

Design and Planning to Develop a Trauma Hospital in Jeddah, Saudi Arabia

Lina Abdullah Alamodi*, Tarek Abdulsalam, Ahmed Refaat

Department of Architecture, College of Architecture and Design, Effat University, Qasr Khuzam St., Kilo. 2, Old Mecca Road.
P.O.BOX 34689, Jeddah 21478, Saudi Arabia

Received September 15, 2021; Revised March 15, 2022; Accepted April 19, 2022

Cite This Paper in the following Citation Styles

(a): [1] Lina Abdullah Alamodi, Tarek Abdulsalam, Ahmed Refaat, "Design and Planning to Develop a Trauma Hospital in Jeddah, Saudi Arabia," *Civil Engineering and Architecture*, Vol. 10, No. 3A, pp. 37 - 42, 2022. DOI: 10.13189/cea.2022.101305.

(b): Lina Abdullah Alamodi, Tarek Abdulsalam, Ahmed Refaat (2022). *Design and Planning to Develop a Trauma Hospital in Jeddah, Saudi Arabia. Civil Engineering and Architecture*, 10(3A), 37 - 42. DOI: 10.13189/cea.2022.101305.

Copyright©2022 by authors, all rights reserved. Authors agree that this article remains permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

Abstract Hospitals are an important aspect of a community where the user is seeking the assistance and use of medical facilities to ensure their well-being. Moreover, the role of the hospital is very critical when it comes to facilitating emergency situations. The government of Saudi Arabia has introduced a vision for 2030, which aims to achieve a well-developed nation status and seeks to establish a world-class medical facility for emergency situations. In order to support the government's initiative, this paper proposes the development of an emergency trauma hospital in Jeddah, Saudi Arabia. In this work, 4 case studies were analyzed to comprehend the design requirement for the proposed hospital. Based on the case studies, for the proposed hospital, the total estimated area is 9228 m². In addition, the hospital consists of a few zones, which are main entrance, inpatient ward department, outpatient ward department, emergency department, operation theatre, radiology, pharmacy, intensive care unit, physiotherapy, occupational and psychological therapy, laboratory department, and support facilities. The hospital will be developed at the proposed development area at Al Marwa District in Jeddah, Saudi Arabia. The hospital is designed with modern features and is expected to meet the vision 2030 requirement.

Keywords Hospital, Emergency, Facility, People, Community, Vision 2030, Saudi Arabia

1. Introduction

Hospitals are gradually changing and transforming under the influence of various external and internal factors, public needs, demands and expectations for healthcare. The reform of hospital system is an extremely realistic, complicated and difficult process for any country [1]. The need for an emergency department in an integrated community hospital is essential in any community or country [2]. Emergency situations have been defined as life-threatening situations requiring urgent attention, both today and vividly [3]. Nevertheless, patients today see the state of emergency as a disease or illness that patients need for immediate treatment [4, 5].

The emergency department is now facing a more urgent, critical and conscious population. As a result, better provision is being introduced recently as the emergency department faces a throng of patients on a daily basis [6]. Furthermore, effective emergency services facilities in the emergency department are considered to be of material benefits because they are effective in providing valuable assistance in emergency situations [7]. Moreover, an effective emergency department or service is of financial benefits because it generates revenue [8].

The Government of Saudi Arabia has introduced a 2030 vision to enable the nation to achieve an advanced status [9]. In line with the vision, the government intends to develop its medical facilities to cater its large community and citizens [10]. Furthermore, the government intends to

provide medical care to its patients in emergency situations quickly and efficiently [11]. Thus, in order to support the initiative set by the government, this paper proposes the development of an emergency trauma hospital at Jeddah, Saudi Arabia.

2. Literature Reviews

2.1. Digital Integrated Care Environment

In the 21st century, the realization of patient medical records has improved the ability to capture, organize, and access information in the medical environment, which is a key component of effective medical service delivery. Therefore, the traditional paper recording system is gradually being replaced by digital recording.

In the past few years, experiments on the integration of information technology environments have been carried out in many sectors. These experiments have produced important benefits and have the potential to surpass the medical industry [12-14]. In the design of modern medical systems, the accessibility of the information lifeline is an important consideration, and inhabitants have also been integrated with sensory response systems and environmental interfaces [12].

Some of the researchers and organizations [15, 16] have realized that narrowing the gap between architecture and technical systems can create a more comprehensive digital integrated environment in which it can be effectively used by enhancing its ability to adapt to changing conditions, improve operational performance, provide medical services and provide a technically complex rehabilitation environment. Ruthven [12] also pointed out that the three key focus areas in the emergency environment will benefit the most from the integration of digital technology architecture, including the entry triage area, patient examination room and staff core. Therefore, critical emergency use components should be evaluated and integrated with digital facilities in these areas to deliver effective emergency care.

2.2. Smart Emergency Department Design

Smart emergency department design helps speed up the treatment process, reduces overcrowding and queue time, and helps medical staff provide better treatment. The development of smart emergency department should be guided by useful elements, such as rapid operation and monitoring of facilities, smooth transportation systems, real-time information systems, sustainable regulations and emergency planning systems, and cultivating a contact system for all-round surgeons.

HMC Architects outline several ways to improve the efficiency of the emergency department, such as wayfinding, waiting area functions, improved room design,

improved staff scaling, and improved staff efficiency [17]. HMC Architects propose lean design in healthcare, which uses a new facility operation plan developed by facility operators and medical staff, rather than just planning and construction strategies. Lean medical architecture design can help improve the efficiency of emergency department staff by creating flexible spaces. Features such as rolling partitions, wheeled furniture and modular components provide adaptability, allowing medical staff to make changes quickly and easily [18]. Besides that, the research of Wang, Zhang and Bai [19] has improved the actual entrance to the emergency department, which has made a great contribution to the development of the emergency department of modern hospitals, and established a comfortable and effective rescue process.

3. Case Studies

Four case studies were evaluated for this work in terms of the general requirement for the hospital. The selected case studies basically give a better understanding of the examples of executed solutions similar to the projects to be created. The selected case studies are all relevant to the hospital and care setting and directly contribute to better conceptualizing the design. Details of the case studies are given as follows.

- i. Rashid Hospital, Dubai
- ii. CAZA Hospital and Trauma Center, Philippines
- iii. Kingwood Emergency Hospital, USA
- iv. Methodist South Emergency Department Addition, USA

3.1. Rashid Hospital

Rashid Hospital is located at UAE, Dubai (Figure 1). The hospital has a built area of 20000 m². There are two entrances to the hospital, one main entrance is from Um Hurair Road and the second is from Oud Metha Road. The hospital currently has 762 beds and 68 emergency beds and treats approximately 14,759 inpatients, 138,000 emergency patients and 121,692 outpatients annually [20]. The hospital provides trauma and specialist services to Dubai and the Northern Emirate. The Rashid Hospital Trauma Centre was established as an emergency and trauma center for the northern states of the UAE [20].

The hospital is constructed from various elements of color, material and design. The cladding consists of different colors to attract attention and has small openings for heat distribution. This ultimately contributes to better ventilation in the hospital compound. In addition, the building is highly sustainable with natural and artificial lighting, creating a fresh and natural environment. Overall, the two separate entrances of this design effectively disperse the cloud of visitors and patients as well as the emergency department.



Figure 1. Rashid Hospital [20]

3.2. CAZA Hospital and Trauma Center

CAZA Hospital and Trauma Center is located at Baler, Philippines (Figure 2). This building was designed by CAZA architects. The area of the building is 6120 m². The hospital has a patient capacity of 75 people per day. In terms of design concept, CAZA built the hospital and trauma center in three sections, with versatile modularity and organizational development in consideration, providing a variety of diverse patient and consultation room configurations. The spatial architecture may be applied to other contexts by means of personalized exterior presence and outdoor venues that adapt to unique local circumstances.

In addition, the facility is built along a nine-by-nine-meter framework to serve a number of patient and consultation room organizations. Furthermore, the primary, interconnected spine would pass through the hospital, distributing personnel and medical equipment, as well as the development of a standardized care delivery system. Surrounded by mountains and tropical vegetation, the medical center supports the increasing population of the area and the many visitors who frequent the city, including surfers attracted to the massive waves of Baler Bay. All in all, the advantage of this design is that the central circulation path organizes the interior area and allows for efficient delivery of services and supplies to the trauma center and hospital area [21].



Figure 2. CAZA Hospital and Trauma Center [21]

3.3. Kingwood Emergency Hospital

Kingwood Emergency Hospital is located at Texas Houston, USA (Figure 3) [22]. It was designed by MEP

Architectural Interiors. It is a three-story medical building with a total area of 59,434 square feet, where the internal expansion of 1st floor emergency hospital (21,978 sq. ft.) and 2nd and 3rd floor shell space (37,456 sq. ft.). The building is designed with modern appearance. In addition, it has large corridors for easy patient movement. The exterior has large glass windows to take advantage of the morning sun and the interior is clad with wood materials. Furthermore, the hospital is prepared to handle any type of emergency cases.

All in all, this case study shows that the hospital provides intimate services with wards designed not far from the nurses' stations for complete privacy and negative pressure in the hallways [23]. Besides, the wards are able to accommodate observation patients to more severe patients who need weeks and weeks of recovery [23].



Figure 3. Kingwood Emergency Hospital [22]

3.4. Methodist South Emergency Department Addition

Methodist South Emergency Department Addition is located at Memphis, TN, USA (Figure 4). Brg3s architects designed it. The building has an area of 23000 m². The design concept consists of a radiating building that contains patient rooms and can be seen from the outside. The house is a new extension to the current hospital. The exterior has a clear white, transparent surface that wraps around the southwest façade. The curved wall intersects the current brick shapes and acts like a flickering candlestick for patients and tourists. The second, wide cantilever, slides behind a translucent curtain.



Figure 4. Methodist South Emergency Department Addition [24]

When one travels from the entrance to the waiting room, the angled wall pulls people into the extended seating space. Vision glazing is conveniently placed to connect waiting rooms to outdoor planters, offering tourists a glimpse of nature. Once inside, the transparent south wall works to maximize natural lighting and minimize heat gain. This wall panel system provides plenty of daylight, while at the same time reducing heat gain and maximizing energy efficiency. As far as medical facilities are concerned, the hospital is equipped with all the necessary and essential tools needed in the event of an emergency. Overall, the Emergency Department Addition provides a complete design solution that responds to its surroundings while creating a new identity and highly visible presence [24].

4. Program Assumption and Space Details

Several program assumption and space details were made based on previous case studies. Table 1 shows the space details for the proposed emergency trauma hospital at Jeddah, Saudi Arabia. With reference to Table 1, the total area of the hospital is 9228 m². The hospital is comprised of few zones, which are main entrance, inpatient ward department, outpatient ward department, emergency department, operation theatre, radiology, pharmacy, intensive care unit, physiotherapy, occupational and psychological therapy, laboratory department, and support facilities.

Table 1. Space details

Zone	Total Area (m ²)
Main Entrance	420
Inpatient Ward Department	541
Outpatient Department	435
Emergency Department	1064
Operation Theater Department	2178
Radiology Department	1030
Pharmacy	610
Intensive Care Unit	1465
Physiotherapy Department	500
Occupational and Psychological Therapy	290
Laboratory Department	240
Support Facilities Department	455
Total	9228

5. Proposed Site and Design Analysis

In this work, the proposed site for development is

located at Al Marwa District in Jeddah, Saudi Arabia (Figure 5). This site has an area of 15700 m².



Figure 5. Proposed development site

The site has a good accessibility, as it is linked to three connecting routes, which are Abu Qatada Al Ansari road, national highway and Alshaikh Abdulaziz bin Baz. In addition, the site has few landmarks, which are Al Hada Garden, Farm supermarket and Albassami Mosque.

In terms of design, the emergency trauma hospital is designed to provide an advance level of emergency services for patients suffering from emergency cases such as car accidents, falls, medical conditions and other relevant cases with excellent equipment to fulfill the needs to the people on 24 hour basis, throughout the year. The building is designed with modern building blocks shape with random arrangements as shown in Figure 6. Flat slabs were used to construct the hospital as it accommodates the design requirements of the building. Furthermore, the other parts of the building were constructed using precast slabs. Also, the building is designed with environmentally friendly approach, whereby trees, shrubs and flower plants are incorporated within a courtyard of the hospital. It assisted to regulate the thermal effects by providing shades to the wall of the courtyard. In addition, it recommends retrofitting the building and equipping it with various active and passive fire emergency safety measures that were found to be lacking [25]. Overall, the building is designed with sustainable features and includes all the latest medical equipment required. Figure 6 to Figure 8 show the proposed design of the emergency trauma hospital.

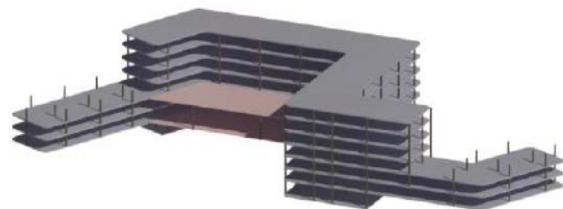


Figure 6. Hospital building shape

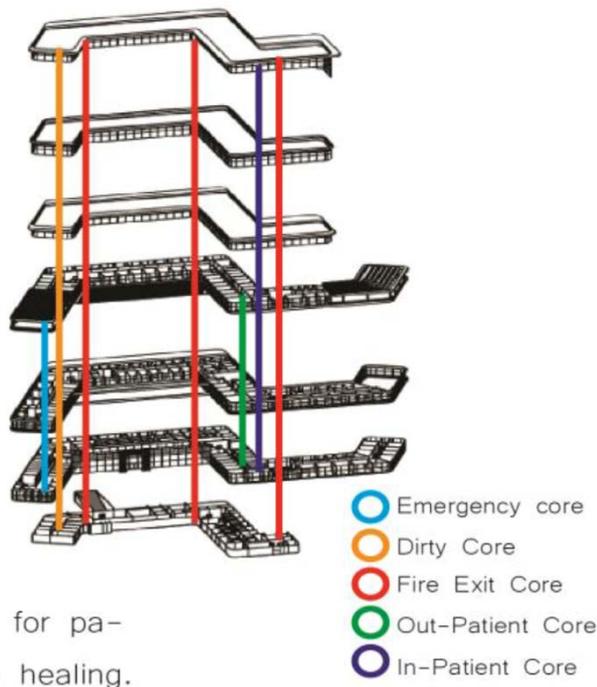


Figure 7. Breakdown of the hospital building



Figure 8. 3D view of the hospital building

6. Conclusion

This work has presented the development of an emergency trauma hospital at Jeddah, Saudi Arabia. The hospital is comprised of few zones, which are main entrance, inpatient ward department, outpatient ward department, emergency department, operation theatre, radiology, pharmacy, intensive care unit, physiotherapy, occupational and psychological therapy, laboratory department, and support facilities. Thus, the estimated overall area is 9228 m². The proposed hospital is therefore expected to provide the best social services that will satisfy the fullness of society and strengthen relations with the community, in line with the vision 2030 set by the government of Saudi Arabia.

Acknowledgements

The authors would like to thank the course lecturers for

their guidance and the support of the College of Architecture and Design, Effat University.

REFERENCES

- [1] Bulakh, O. Chala, and V. Divak. Dynamics of Architectural and Urban Planning Hospital Systems Evolution, *Civil Engineering and Architecture*, Vol. 8, No. 4, pp. 586-598, 2020, DOI:10.13189/cea.2020.080423.
- [2] R. DeVries, D. Kriebel, and S. Sama. Outdoor air pollution and COPD-related emergency department visits, hospital admissions, and mortality: a meta-analysis, *Journal of Chronic Obstructive Pulmonary Disease*, Vol. 14, No. 1, 113-121, 2017, Doi: 10.1080/15412555.2016.1216956
- [3] P. McKenna, S. M. Heslin, P. Viccellio, W. K. Mallon, C. Hernandez, and E. J. Morley. Emergency department and hospital crowding: causes, consequences, and cures, *Clinical and Experimental Emergency Medicine*, Vol. 6, No. 3, 189-195, Doi: 10.15441/ceem.18.022
- [4] S. Jay, P. Whittaker, J. McIntosh, and N. Hadden. Can consultant geriatrician led comprehensive geriatric assessment in the emergency department reduce hospital admission rates? A systematic review, *Age and Ageing*. Vol. 46, No. 3, 366-372, 2017, Doi:10.1093/ageing/afw231
- [5] P. A. Lenaghan, N. M. Cirrincione, and S. Henrich. Preventing Emergency Department Violence through Design, *Journal of Emergency Nursing*, Vol. 44, No. 1, 7-12, 2018, Doi:10.1016/j.jen.2017.06.012
- [6] D. Pati, S. Pati, and T. E. Harvey. Security Implications of Physical Design Attributes in the Emergency Department, *HERD: Health Environments Research & Design Journal*, Vol. 9, No. 4, 50-63, 2016, Doi:10.1177/1937586715626549
- [7] F. Visintin, C. Caprara, and F. Puggelli. Experimental design and simulation applied to a paediatric emergency department: A case study, *Computers & Industrial Engineering*, Vol. 128, 755-781, 2019, Doi:10.1016/j.cie.2019.01.019
- [8] Gharaveis, D. Kirk Hamilton, M. Shepley, D. Pati, and S. Rodiek. Design suggestions for greater teamwork, communication and security in hospital emergency departments, *Indoor and Built Environment*, Vol. 28, No. 8, 1126-1139, 2019, Doi:10.1177/1420326x19836209
- [9] S. Elsheikh, A. M. Alqurashi, M. A. Wahba, and T. E. Hodhod. Healthcare Workforce in Saudi Arabia under Saudi Vision 2030, *Journal of Health Informatics in Developing Countries*, Vol. 12, No. 1, 2018, Online available from <https://www.jhdc.org/index.php/jhdc/article/view/173>
- [10] R. Redwanur, and A. -B. Hussein M. Strengthening the Saudi Arabian healthcare system: Role of Vision 2030, *International Journal of Healthcare Management*, 1-9, 2020, Doi:10.1080/20479700.2020.1788334
- [11] M. F. Alharbi. An investigation of the Saudi healthcare system's readiness for change in the light of vision 2030: The role of transformational leadership style, *Journal of Health Specialties*, Vol. 6, No. 45, 2018,

- Doi:10.4103/jhs.JHS_142_17.
- [12] D. Ruthven. The Interactive Medical Emergency Department (iMED): Architectural Integration of Digital Systems into the Emergency Care Environment. Dissertation of Master Degree, Clemson University, 2007, Online available from <https://core.ac.uk/download/pdf/268631772.pdf>
- [13] W. He, Z. J. Zhang, and W. Li. Information technology solutions, challenges, and suggestions for tackling the COVID-19 pandemic. *International journal of information management*, Vol. 57, 2021. Doi:10.1016/j.ijinfomgt.2020.102287
- [14] S. Dash, S. K. Shakyawar, M. Sharma, and S. Kaushik. Big data in healthcare: management, analysis and future prospects. *Journal of Big Data*, Vol. 6, No. 54, Doi:1186/s40537-019-0217-0
- [15] National Academy of Engineering (US) and Institute of Medicine (US) Committee on Engineering and the Health Care System; Reid PP, Compton WD, Grossman JH, et al., editors. *Building a Better Delivery System: A New Engineering/Health Care Partnership*. Washington (DC): National Academies Press (US); 2005. 4, Information and Communications Systems: The Backbone of the Health Care Delivery System. Online available from: <https://www.ncbi.nlm.nih.gov/books/NBK22862/>
- [16] S. Tian, W. Yang, J. M. L. Grange, P. Wang, W. Huang, and Z. Ye. Smart healthcare: making medical care more intelligent, *Global Health Journal*, 2019, Doi:10.1016/j.glohj.2019.07.001
- [17] Emergency Department Design for a More Efficient and Safe ER, HMC Architects, 2019. Online available from <https://hmcarchitects.com/news/emergency-department-design-for-a-more-efficient-and-safe-er-2019-02-27/>
- [18] G. Vangelatos, *Improve Hospital Operations Through Lean Design In Healthcare Architecture*, HMC Architects, 2018, Online available from <https://hmcarchitects.com/news/improve-hospital-operations-through-lean-design-healthcare-architecture-2018-12-07/>
- [19] T. Wang, S. S. Zhang, and X. P. Bai. Study on the Design of Emergency Entrances for Hospitals Evidence from extremely cold regions - Urban healing transition space, UIA 2017, Seoul World Architects Congress, 1-6, 2017.
- [20] DHA Service Categories, About Rashid Hospital. Online available from <https://www.dha.gov.ae/en/RashidHospital/Pages/AboutRashidHospital.aspx>
- [21] Baler Hospital and Trauma Care Center in The Philippines, 2016, Online available from <https://www.e-architect.com/philippines/baler-hospital-and-trauma-care-center-in-the-philippines>
- [22] Kingwood Emergency Hospital : Kingwood, TX, Online available from: <http://kaim-inc.com/archives/portfolio-type/kingwood-emergency-hospital>
- [23] Kingwood Emergency Hospital, Online available from: <https://architizer.com/projects/kingwood-emergency-hospital/>
- [24] Methodist South Emergency Department Addition / brg3s architects, 2017, Online available from: <https://www.archdaily.com/804761/methodist-south-emergency-department-addition-brg3s-architects>
- [25] S. A. Babatunde, A. G. Oche, and O. Paul. Fire Emergency Safety Preparedness in the College of Leadership Development Studies Building in Covenant University, Ota, Nigeria, *Civil Engineering and Architecture*, Vol. 8, No. 6, pp. 1463-1480, 2020, DOI:10.13189/cea.2020.080628.