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## Green Building Design Concepts of Healthcare Facilities on the Orthopaedic Hospital in the Tropics

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### Abstract

The issue of Global Warming is rapidly evolving, so every healthcare facility requires the Green Building Concepts. The Orthopaedic Hospital of Professor Dr. R. Soeharso is in Surakarta, Indonesia. It needs strategies on the green building concepts application. The purposes of this study are green concepts consisting of functional program, additional capacity of hospital services, and marketing strategies based on clinical approaches. Market share figures will be able to predict the number of patients coming up by the year of 2020. By this method, the researchers will be able to find out some essential facilities that should be built by the hospital.

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*Keywords* : Green building concepts; ortopaedic hospital; services capacity

### 1. Background of study

The Orthopaedic Hospital of Professor Dr. R. Soeharso continues to grow because of the additional capacity of services from year to year. Development of a hospital requires a systematic and rigorous method consisting of various interrelated aspects of hospital. Development of the hospital should be able to realize the Quality of Life. In addition, the development of hospital services is closely related to the education, economic, demographic, and socio-culture which are aspects of many local factors that influence the hospital (*Somboonwit, N., & Sahachaisaeree, N., 2012*). The Hospital must be

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environmentally oriented. Therefore, it needs implementation of a sustainability concept. In addition, the sustainability concept is necessary in responding the issues of green hospital which concerns with several aspects such as the use of natural resources, the development of alternative energy and the utilization of energy saving system as well as the efforts to minimize the emission of carbon dioxide gas (CO<sub>2</sub>) in both of planning and implementation process. The orthopaedic hospital of Prof. Dr. R. Soeharso is an Orthopaedic and Medical Rehabilitation Services Hospital in Indonesia. The Indonesian Minister of Health has transformed the hospital into an A-Class Hospital specializing in Orthopaedic and Traumatic fields by Decree number: 839/VII/2007 dated on 20<sup>th</sup> July 2007 and the Indonesian Ministry of Health Regulation number: 256/III/2008 dated on 11<sup>th</sup> March 2008. Furthermore, the Strategic Business Plan of the orthopaedic hospital for the year of 2008- 2012 confirmed that based on the results of the ‘Strength, Weakness, Opportunity, and Threat’ analysis, the hospital was in ‘*Second Quadrant*’ condition. The condition mentioned that the orthopaedic hospital should implement and conduct strategies to develop with the term of ‘Rapid Growth’ (The final report of the orthopaedic hospital master plan, 2009). Some disadvantages often appearing in the hospital are connection between facilities that have not been well integrated, the lack of patient’s satisfaction and the lack of capacity in several hospital installations. Sustainable concepts in buildings are important for the patients’ comfort in facing their illness. In the opposite situation, they will be discomforted because of both the burden in unsustainable physical environment and the burden of illness (Jain Malkin, 2002). Based on those facts, the hospital tends to have many constrains related to those disadvantages and thus the hospital requires a study of the sustainability concept in a green hospital design.

### *1.1. Research question*

The question of this study is how to design the layout, infrastructure facilities of a Green Hospital, medical facilities with the development of science and technology as well as how to design comprehensive spatial planning and buildings of the orthopedics hospital having concepts of green hospital that consider the layout of buildings, healthy outdoor spaces, infrastructure, local town planning regulations, and the elements of an integrated health and behavior system.

### *1.2. Research aim*

The realization of Strategic Comprehensive Design reference having concepts of green hospital conducted by reviewing the technical regulations in both internal and external aspects of the ortopaedic hospital, such as government regulations, especially the local region regulation, as a territorial services of the ortopaedic hospital. Reference design considers not only the aspects of human behavior hospital but also the integrated design process on sustainability concept associated with patients, medical staff, staff outcomes and physical environment.

## **2. Sustainability and green concept literature review**

The concept of the Green Hospital Sustainability requires integration consisting of several multi disciplinary professionals. The integration of the whole is called the Integrated Design Process and starts from planning, implementation to operational buildings (Jain Malkin, 2002). The Integrated Design Process makes a sustainable, green and high performance building which are designed, constructed, and operated to make the world a better place by improving the environment through nurturing lives, restoring environmental assets, and offering inspiration by drawing on the collaborative experience of a multi disciplinary team of professionals. Furthermore, the Integrated Design Process generates sustainable

concepts that aim to minimize the negative impacts of building on the global, regional and local environment. The integrated Building process means achieving good design for long term sustainability and it must start at the beginning of a project and should continue throughout the building operation.

In addition, not all of the construction process will have a positive impact in terms of human resources comfort in hospital for both patient and medical staff. Some cases even signify that conductiveness of occupants reduced during wards renovation. Patients and medical staff sometimes feel more comfortable on the old wards than in the new wards (*Ghazali, R and Abbas, M.Y., 2012*). Therefore, the level of satisfaction of users is a very important aspect and can shorten the patients healing process. The shortened healing process can save the cost of hospital in the treatment of patients and positively impact the overall cost savings.

### *2.1. Sustainability and green concepts*

Sustainability based on the Green concept has several approaches. Two of the various approaches are the architectural and mechanical electrical approaches (B. Vale, 1991). The architectural approaches consist of land use efficiency, water savings, energy efficiency, application of the building materials used in the construction process to save the waste that occurs (the concept of recycle materials) and maintenance of healthy indoor air quality. Meanwhile, mechanical and electrical approaches consist of alternative energy to reduce the dependency of using electricity power of the State Electricity Company. The approaches consider the utilization of several equipments such as the Solar Cell Generator system; innovation on natural lighting, energy saving in electricity, and the application of information technology (IT) with the concept of High Technology.

### *2.2. Health, behavior and social comfort*

Health and behavior are two interconnected aspects of the hospital. Hospital practitioners, patients, families and politician discuss the health and behavior issues in many ways and perceptions. The correlation between health and behavior is complex. It is neither easy nor straight (The National Academies, 2001). Even though health and behavior are unlike, but in a hospital system, they have a closer interconnection due to the healthy environment system. Hospital consist of many human resources who have connection to each other. They are multi-disciplinary people who have to connect with each other in the health services system, so these connections need specific behavioral sciences which move dynamically in 'bio-atmosphere'. The reports on health and behavior use the term of "bio-behavioral sciences" to encompass the many disciplines that contribute to behavior and health because they reflect the rich, dynamic, and interactive nature of the fields contributing to knowledge of health and behavior. On the other hand, the term bio-behavioral sciences includes not only the behavioral sciences that conduct experimental analysis of human behavior but it also is broadly inclusive of relevant medical sciences (Roger Ulrich, et.al, 2004; National Academies, 2001)

Hospital design is a plan that can combine health and behavior. The development of drugs is very sporadic in medicine fields guided by an understanding of the Evidence based medicine. Meanwhile, the development of the design of the hospital guided by several concepts of sustainability related many researches is moving towards to an understanding of the Evidence based Design, which connects the physical environment with the patient and staff outcomes (Roger Ulrich, et.al, 2004). On the other hand, Sarah Hosking analogize the hospital as a workshop where people are taken to be checked and repaired before being sent off to resume their journey (Hosking, Sarah and Haggard, L, 1999). Diagnosis and treatment are achieved by a combination of scientific and machine calculation balanced by human wisdom and experience; sometimes it has to be accepted that the whole journey is over and discreet

disposal is made of the chassis after those parts deemed to be still able to function elsewhere on another vehicle are removed. But man is not a vehicle that has feelings and can judge about the quality of the environment he faces on. Humans have a sense of satisfaction and dissatisfaction that can be expressed through behavior. Social comfort is a very important aspect in a hospital. The hospital is a very large institution. It takes a comprehensive bureaucracy to move on. Hospitals also have high-tech devices that require skill, and high intellectualism to operate. Therefore, the hospital takes the aspect of "aesthetic of hospital". The aesthetic of hospital will answer the question of why the hospital is very difficult to be planned, built, operated and maintained. It consist of human comfort, well-designed and well-maintained building.

### **3. Research methodology**

The research method used was action research design, where the team was directly involved in the research process and involved many participants from hospitals in doing this planning process of green hospital. This process has several steps:

#### *3.1. Data collecting process*

The required data are the primary data and secondary data. While aspects of the survey are correlated to the component under review. The observation location for each aspect of the survey is based on the characteristics of the hospital environment.

#### *3.2. Data analyses*

Analysis was performed on data that has been collected in two aspects which consist of city planning data and state of the location of the hospital. The city planning data is needed in order to set out the building in the master plan. It uses the basic order of local district of City Master Plan, The Part of the City Plan Regulation and Detail Spatial Plan. Meanwhile, the analyses of the state of the location include site plan, zonification, circulation, parking and appearance of the buildings.

#### *3.3. Function programming*

The Function Programming in the form of block plan is a translation of the master program that has been described in terms of the activities that will be conducted by Prof. Dr. R. Soeharso Orthopaedic Hospital in Surakarta. The master program consists of the hospital policy in the future which considers of patient safety, staff outcomes, patient comfort, sustainability concepts, green concepts, additional capacity of hospital services and the reduction of the impact of building on the global, regional and local environment.

### **4. The resources data of the orthopedics hospital**

Orthopedics Hospital Prof. Dr. R. Soeharso has major facilities such as outpatient, inpatient, emergency department, radiology installation, installation of medical rehabilitation, central operating theater (COT), Intensive Care Unit (ICU), hospital maintenance installation, sanitation and the executive wing of the orthopedics hospital. Recently, there have been nine types of services held at regular outpatient. They are Orthopedics' Clinic, Dental Clinic, Pain Clinic, Acupuncture, Specialist Clinic (internal medicine, neurology, psychiatry, general surgery), Club Foot Clinic, Illizarof Clinic, Clinic

anesthesia, Clinical Integration (orthopaedic, medical rehabilitation specialists and all) as well as One Day Care Clinic. The type of Ambulatory Care Executives throughout five years has undergone various developments. So far, there are 11 (eleven) types of services held, the Orthopedics Clinic, Dental Clinic, Pain Clinic and Acupuncture, other specialized clinics, Club Foot Clinic, Integrated clinic (ortopaedic, medical rehabilitation specialists, and all), Illizarof clinic, Clinic of Anesthesia, Clinic of One Day Care and clinic of Osteoporosis. The total number of visitors in the outpatient department is gradually increasing year by year. The hospital's statistic data wrote that there are 57.877 visitors in the year of 2006 and the increase has been recorded up to the number of 70.489 visitors in 2010. Inpatient care given to patients who have been classified into groups of adult male patients (Orchid Room), a group of adult women and children (the Bougainville room), the group of patients with infections (*Cempaka* Room), patient groups Injury Pour Rear / Paraplegia (Dahlia ward), the treatment of patients with class I (*Edelweis* room), the group of patients with primary care grade (*Flamboyan* room), the group of patients with the executive treatment class (pavilion of *Wijaya Kusuma*). The pattern of the services is provided by case, sex and age. While inpatient performance indicators is shown in the table below:

Table 1. Performance of hospitalization in 5 consecutive years

NO	INDICATOR	YEAR				
		2006	2007	2008	2009	2010
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>
1	BOR	76,6	71,46	48,02	46,27	46,08
2	LOS	9,6	8,93	6,97	6,75	5,98
3	TOI	3,07	3,65	7,73	8,45	7,56
4	BTO	27,8	28,56	24,62	25,62	24,25

Medical Rehabilitation Service is a therapy service provided for patients in need of treatment in the healing process. This service consists of 5 (five) types of care provided to patients in an integrative way. Performance results of the visitor number in five consecutive years as shown in the table below:

Table 2. The data of visitors in medical rehabilitation facilities

NO	SERVICES	2006	2007	2008	2009	2010
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>
1	Physiotherapy	84.150	98.085	103.168	108.987	114.954
2	Occupancy Therapy	8.410	6.135	3.913	4.572	6.356
3	Orthotic Prosthetic	1.411	1.785	1.306	1.649	1.842
4	Psychology	2.345	2.135	1.735	2.371	1.874
5	Community Social Labour	3.669	5.578	3.637	4.593	3.927
Total		99.985	113.718	113.759	122.172	128.953

With the rapid development of Medical Science, Central Surgical Installation of Prof. Dr. R. Soeharso Orthopaedic Hospital in Surakarta have planned the development of new techniques in the fields of Spine Scoliosis Surgery, Vertebra-plasty, IDET, Adult Reconstruction and Total Joint Replacement, Hand Surgery, Micro Surgery, Arthroscopic Surgery, Pediatric Reconstruction, Illizarov Limb Lengthening Procedure. Anesthesia services and Reanimation are services provided before and after surgery or surgery

provided services. These services are in the installation of Anesthesia and Reanimation (Recovery Room). The more complex and varied types of surgery, the better management of anesthesia is needed so that patients feel comfortable, do not feel pain, and stress during anesthesia (master plan final report, 2009).

As the hospital's core business, these services provide a significant contribution to the development and progress of the hospital. The patient surgery was first determined by an orthopaedics surgeon who then followed up by a specialist anesthetist. The indicator data are as follows:

Table 3. Performance of central operating theatre and intensive care unit

NO	SERVICES	YEAR				
		2006	2007	2008	2009	2010
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>
1	Operating Treatment	5.039	4.105	3.518	3.498	3.672
2	Intensive Care	188	320	493	529	591

Network Utilities to support operations within the Hospital Prof. Dr. R. Soeharso Surakarta consist of electricity, hydrant networks, telephone networks, water networks and sewage networks.

## 5. Discussion and analyses

### 5.1. Capacity of services development

According to Horak, B (2009) the additional service, service capacity and development are the integrated systems in the strategic plan of the hospital. The planning of the hospital's business strategy is a mutual process covering the entire system and sub-system of the hospital and their developments. The planning of the hospital's business strategy has some requirements. The hospital's business strategy requires leadership and commitment both at the level of hospitals and other stakeholders. In business strategy plan, there is the physical environment planning as one necessary aspect to achieve Hospital Balanced Scorecard. Orthopedics hospital has centers of excellence in the field of Traumatic and medical rehabilitation. Therefore, the preparation of a hospital's business strategy should start from the development of systems and sub-systems of the trauma unit and the medical rehabilitation. In the aspect of human resources, the hospital need to think about the development of human resource skills, to develop teamwork and so on. For the financial aspect, billing systems and financial information systems should be developed so that they not only could provide certain financial information to users (patients and families) and but also could manage in a timely and accurate manner.

Based on the clinical program, the clinician, professional and management support each other. The Orthopaedic Hospital is a hospital-based on digestive program or orthopedics surgery. The development of the services capacity must be started from the surgery while the directors and management should support it. Physical facilities that will be developed should follow the direction of the development that has been created by the surgical clinic as a core business. With the core business of health care, hospital business strategic planning should focus on service activities. Vision of the hospital must be translated into a strategy that is based on the results of the user-need assessment and providers of subsidies. These strategies are then translated into planning clinic to determine the amount of services and value to be given to the user and giving subsidies (Swayne, et.al, 2006). The Prof. Dr. R. Soeharso Orthopedics Hospital has some pretty specific services that are not owned by other similar hospitals. Analysis of the capacity that will be taken into account is only the global analysis but has been able to portray the

condition of hospitals in the future. The types of services that will change in accordance with market developments are IGD, Regular and Executive Outpatient Department, Inpatient Department and Medical Record. Meanwhile, the supporting services will also experience growth, but the changes are not very significant to the capacity of the space that must be provided. The calculation assumes that the market served by the Orthopedics Hospital is patients from all over Indonesia. Room installation capacity of orthopedics surgery at the hospital right now is about 11 to 15 patients per day, or if the operation is taken the average were 12 patients. There is actually a market estimated to reach 13 patients in the everyday operations. With these conditions and assuming the duration of the operation up to 6 to 8 hours and stay occupancy was 75% used the operating room takes 7 operating rooms and in 2020 only requires 8 operating rooms. As with the installation of inpatient and outpatient installation, when patients expect more than that now it is absolutely necessary marketing and constantly strengthen the service infrastructure such as the concept of the Value Chain. Here is the estimated capacity of the orthopedics' hospital services:

Table 4. The physical capacity estimates of hospital services

Year	Out patient	Inpatient	Executive class	COT	Medical Rehabilitation	Emergency
2009	314.91	124.24	88.18	7.22	381.25	38.73
2010	318.41	125.62	89.15	7.30	385.48	39.16
2011	321.94	127.01	90.14	7.38	389.76	39.60
2012	325.52	128.42	91.14	7.47	394.09	40.04
2013	329.13	129.85	92.16	7.55	398.46	40.48
2014	332.78	131.29	93.18	7.63	402.88	40.93
2015	336.48	132.75	94.21	7.72	407.36	41.39
2016	340.21	134.22	95.26	7.80	411.88	41.85
2017	343.99	135.71	96.32	7.89	416.45	42.31
2018	347.81	137.22	97.39	7.98	421.07	42.78
2019	351.67	138.74	98.47	8.06	425.75	43.25
2020	355.57	140.28	99.56	8.15	430.47	43.74

## 5.2. Green design concept of orthopedics hospital

The ortopaedic hospital has a strategic site planning where it is located in the main road linking the three important cities of Semarang, Yogyakarta and Surakarta. The total land area of the ortopaedic hospital reaches 103,000 square metres and the land up to today is approximately 40,000 square metres. According to the local regulation on city planning years 2004-2013, the area is established as Health Care Region. Based on the analysis of program functions, the development trend and increase service capacity, the hospital requires the addition of several physical buildings.



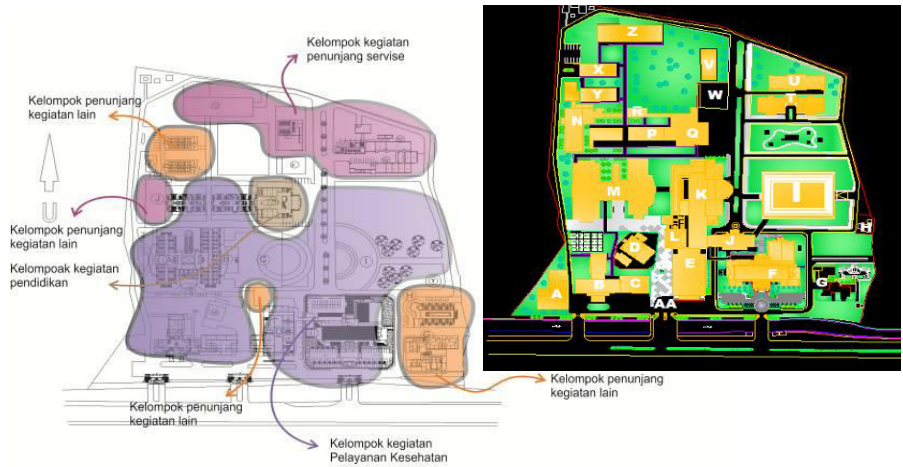


Fig. 1. Master plan RSO based on projected service capacity within the next 5-10 years

The ortopaedic hospital had two old gates which are located on the eastern and western sides, while it had no access to the hospital emergency unit. Therefore, the hospital planned to add an access gate for the emergency department. Furthermore, the old access gates will be renovated by creating a green gate access concept on them. The new gate will be equipped with some properties such as landscape, shelter, pedestrian access from public transportation station, elderly and disabilities pedestrian ways. Design with the concept of Green Hospital planning should consider the easy and low maintenance aspects as well as the "long-live durability" specification. The low maintenance is implemented in by using the building materials which have easy-to-clean and non-corrosive specifications. Those materials should not obsolete under the climate change throughout the year.

Utilization of natural energy and energy saving system is essential to reduce the energy dependency on the Indonesian electricity power (PLN) and generators. This effort is applied by using Solar Cell and the creation of a simple alternative energy.

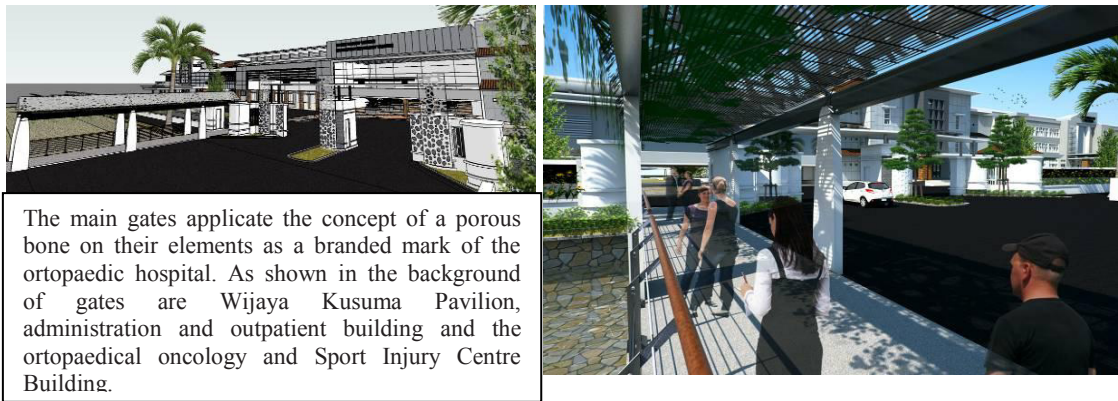


Fig. 2. Green Gate Access in Orthopedics Hospital: (a). The gate and the background of Orthopedics Oncology Centre; (b). Green gate access concept



The Development of energy efficiency and environmentally friendly buildings should be cheap, easy, and have wide spread impacts. The development to reduce the global warming and global crisis are growing up by many efforts such as the development of green cities, green properties, green buildings, green office, green school, and the use of the green products.

Green building concept requires some ratios which consist of building layout design (10 percent), consumption and water management (10 percent), electrical energy needs (30 percent), building materials (15 percent), air quality (20 percent), and the breakthrough of innovation (technology, operations) at about 15 percent. According to the standards of LEED (Leadership in Energy and Environmental Design) standards of the Agency Green Building America, a building must contain some criteria which contains a certain value each criterion.

The focus of the utility or electrical mechanical concept is a Green Building system. It is possible to use an alternative energy to reduce the dependency of PLN and Generator set by using the Solar Cell System. Furthermore, Building Lighting Systems is implementing several systems as mentioned below:

- Natural lighting system from glass curtain wall, Dimming management system when natural lighting from outside is adequate in intensity of light. Moving sensor system: if there is no activity, the artificial lighting system will turn off automatically.
- Air Conditioning (AC) System in Building implements saving energy system by using the Inverter Air Conditioning System, a digital-management air conditioning system equipped by Environmentally Friendly Refrigerant, which is recommended to have both operation and maintenance management system.
- Waste and sewage systems are using products operated by natural energy and require less electrical energy (Rotor System).

The lack of parking area in the future will be fulfilled by the Green Parking Building having an integrated concept that connects it with the main buildings and other medical facilities through the flying corridor. The Green Parking Building can accommodate 400 cars and 800 motorcycles. In order to maintain the hospital microclimate to always be in a comfortable temperature, the building applied green surfaces in which the building is blanketed by the grass on its surfaces. Implementation of this green concept can be shown on the display of the building below.

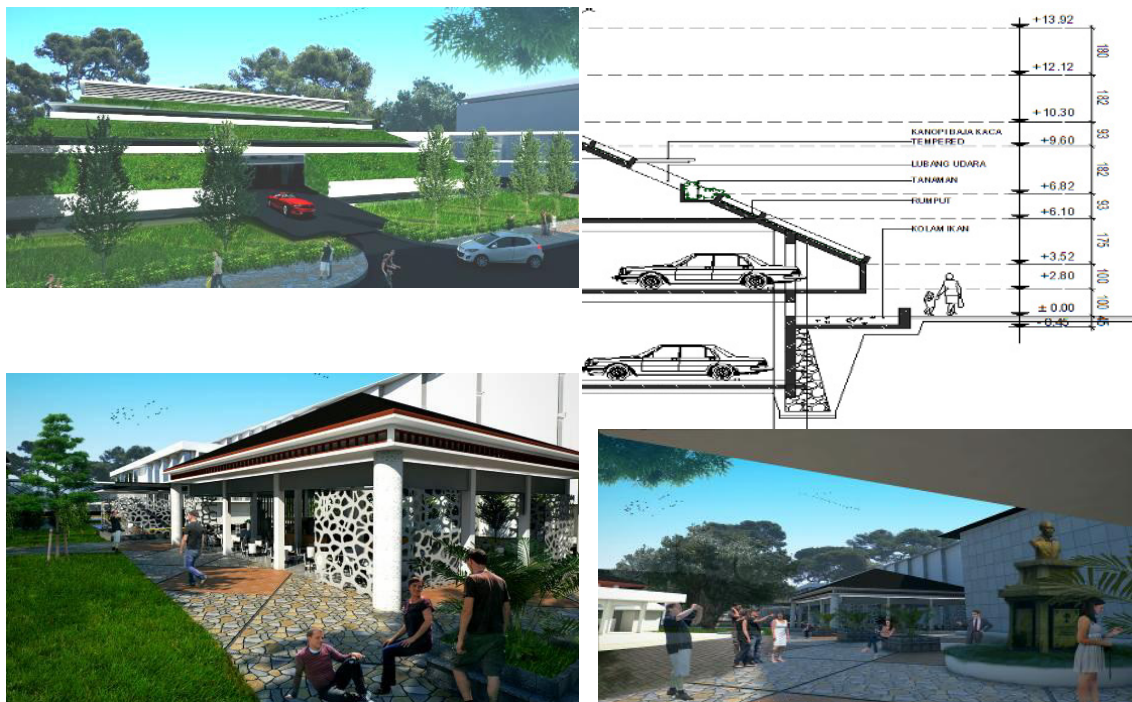


Fig. 3. Green parking building and city walk facility in orthopedics hospital  
 (a). Green Parking Building; (b). Reducing Heat Island by creating pool surrounding the buildings;  
 (c). City Walk in Hospital; (d). Memorial Park dedicated to the founder, Professor *Dr. R. Soeharso*

The proportion of land up and open space is 60%: 40%. With this ratio, the area still has many extension by using green pavement or grass block in land coverings. To provide comfort for pedestrians, the orthopedics hospital planned the cities walk area around the western part which is located right after the Western Main Gate to the Inpatient Units of *Angrek*, *Bougainvillea*, *Cempaka*, and *Dahlia* (ABCD), the inpatient units department using name of various Indonesian flowers. The eastern cities walk area is located within the Diagnostic Building and parking building. Anticipating the demands of modernity in the building, the design of infrastructure and facilities have modern contemporary concept by considering elements of local cultural identity.

## 6. Conclusion

Patient satisfaction and medical services reliability is a top priority in a green hospital. The capacity and clinical program approaches that are used as a methodology in this study concluded that the Orthopedics Hospital requires the addition of several physical buildings, particularly the facilities as centers of excellences. As a hospital based on orthopedics or digestic surgical services, the hospital requires additional Central Operating Theatre (COT), while the number of inpatient units capacity is still sufficient. In accordance with the plan of the hospital's business strategy and in the achievement of Hospital Balanced Scorecard, the concept of sustainability is needed in the development of hospital consisting of aspects of human resources, financial management and the physical environment. Sustainability Concepts in Green Hospital adopted by the hospital are the implementation of eco-cultural

concepts, modern and local identity appearance, green gate access concept for the elderly and disabilities people, low maintenance concept, minimization of energy resources, alternative energy utilization, minimization the negative environmental impact, the Integrated Design Process, eco-friendly parking area concept, anticipation efforts to the heat island effect, and the application of pedestrian facilities included cities walk area in hospital to reduce CO<sub>2</sub> (carbon dioxide).

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