settings into a complex, ambiguous, stressful, noisy and unpleasant environment.

Circulation systems should be focused on separation of pubic traffic, service traffic and movement of goods for easy control of people's movement and maximizes security. Basically, circulation systems aim to make clear separation of public and staff movements, as well as to define the circulation for movement of goods and services—back alleys.

Well planned facilities improve wayfinding through minimizing spatial disorientation, minimizing discontinuity and disruption of care delivery, reducing long travel distances, facilitating connections to existing buildings, easily integrate any change or need in technology, facility size, new services demand, . The buildings capacity to change and grow guarantees its long life cycle to accommodate long term programs. (Kobus, Skaggs, Borrow, Thomas, Payette, Chin. 2008)

Related objectives:

- Minimize spatial disorientation and maximize security
- Facilitate growth and optimize patient and work flow
- Minimize hospital-acquired infections and medical errors
- Optimize care delivery
- Maximize patient, family and staff satisfaction and staff productivity
- Maximize social support
- Minimize stress, anxiety, frustration and travel distances
- Maximize independent growth without disruptions
- Maximize extended facility life-cycle to accommodate future needs



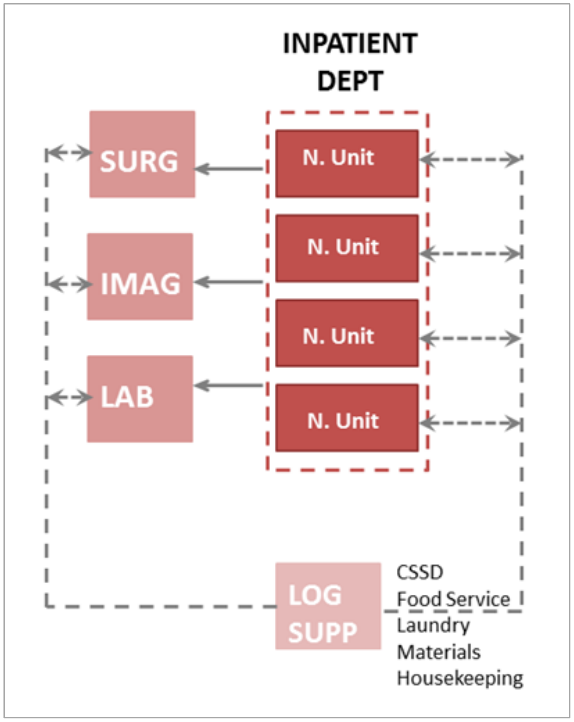
203: Emergency and Outpatient Departments Departmental Relationship Conceptual Diagram

Provide ancillary departments: Group Ancillary departments together through developing a departmental evaluation relationship that ensures appropriate and required service adjacencies. The adequate alignment of departmental functions and operations will provide a consistent work and patient flow. Locate core services close to elevators for easy circulation and supplies transportation. Departments should be grouping as following:

- Outpatient department, imaging and clinical laboratory;
- Emergency, imaging and surgery departments;
- Intensive care unit, surgery and emergency departments;
- Gynecology obstetric and emergency departments.

Ensure safe operations 24 hours a day, through providing easy access and enhanced security and defining clear and hierarchical circulation for public, staff and services and supplies.

Support and logistic department should easily access ancillary departments through by back of the house. (Kobus, Skaggs, Borrow, Thomas, Payette, Chin. 2008)

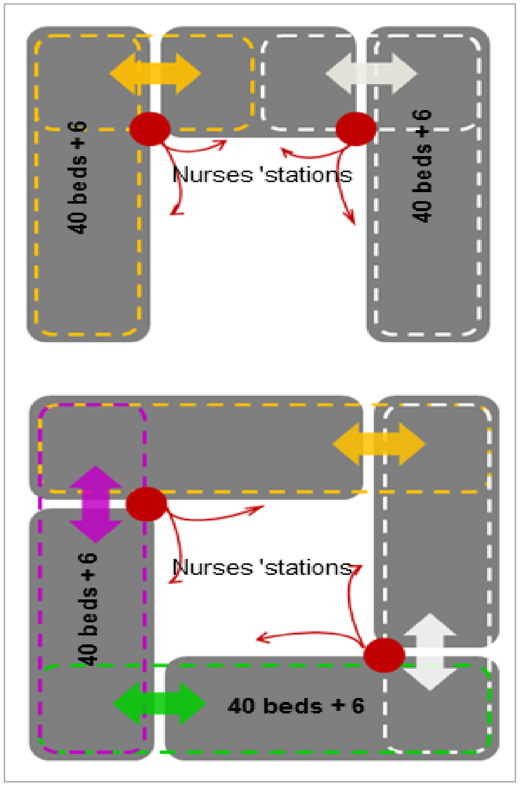


204: Inpatient Department
Departmental Relationship Conceptual Diagram

Locate inpatient departments strategically: This allows them to be supported by diagnostic and treatment, and logistic support departments. Organize adequately space adjacencies through alignment of functions for efficient care delivery and to ease address issues of limitation of staff. The need of sharing equipment and service shifting requires the location of nursing units close to each other. Vertical circulation should be easy accessible from nursing units. Locate inpatient department close to elevators for easy circulation and supplies transportation. Thus, locate nursing units accessible to key services, as following:

- Inpatient department directly accessible from surgery department
- Inpatient department directly accessible from diagnostic department
- Inpatient department directly accessible from imaging.

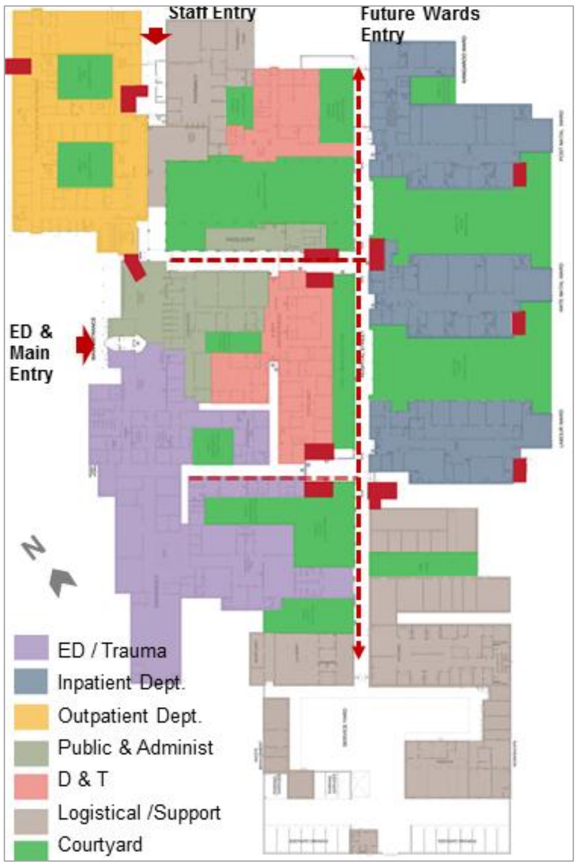
Support and logistic department should easily access inpatient department through by back of the house. (Kobus, Skaggs, Borrow, Thomas, Payette, Chin. 2008)



205: Flexible Patient Units : Conceptual Diagram

Provide flexible patient units: Provide inpatient units for generic use. Over specialized units limit flexibility over the time. Inpatient units should allow swing bed capacity (increase/reduce number of beds) if necessary to accommodate critical situations of outbreaks diseases. Space unit, a ward or a patient room, should allow accommodating different acuity (general care and intensive care) levels of care over the time. Locate nurses' stations strategically to ensure visibility from workstation to patient bed. Allow visibility among staff and short travel distances through strategic location of nurses' core support services. Design flexible units for efficient care delivery in a shortage staffing situation.

(Kobus, Skaggs, Borrow, Thomas, Payette, Chin. 2008)



206: 1st Floor plan - Departmental adjacencies, Khayelitsha Hospital, SA

Case study:

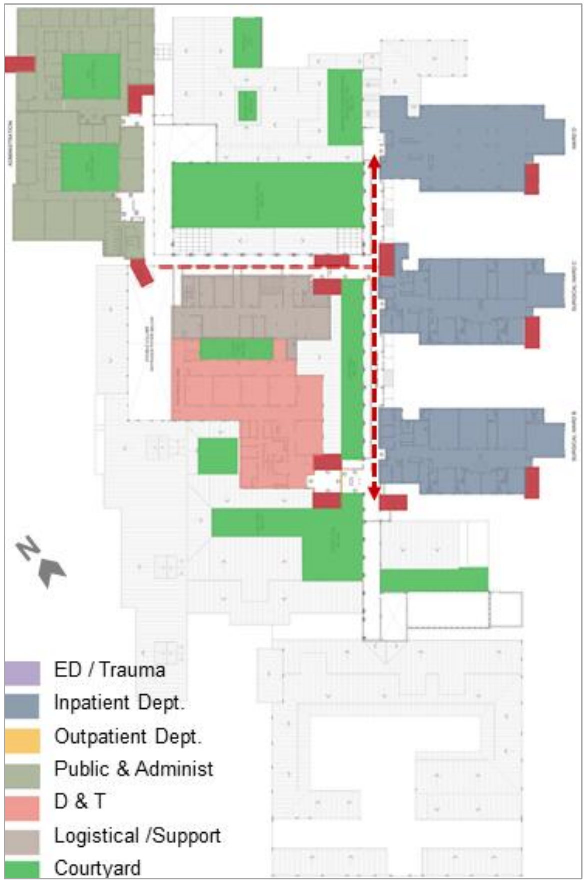
(1) Khayelitsha Hospital in Cape Town SA, previously described in other guidelines, was designed according with the required adjacencies. The 1st floor is organized as following:

Adjacencies:

- Emergency department/trauma close to diagnostic and treatment - x-ray, clinical laboratory and day-hospital services;
- Outpatient department is adjacent to pharmacy and physical therapy services;
- Labor ward is adjacent to ante natal, post Natal and kangaroo inpatient units;
- Logistic and support is strategically located for easy supply to other departments.

Circulation system is basically mixed:

- Hospital spine drives the public to the majority of hospital departments, as required, but circulation is mixed, staff and public;
- Spine, primary circulation separates clearly the inpatient department, wards, from the other ancillary departs, allowing mixed circulation- public, staff and services;
- Lifts 'core and staircase are subdivided by function: surgery, public and staff. Strategically lifts are located to serve specify population segment;
- Secondary, tertiary and back of the house circulations are not clear. Mixed circulation.



207: 2nd Floor plan - Departmental adjacencies, Khayelitsha Hospital, SA

The 2nd floor has surgery services as a core of the floor and it was approached as following:

Adjacencies:

- Surgery department is adjacent to central sterile processing (CSP);
- Inpatient surgical units are close to surgical suite, however separated through main corridor, hospital spine, which allows to have mixed circulation through it;
- Post-surgical patients cross through the public corridor to access the wards
- Public and administrative department is accessed independently through staff circulation core - staircase and elevators

Circulation system:

- Hospital spine allows mostly mixed circulation, public, staff/patients, services and movement of goods
- Circulation circuit to access central sterilizing process by other hospital departments is unclear.
- Back of the house is mixed with public movements.

(ACG Architects/Ngonyama Okpanum Associates)

Wayfinding: Circulation Hierarchy and Signage

208: Lobby entrance, Banner Health Medical Center Arizona, US

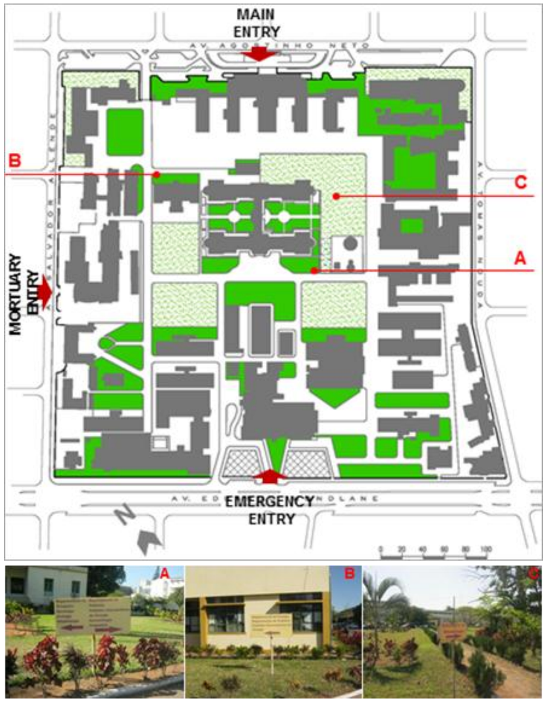
Wayfinding is the ability of spatial orientation that enables the wayfinder to navigate spaces within the facility. Good wayfinding system consider the visitor decision making process, the knowledge of the wayfinder (patient, staff, visitor), and good building clues and tools to ensure successful decision-making and clear recognition of the pathways and destinations. Additionally the system should consider inclusion of a comprehensive signage system to convey complete, accurate and concise information as simply as possible for those who cannot read and see. This includes simple and precise written information labeled in diverse color pallet and other signage options such as pictographic signs.

Another important wayfinding strategy is the clear definition of hierarchical circulation system. Circulation realms are meant to allow clear transition between the front of the house—public areas to the back of the house—private areas.

209: Single-loaded corridor, St. Elizabeth's Hospital Enumclaw, WA, by Mahlum

If the circulation system is well defined and focuses on separate public traffic, service traffic and movement of goods, then a good platform to achieve best wayfinding system is guaranteed. In other words, within a healthcare facility, interdepartmental circulation (secondary public corridors between departments) and intradepartmental circulation (tertiary staff and services corridors within departments) mostly called side streets and back alleys should be well configured to make easy building navigation for patients and staff. A good circulation system also provides clear indication of entries and exits through the building fabric, as well as external signage, access and exit points through the entire facility.

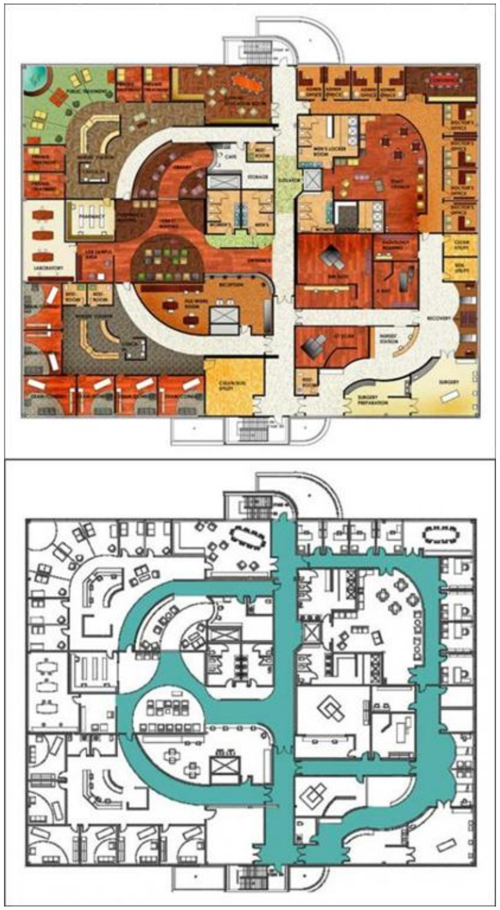
Facility type and spaces: Large and complex healthcare facilities which are likely to promote bad wayfinding for the users: General, provincial, central and specialized hospitals. This guideline is also all other large hospitals in rural areas.



210: Maputo Central Hospital Site Plan (1910-40) Maze wayfinding, Mozambique

Problem statement: Unfortunately, the circulations systems in most hospitals are arranged in an intricate manner. People, unfamiliar with the environment, find it very hard to navigate the facility, frequently characterized as being a confusing, complex and hostile environment. Weak signalization added to a considerable level of noise, confluence of people from different socio-cultural stratifications, and barriers of language makes it hard to communicate. A lack of cues and tools lead to spatial disorientation and bad wayfinding. These problems are usually caused by lack of master planning to orient facility growth (Huelat / EDAC. 2007, Cooper.2010, Lion, Dubin, & Futrell .1996).

Most of the times, the basic process to get from one place to another, represents an unpleasant challenge and very overwhelming process for those who are already exhausted, stressed and ill (Huelat / EDAC. 2007). Additionally, signs are frequently provided with insufficient or excessive useless information, which makes more difficult for the wayfinder to engage in a progressive disclosure process through the way. Signs should provide essential and sufficient information to direct a wayfinder from a specific point to another (Huelat / EDAC. 2007).



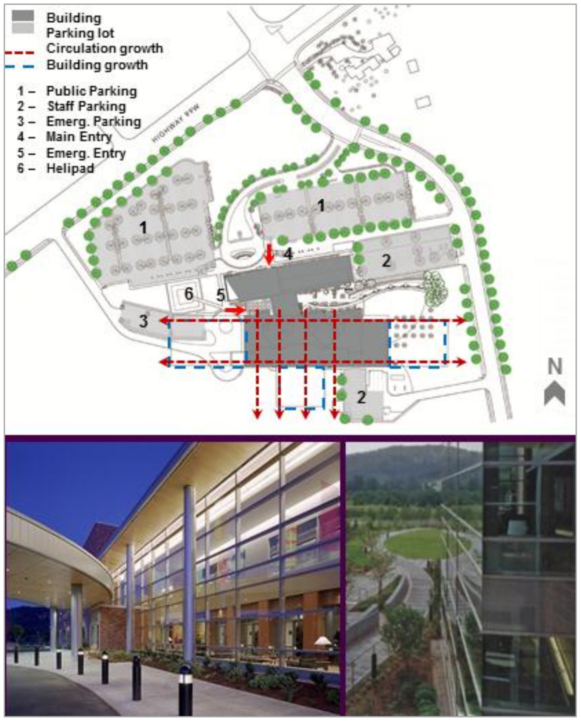
211: Wayfinding problem: complex, confusing and stressful: Illustrative diagrams

Maze-like and confusing wayfinding, complex and stressful environments worsen patients, staff and visitors heath and efficiency. A sense of helplessness and frustration; stress, anxiety and fear; high blood pressure and headaches; physical exhaustion and fatigue are the most common effects found in people who experience bad wayfinding and spatial disorientation. As direct consequence of these symptoms, patient and family satisfaction decreases drastically, staff productivity and satisfaction also decreases, and affects the reputation of a healthcare facility (Ulrich, Zimring, Zhu, DuBose, Seo, Choi, Quan & Joseph. 2008). Intelligently planned circulation system at the beginning of the design process has a beneficial impact on overall hospital complex and promotes healing, health, wellbeing, and safety, through reduction of all symptoms above mentioned and ensures structured facility growth.

Related Objectives:

212: Circulation & main entrance, windows along corridor, St. Elizabeth's Hospital, WA

- Optimize building navigational process
- Minimize stress and anxiety
- Minimize frustration, anger and sense of helplessness
- Minimize physical exhaustion, fatigue and headaches
- Minimize medical errors and other adverse events
- Maximize staff productivity
- Maximize satisfaction
- Maximize time spent with patient
- Improve communication of the illiterate and blind people
- Optimize building organization and growth
- Maximize daylight and nature views
- Promotes the healthcare facility
- Eliminate labyrinth circulation system
- Minimize socio-cultural conflicts



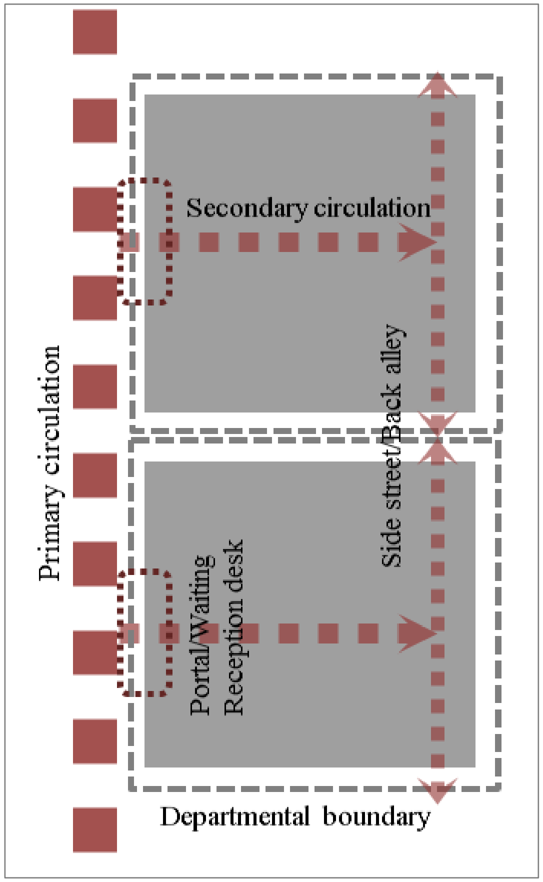
213: Master plan of Providence Newberg Medical Center Hospital, Oregon US

Create a master plan *(Case study):* Master plannig which clearly plans the growth of the buildings, expansions and main path systems, make easy wayfinding for all users. The master plan evaluates how people enter the buildings, find vertical circulation and how buildings interconnect.

Providence Newberg Medical Center in Oregon US, a two-story building, 40 bed capacity and 1st Gold LEED certification in US, designed by Mahlum Architects had its master plan design approached as following:

- Provided free space on site for building and circulation growth
- Provided exterior circulation pathways
- Clear definition of:
    - Main hospital entry
    - Emergency entry
    - Emergency parking lot
    - Patient and public parking lot
    - Staff parking lot.

(Verderber. 2010, http://wmig.aiaseattle.org/node/65)



214: Circulation Hierarchy: Conceptual diag.

Provide clear building layout and indoor physical characteristics features as landmarks: If well designed, interior architecture can add to wayfinding. Building features such as vivid color pallet, texture of materials, statues, large windows along single-loaded corridors, etc., may provide visual and remarkable cues to health a wayfinder to navigate the building.

Design clear and navigable pathways for all users.

- Primary Circulation
- Secondary Circulation
- Tertiary Circulation
- Back alleys or Service Movement

Provide interior architecture elements that are good drivers for easy building navigation and may act as landmarks for visitors.

- Windows along corridors allow different outdoor views
- Distinguishable entrances are easy to recognize
- Visible and well located elevators

- Provide vivid color palette and material texture
- Provide well located lighting. (Lion, Dubin, & Futrell .1996).

215: Primary circulation corridor,
St. Elizabeth's Hospital Enumclaw, WA

Provide primary circulation: It is a public circulation that provides direct access to a large extension of hospital services and activities that convey convenient movement, sense of openness, harnessed by daylight and views and have comfortable finishes with different color pallet:

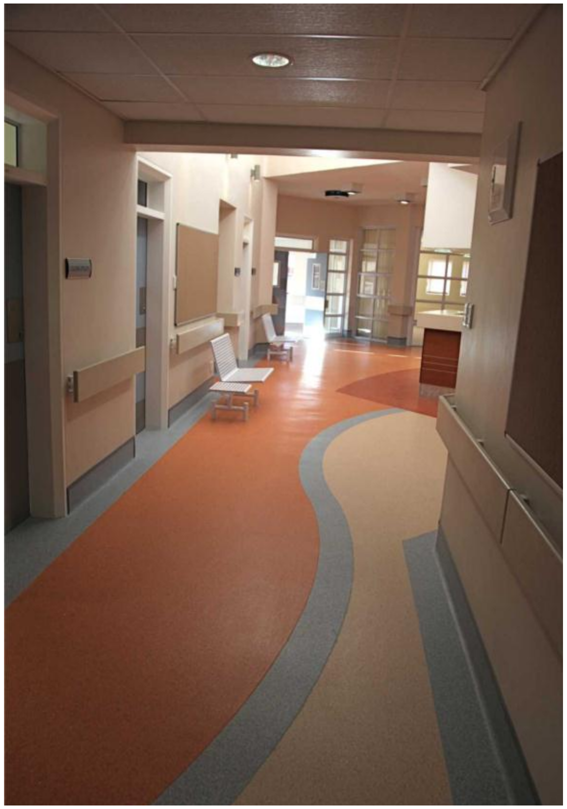
- Atria or Mall
- Hospital Spine
- Wide single-loaded corridor

Populated these spaces through placing on them:

- Waiting areas
- Elevators, staircases lobbies, stairways
- Dining areas/cafeterias
- Registration desks
- Gift shops and spiritual spaces

Provide marked and well defined portal points along the primary circulation to access service departments and create a sense of departmental territoriality and security. (Lion, Dubin, & Futrell .1996).

Provide secondary circulation: Provide direct access from the entry portal of specific department to the any space within that department. It is semi-public circulation and the control and security of these spaces is achieved through:



216: Male medical ward, Vryburg Hospital, Northeast Province, SA

- Reception desks
- Check-in desks
- Nurses ‘stations
- Semi-waiting areas

Staircases in the departments should be open to or start from the department circulation realm and placed close to the staffed areas.

Provide spatial cues along the circulation corridor:

- Place along the external walls large windows to provide daylight and outdoor views. They can be used as signs to help wayfinder.
- Provide unusual material finishes with vivid colors, to identify different departments, clinic services or public circulation from the staff circulation.

(Lion, Dubin, & Futrell .1996)

217: SSM Cardinal Glennon Children's Medical Center

Provide tertiary circulation, side streets or clinical traffic: Clinical staff should circulate in a nonpublic area, which are corridors between departments for the efficient and discreet movement. These corridors should be located to limit or control unauthorized movements between departments. They should have the following features:

- Lowered ceilings
- Closed cross-corridor departmental doors
- Standard hospital corridor sized 240cm wide X 240 cm high

218: Healdsburg District Hospital, service movement circulation

Back alleys or Service Movement: Are corridors dedicated for service traffic and supply of goods within the departments. They are accessed from public corridor in well-defined and discrete securable doors, close to staffed areas. These doors require being keyed, coded, card access or voicing activated hardware. They should be also be equipped by hands-free security hardware.

Case Studies:

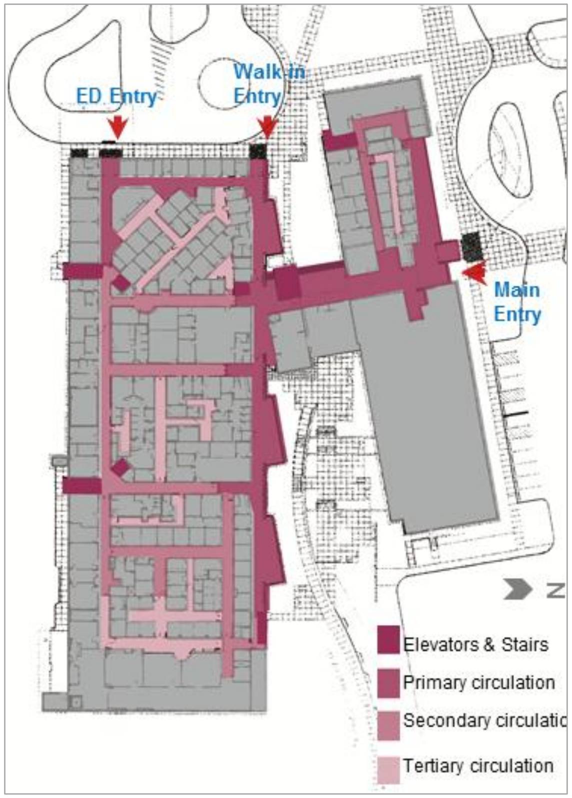
(01) Designers of Providence Newberg Medical Center, Oregon, US, planned the navigational building pathways to allow easy wayfinding for all users through clear definition of hierarchical circulation system and public realms, which allows well defined transition between front of the house and back of the house. The circulation pathway is as following:

- Vertical Circulation
- Public and Service traffics and Movement of Goods
- Defined clear and visible ingress and egress points

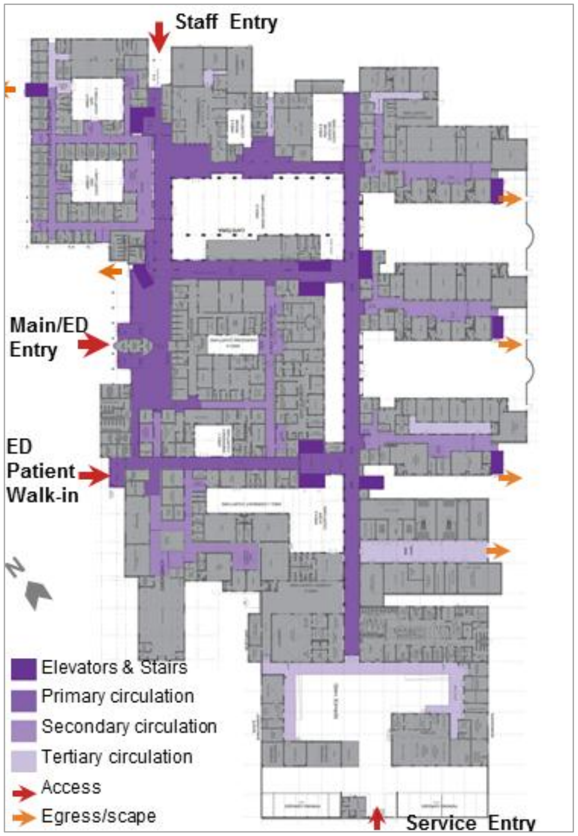
Well defined and visible ingress and egress points through circulation pathway:

- Main entry
- Emergency entry
- Walk-in entry

(Verdeber. 2010, http://wmig.aiaseattle.org/node/65, Lion, Dubin, & Futrell .1996)



219: Circulation system – Ground floor plan, Providence Newberg Medical Center Hospital



220: Circulation system – Ground floor plan Khayelitsha Hospital

(02) Designers of Khayelistha Hospital in Cape Town SA planned the navigational building pathways to allow easy wayfinding. Were provided:

Clear primary circulation however mixed (public, staff and service)

- Harnessed by daylight and views through courtyards along the circulation
- Populated through waiting and sub- waiting areas
- Provide access to all hospital departments
- Mixed movement of staff & public

Secondary circulation also mixed (patient, staff & movement of goods). The back of the house (service circulation) is not clear.

Ingress and egress points

- Provided merged main and emergency department entries
- Provided Staff entry; emergency walk-in & service entry
- Provided several exit points

(ACG Architects/Ngonyama Okpanum Associates)

221: Primary circulation corridor, Emergency and Urgent Care facility in Frisco, Texas

(03) Designers (5G Studio Collaborative) of a Free-standing Legacy Emergency and Urgent Care facility in Frisco, Texas developed a facility design that consists of urgent care rooms, special treatment rooms, radiology suites, and trauma suites organized around an elemental ceiling spine, that welcomes patients and visitors from the point of patient entry, that bisects through the interior spaces. The hospital spine features include:

- Diamond-polished color concrete floor that adds to the interior a spatial dimension
- Abundant daylight reflected by the polished floor comes through rhythmically-spaced skylights
- Comfortable finishes including translucent colored resin panels enclose the primary facility functions.

(5G Studio Collaborative)

222: Exterior directional signs, Children's Hospital of Pittsburgh

223: Hospital Graphical Signage images

Provide a Signage System: Exterior signage is important to indicate the arrival in a healthcare institution. This type of signage can be provided through large visual logo organization for site or campus identification and directional signage in all major intersections and where other spatial cues such as color flooring or material texture are provided. Directional signage is also important for interior signalization. Additionally, logical and clear nomenclature for departments and services should be provided inside of the buildings. If there are not key decision points (cues) in all pathways, place signs in approximately every 45 to 75 meters.

Each sign should not have more than 3 different destination points, to ensure progressive disclosure process. Graphic or pictographic signage should be consistent and must be provided to enable communication to illiterate and preschool children. Graphic signage can be provided through colored graphics, strong contrast and visibility, bright signs, logos and symbols.

(Huelat / EDAC. 2007, Cooper.2010)

Building Form and Scale

224: Kassel Clinical Center, German

The form and scale of buildings deeply impacts the performance of the building itself in terms of the environmental impact of materials, energy efficiency, water conservation and efficiency and waste production. Yet, in the most important perspective, a building form and scale profoundly impacts the health and wellbeing of those who live, work and spend much of their time sheltered in them. In healthcare facilities, the form and scale of a building is a huge matter, since these facilities are meant to heal, not to harm; and the current trends of healthcare design have shown that developing environmentally conscious design techniques that seek to minimize the negative impact on the environment, by increasing energy efficiency and controlled use of natural materials and resources available is the best way of preserve and protect the life and health of building users; the building itself; and the surrounding communities.

225: Providence Newberg Medical Center, Oregon, US

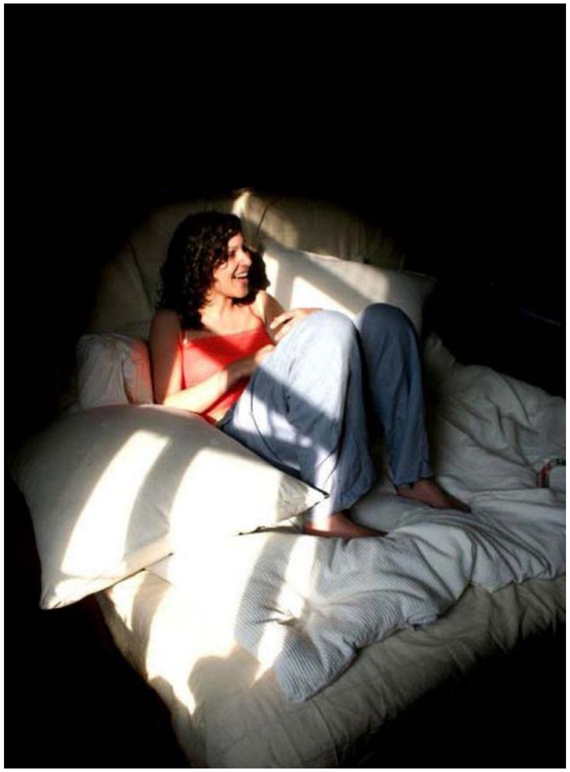
Healthcare buildings configured in order to provide access to natural ventilation, natural light, nature views, will positively impact health, the healing process and the wellbeing of patients and staff; will reduce energy demand, water consumption and other resources; will minimize the burden of operational costs which is very high in healthcare buildings; and lastly will benefit the overall community due their reduced impact on the surrounding environment.

226: Transparency and visibility, Legacy ER, Texas, US

The configuration of buildings has an impact as well on staff efficiency and effectiveness in terms of quality of care delivery. Adequate building configuration should minimize travel distances between the nursing work core with patient care area. Ample visibility from the nurses station to patients room or wards while maintaining privacy and clarity in circulation are required aspects to ensure quality in care delivery and overall satisfaction in healthcare facilities. Integrated building forms and scale, should efficiently and effectively address these aligned aspects.

These forms may include articulated, courtyard and perforated buildings, which will have to meet climate, social-culture and economic aspects of the local context.

Facility Type and Spaces: All type of healthcare facilities may employ these buildings forms; however hospitals due their nature, of housing large number of patients and staff, are typically large footprint buildings and therefore the most critic settings for the application of these building forms.



227: Patient affected by Seasonal Affective Disorder

Problem statement: The access to natural light, ventilation and views is a primordial principle to ensure health and wellbeing, and improve patient outcomes. Light (sunlight and daylight) affects the production of "Vitamin D" in a human body, which is directly related to many diseases including but not limited to seasonal depression or seasonal affective disorder (SAD), bone disease, heart disease, multiple sclerosis, cancer and diabetes. Light regulates our internal body clock in terms of "light-dark" diurnal cycles. Light affects hormonal and metabolic human body systems through hypothalamus gland, by balancing energy and body fluids, regulates growth, maturation and reproduction, regulates circulation and breathing systems and heart and circadian cycle. (Bouberki.2008, Marberry.2006, Ulrich, Zimring, et al. 2008).

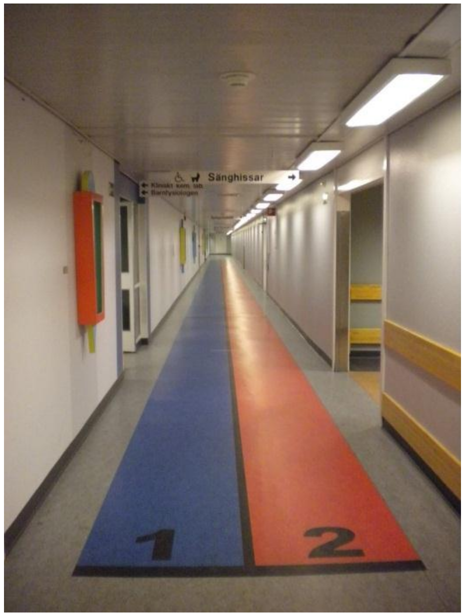
Daylight and nature views improve patients' outcome, healing and recovering processes. Their impact extends to reduction of pain which in turn reduces the need for medication; reduces psychological and physiological stress; it also reduces anxiety and depression, and length of stay. Altogether these elements boost patient mood and improve satisfaction; improve patient sleep and circadian rhythms in adult & elderly patients and above all encourage social support. Effects of daylight and nature views on staff include reduction of stress that leads to burnout, reduce medical errors and other adverse events which in turn impacts staff mood, higher job satisfaction and improved patient care delivery. (Bouberki.2008, (Marberry.2006, Ulrich, Zimring, et al. 2008).

228: Patient room, Providence Newberg Medical Center, US

On other hand, natural ventilation has positive impact on infection control. It provides healthier air for breathing [unless the hospital is situated in areas prone to low air quality] by diluting sources of pollutants within the building, then removing the pollutants from the building. This is achievable not only by operable windows but also ensuring high ventilation rates to decrease the risk of airborne infections due their high capacity in diluting airborne pathogens (pollutants). This in turn reduces the risk of airborne infections. (P. G. WHO.2009)

229: Global environmental impact of energy production and consumption

Energy production generates carbon dioxide, the major cause of global warming. Energy consumption represents 30% of typical hospital buildings operational costs since they consume double the energy of other types of building. Enabling buildings to access natural light and ventilation, makes high impact on building energy efficiency. Natural light and ventilation allow reduced consumption of electric energy through reduced reliance on mechanical systems to ventilate and illuminate buildings. Buildings should be designed to reduce energy demand, starting from orientation on site and placement of envelope openings, to roof design solutions that reduce unwanted heat gain. (Guenther and Vittori. 2008)

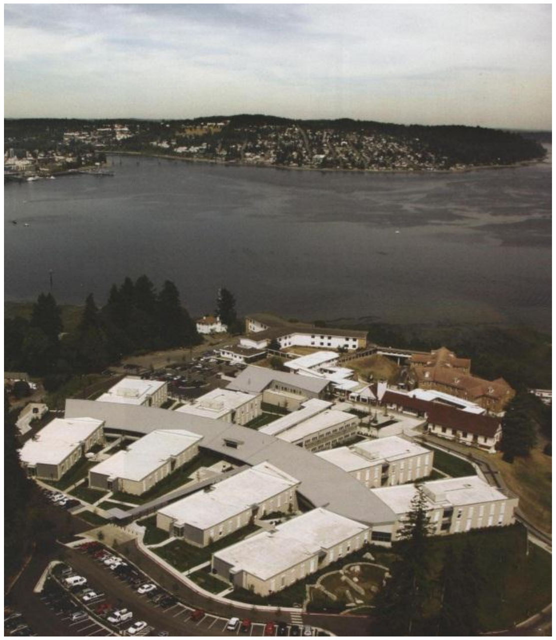


230: Corridor at Drottning Silvias Children Hospital

231: Operation Corridor, Robina Hospital

Quality of care delivery is profoundly impacted by building configuration and design features that affect staff when performing their tasks in many ways. Staff spends only 57% of the shift working time in patient care activities and around 29% of the shift working time walking to fetch supplies from nursing support service to patient head. Communication and coordination activities spend around 17% of the shift working. Staff also spends more time giving directions to visitors and patients on how to navigate the building, if the pathway system is intricate, not clear and simple (Marberry.2006, Zimring, et al. 2008, McCullough. 2010, Huelat / EDAC. 2007).

It is reasonable to state that the relevant aspects of building configuration and design features which influence staff performance include: the location of nursing work core relative to patient rooms and wards, location of nursing stations through the unit, the number of beds that are directly related and observed from the nursing station; work place and physical environments that enable clear visibility among workers and between staff and patients; spaces that enable privacy for patients-family, staff-patient and staff-family to disclosure confidential information, opportunity for private workplaces; among many other factors.



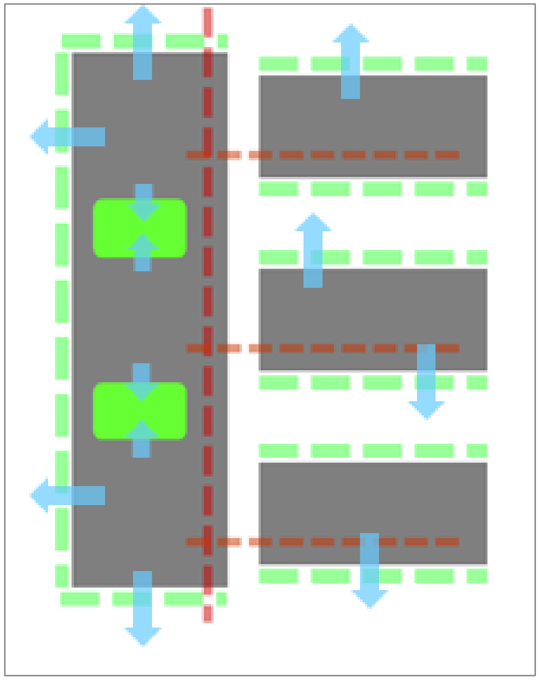
232: Washington State Veteran's Center Retsil, WA: articulated building form

Contemporary design trends are focused on addressing these issues. Thus they argue that buildings should be configured to allow access to large amounts of natural air, daylight and views, while at the same time providing opportunity for privacy, short travel distances, and visibility; and be highly energy efficient. These design features may be achievable through the design of articulated and courtyard building plans (narrow building footprint: single-corridor or double-corridor plans) that allow placement of a large number of operable windows, clerestories and skylights, and may also allow better distribution of nursing work core, nursing stations and many other support functions to temper the impact of staff shortage circumstances. Perforated building configurations as well offer many opportunities to access daylight, natural ventilation and views. Through placement of several courtyards and skylights, many functional design solutions can be achievable in this typology of building. Furthermore, the extended perimeter of thick perforated plan allows placement of mainly patient areas along the façades.

Related objectives:

- Minimize hospital acquired-infections and medical errors
- Maximize daylight, natural ventilation and views
- Optimize patient healing and recovery processes
- Optimize staff efficiency and effectiveness – higher job satisfaction
- Minimize stress and pain
- Minimize anxiety and depression
- Optimize patient sleep and circadian rhythms
- Minimize travel distances
- Minimize physical exhaustion and fatigue
- Maximize staff productivity and job satisfaction
- Maximize overall satisfaction
- Maximize time spent with patient

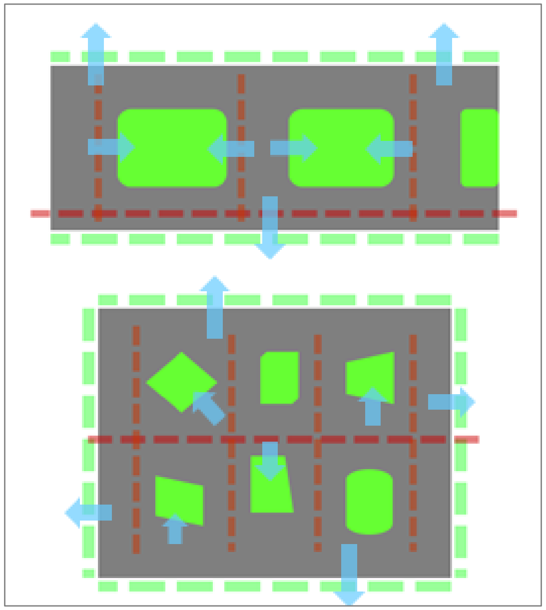
233: Kaleidoscope, Lewisham Children and Young people's Centre, UK



234: Articulated Building - Conceptual Diagr.

***Articulated building**:* This typology is basically an articulation of different nursing unit blocks that connect to main building footprint, diagnostic and treatment block through the main hospital circulation area, the hospital spine. Given its extended perimeter line, makes possible to provide abundant natural ventilation by placing large number of operable windows and clerestories. The patient wings are basically single corridor plan (double-loaded corridor), which enable crossed ventilation basically through all the unit compartments; while the D&T building plan is usually double corridor (race-track plan) in which patient area is flanked along the building perimeter and the nursing work core is arranged on central area of the building.

The drawback of this typology is that frequently the nursing work core has no access to daylight, natural ventilation and views. To minimize that situation, a number of courtyards should be provided alternately along the nursing work core to allow access to ventilation and daylight. Well-designed, this typology may allow also reduced distances between staff core service and patients' rooms or wards.



235: Courtyard and perforated building form Conceptual Diagrams

Courtyard building: Is basically the same concept with articulated buildings typology. There are complex racetrack building plans, with wide courtyards inserted within the building block. These courtyards provide natural light to the more centralized spaces. Different building plans—double loaded or single loaded corridors, articulated may form a courtyard building. Building functions are flanked surrounding large courtyards, with direct access to courtyards—daylight and views. In an articulated building typology nursing unit, usually form courtyards or patient gardens. Increase of travel distances is the most cited drawback of the courtyard typology.

Perforated building: This is a large or thick building footprint plan, perforated by courtyards, irregular shaped and located in an irregular manner to add dynamic to the environment. These courtyards bring light and sense of nature to indoors. In this typology, support areas are organized in a central area, while patient areas are arranged along the building perimeter to allow daylight, views and ventilation.

236: Ground floor plan, D&T, OP & ED serv.

237: Overview of the hospital Sant Joan Despi Barcelona

Case studies:

(01): The hospital of Sant Joan Despi Barcelona, Spain, designed by Brullet-De Luna Architects + Pinearq, is a new construction with five-story + two-story basement for parking. The facility is sized to serve 300.000 people of Sant Joan Despí and it has an area of 45,725 sqm. The project design completion date was 2010.

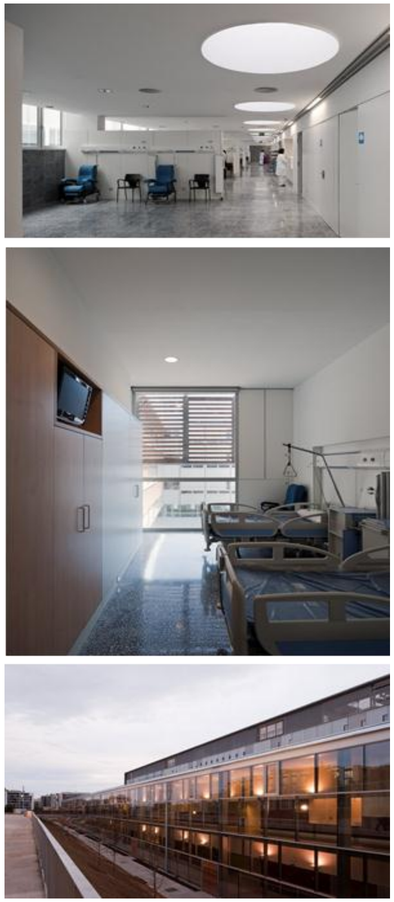
Access to the facility is provided accordingly with the position of the site in relation to the main public roads. The main entry, emergency and outpatient entries are the most important accesses used by public. Service and parking garage entries are also provided separately. A clear circulation system is achieved by separating public circulation, staff, and services circulation. Different entry points allow the public to directed access the hospital services. The thick block houses D&T, OP and ED services, all organized along the principal circulation corridors, harnessed with daylight by skylights. The ground floor of the nursing block, houses the

238: Typical Nursing Unit plan and building section, hospital Sant Joan Despi Barcelona

239: Nursing unit wings enclosing courtyard, hospital Sant Joan Despi Barcelona

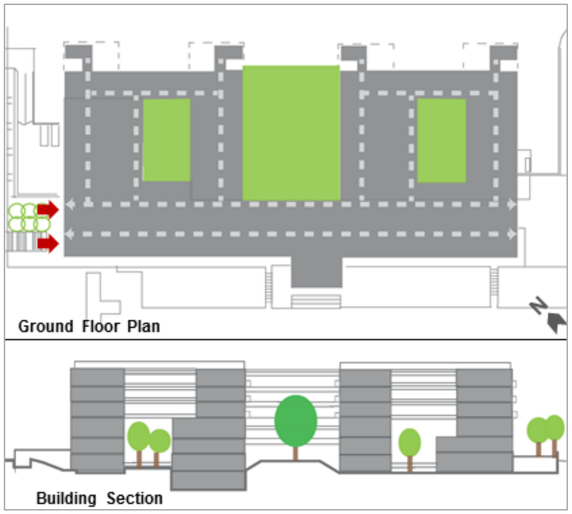
remaining OP, logistic and support services, organized in a race-track & single loaded corridors building plans.

Nursing wings, located on the upper three floors, houses patients in double-patient rooms, arranged in single-loaded corridor, which embrace three opened courtyards that allow of daylight, nature views and natural ventilation. Natural light is enhanced through skylights placed through the ceilings of the most deep building footprint. Patient' rooms are overlooking a quiet wooded park toward South, and also have access to opened courtyards and garden roofs of the D&T and OP services buildings. The orientation of the nursing units requires sun protection devices along the southwest façade for climate control. Additionally, nursing work core is flanked on the right side of the nursing block and allow interaction and visibility among.



240: Daylight, views and ventilation, hospital Sant Joan Despi Barcelona

Daylight, views and Ventilation in overall hospital facility is provided through large number of building features, namely: windows, skylights and inner courtyards. Outpatient areas are provided with abundant daylight through windows and skylights and the typically patient room, too narrow for two patients has window in a position not adequate for patients have an outdoor view. The thick D&T block is featured with a large number of windows on North-East façade allowing a considerable amount of views, daylight and perhaps ventilation. Public single-loaded corridor, affords large windows and comfortable finishes, which adds to wayfinding.



241: Ground Floor plan and building section, University Clinical Center Carl Gustav Carus


242: Building façade- main entry, University Clinical Center Carl Gustav Carus

(02) The University Clinical Center Carl Gustav Carus, Dresden Germany, designed by Heinle, Wischer & Partner, Freelance Architects, is a Pediatric and Gynecological six-story building, sized for 250 beds with additionally pediatric and neonatal intensive care beds. Two square blocks, enclosing a central courtyard are linked through the garden hall—hospital spine which houses diverse recreation activities. Major departmental circulations and patient areas are arranged around the courtyards and the patient garden to afford transparency, daylight and views. D&T, OP and ED services were located on lower floors, while nursing units are on upper floors.

243: Interior design featured by vivid color pallet, adds to wayfinding

The major focus during the design process was to address issues related to daylight, transparency and building navigation. These features were achieved through employing a colorful pallet and textured materials to allow easy building navigation. Outdoor views through large number of windows placed on single-loaded corridors through the building, add to wayfinding. The spacious and transparent garden hall (single-loaded corridor) is featured by glazing walls, allowing views to outdoor and to the patient garden, with public space houses such as conference room, cafeteria, library and reception / information / registration areas are to make the public circulation more populated, adding to security. Bright, colorful and ample hallway at the nursing units is overlooking to the central garden through generous glazing wall and is imposing a vivid color pallet employed in entire facility. It positively impacts on staff mood, reduces stress and increase job satisfaction.

244: Operable windows on façades allow connection with exterior garden

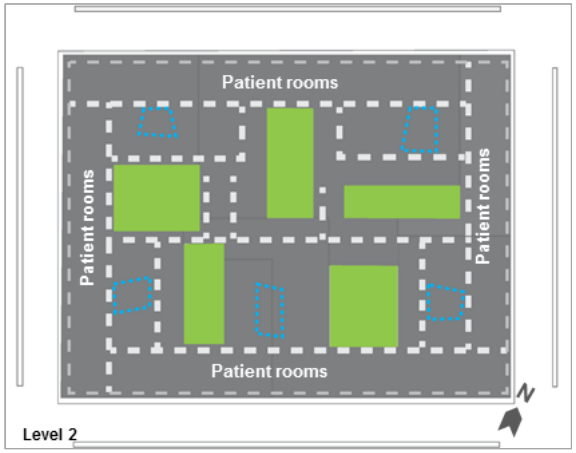
The façades are featured by operable windows for natural ventilation, views and natural light. All rooms—patient and clinical, treatment and consultation rooms are featured with glazing to the floor, and they all have balconies to link exterior and interior environments and to access to outdoor views. The relation transition between interior and exterior is buffered through green courtyards and the central oak garden that provides a sense of natural environment. Given aesthetic and environmental reasons, the solutions employed for ambience control and views is planted roofs, to which patient rooms are overlooking.

245: Ground Floor plan, perforated by courtyards and skylights

(03): REHAB Basel, Switzerland, designed by Herzog & De Meuron, is Center for Spinal Cord and Brain Injuries. This two-story horizontal building + roof terrace is sized for 92 beds. The design concept was to provide a facility that allows patients to feel comfortable in a home-like environment. Patients spend an average of 18 months housed in the facility, thus the main features were to provide a facility acting as small town, which comprise roads, gardens and living areas, and it is also easy accessible for wheelchairs.

246: Building façades featured by wood material to provide thermal and sun control

Ground floor houses D&T services, arranged around 5 courtyards and along the building perimeter to allow natural light, views and ventilation. Different types of wood combined with textiles make an ornamental building façades. Circulation is informally articulated, yet visible & transparent, enhanced through several irregular shaped volumes, courtyards, that adds for spatial orientation.



247: First floor plan, patient areas distributed along building perimeter

248: Verandah surrounding the building, acts as a connector interior – exterior from the patient rooms

The connectivity from interior to exterior from the patient rooms is made through a long balcony located on the building perimeter, with large windows overlooking the nature landscape. Along the balcony patients can have a therapeutic walking with access to views to and natural ventilation. A clear circulation pathway promotes easy access to patient rooms, while the access to nursing support activities flows along the courtyard volumes. Operable windows are featured throughout the entire building in all compartmentalizations. Thermal comfort and visual privacy are achieved through an overhanging wood deck and sun control devices placed along the building perimeter. Five skylights and spherical sky-domes supplement daylight into the building through each patient room respectively.

249: Courtyards featured by different materials and functions

Therapeutic courtyards: they bring fresh air and natural light to the interior spaces and add for spatial orientation providing visual cues for the building users. The courtyards are accessible and each one is designed to supplement the correspondent therapeutic treatment area surrounding it. One central courtyard welcomes who enter the building, other is an open space filled with water, another is completely within wood, and there is a bathhouse courtyard, and so on. The variety of the courtyards provided allows patients to have opportunity for choice, increase emotional, psychological and physiological positive changes, speed therapeutic and restorative processes and increase overall patients and staff satisfaction. The courtyards were named as following: Field courtyard, along the main entry; Woodland courtyard; Water courtyard; Greenery courtyard and Bathhouse courtyard.

Conclusion and Future Directions

The main platform to ensure universal access to care, equity and quality of health care delivery is to provide adequate healthcare facilities that respond the state of the art in healthcare design. Based on the current stage of the healthcare design practices in Mozambique, and analyzing the current quality of care delivered in the NHS, it is concluded that many changes need to be done in terms of how to approach, plan and design healthcare facilities, to increase the overall outcomes, in a means of health safety, wellbeing and efficiency and effectiveness.

The set of guidelines provided, make available fundamental tools, information and knowledge to minimize the main causes that negatively impacts the level of care services delivered—the quality of healthcare facilities. Site selection and facility design and organization issues must be adequately addressed during the planning and design processes to ensure that the future healthcare facilities will reflect the best practices and the achievable state of the art in healthcare design in the current and local contexts.

Obviously limitations such as lack of financial resources, the need of changing institutional culture, and the availability of skilled human resources among others, constitute constraints for the full implementation of these guidelines. However, the country must make this required change. Decision makers should make bolt decisions in order to adequately apply the available resources to gradually achieve the best level of care delivery in Mozambique. All interested parts, health related institutions, Government, NGO's donors and planners and designers, should move together toward the goals highlighted on this study.

Looking forward, much work should be made to improve healthcare outcomes. The understanding of the specificities and ergonomics of specific healthcare spaces in terms of design requirements and features, will greatly improve the quality of care delivered. Spaces such as patient room or patient ward for intensive and acute care; exam and treatment rooms; staff respite and family accommodation spaces; and public realms—waiting areas, lobbies and entries, spiritual spaces and courtyards and terraces—should be designed to meet the universal standard in terms of best practices, while respecting culture and habits of the local populations. Universal information and knowledge that supports the need for improving the physical environment of these spaces is available. Local research should be made to adjust these universal standards and tools to the real and current contexts. The physical environment features of a healthcare setting play an important role in terms of outcomes—physiological, psychological, emotional, therapeutic, and restorative process of the patients, staff and families. Thus, it is urgent and important to target this field of study and research.

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DHV, Mozambique – Design Firm, Maputo.