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THE ARCHITECTURE OF MEDICINE IN MOROCCO: BRIDGING THEORY AND PRACTICE

This study explores the architectural evolution of medical education and healthcare facilities in Morocco, focusing on integrating theoretical learning with practical training. It highlights design strategies such as flexible learning spaces and integrated medical-hospital models to enhance education, healthcare efficiency, and accessibility, creating a more effective and equitable system.

Keywords: *Medical Architecture, Healthcare Infrastructure, Educational Institutions, Medical University, Urban Design*

Statement of the problem

Morocco faces significant challenges in the integration of medical education with healthcare services, particularly in smaller cities where infrastructure limitations hinder the practical training of medical students. Many medical schools are located in urban centers, making it difficult for students in remote areas to gain hands-on experience. Additionally, healthcare facilities in these regions often lack the spatial and functional organization needed to support both medical training and patient care. The disconnect between theoretical education and practical application results in a workforce that is less prepared for real-world medical challenges.

One major issue is the outdated infrastructure of existing healthcare facilities, which do not provide adequate space for medical students to observe, learn, and practice essential clinical skills. Many hospitals and clinics are not equipped with dedicated training areas, limiting the effectiveness of experiential learning. Furthermore, the lack of collaboration between medical institutions and healthcare centers results in fragmented training experiences that do not fully prepare students for the demands of modern medical practice.

Another challenge is the uneven distribution of medical resources across Morocco. Urban centers benefit from well-equipped hospitals and specialized medical staff, while smaller cities and rural areas struggle with a shortage of healthcare professionals and facilities. This imbalance not only affects patient care but also deprives medical students of the opportunity to work in diverse healthcare settings. Without exposure to a range of medical cases and environments, students may graduate with an incomplete understanding of healthcare challenges in different regions of the country.

Addressing these challenges requires an architectural approach that prioritizes both educational and healthcare functions within a single, cohesive design. This involves creating flexible medical facilities that integrate classrooms, simulation labs, and real-world clinical environments. Additionally, designing CHCs with built-in training programs can ensure that students gain practical experience while simultaneously improving healthcare access in under-served areas. By developing a new model of integrated medical education and healthcare facilities, Morocco can create a more efficient and equitable system that better prepares future medical professionals while enhancing the overall quality of healthcare delivery.

Analysis of recent research and publications

Recent research in medical education and healthcare design highlights the integration of theoretical frameworks and empirical evidence to enhance professional development and built environments.

“Advancing Careers in Medical Education: Practice Architectures for Medical Educators” by Asela M Olupeliyawa, Wendy C Y Hu, Renée E Stalmeijer employs the Theory of Practice Architectures (TPA) to investigate the development of medical education careers, particularly in resource-constrained settings. It offers insights into how theoretical frameworks can inform practical advancements in medical education [1].

“Building Bridges Between Theory and Practice in Medical Education” by Diana H. J. M. Dolmans and D. Tigelaar advocates for the integration of design-based research (DBR) in medical education. It emphasizes that DBR can simultaneously advance theoretical understanding and practical application in educational settings [2].

“Healing Architecture in Healthcare: A Scoping Review” by Thorben Simonsen, Jodi Sturge, Cameron Duff is a scoping review that summarizes findings from seven articles that specifically describe how patients and staff experience characteristics of healing architecture [3].

“Evidence-Based Practice: From Research to Design Implementation” by Archontia Manolakelli discusses the process of **Evidence-Based Design (EBD)**, which involves making design decisions for built environments based on credible research to achieve optimal outcomes. It highlights the importance of empirical evidence in shaping healthcare environments [4].

"Monumental Advancements in Moroccan Healthcare with New University Hospital" by AIA Architectes discusses the Mohammed VI International University Hospital in Rabat, set to transform healthcare delivery and medical education in Morocco. Scheduled for completion by September 2025, this architectural marvel will feature four six-story buildings and a central 25-story structure, encompassing 275,000 square meters. The facility will include 15 lecture theaters, 72 teaching rooms, and 217 practical workrooms, all equipped with cutting-edge audiovisual technology [5].

Formulation of the goal of the article

The main goal of this article is to propose an architectural framework that effectively integrates medical education and healthcare facilities in Morocco, with a focus on small and medium-sized cities. By analyzing existing challenges and reviewing best practices from international case studies, this research aims to develop strategies for designing multifunctional healthcare institutions that accommodate both learning and patient care.

To achieve this goal, the article sets the following objectives:

1. Identify key architectural and infrastructural deficiencies in current Moroccan medical education facilities and healthcare institutions via analyzing case studies of international examples and comparing them with the Moroccan situation in this field.

2. Identify the influence of spatial design on the effectiveness of medical training via content analysis of the architecture of medical schools and training facilities across Morocco

3. Examine the impact of architectural solutions on the quality of medical training and healthcare delivery via analyzing existing studies on the topic

4. Identify adaptable design principles via analysis of case studies of successful models from other countries.

5. Identify architectural solutions and corresponding techniques for addressing infrastructure challenges in Morocco’s urban and regional development context.

This research aims to contribute to a more sustainable and effective medical education system by advocating for architectural innovations that enhance the synergy between learning spaces and healthcare facilities.

Presentation of the main material

Morocco’s limited number of modern medical universities presents challenges in effectively connecting medical education with the country's healthcare system. The country has seven medical schools directly affiliated with a University Hospital Center (CHU), located in Rabat, Casablanca, Fez, Oujda, Marrakech, Tangier, and Agadir. These institutions provide integrated medical education and clinical training, yet gaps remain in aligning educational infrastructure with healthcare service delivery [6].

This research adopts a comprehensive mixed-method approach, combining qualitative and quantitative methodologies to examine the role of architectural design in addressing these challenges. Through content analysis and case studies, the study critically assesses existing architectural practices within medical institutions and healthcare facilities, analyzing their impact on both medical training and patient care. By investigating the spatial and functional relationships between educational and clinical environments, this research aims to develop evidence-based design strategies that better integrate theoretical learning with practical application in medical education.

1. The Role of Architecture in Medical Education

The role of architecture in medical education is crucial, as it directly affects the learning environment for medical students. Medical education facilities require specialized design considerations to foster a conducive environment for learning, collaboration, and hands-on experience. This study is based on content analysis of the architecture of medical schools and training facilities across Morocco to identify how spatial design influences the effectiveness of medical training (Fig. 1).

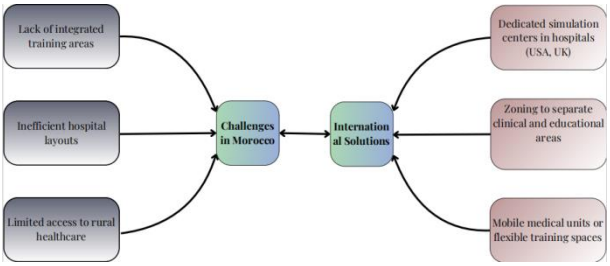

Fig. 1 – Healthcare Challenges in Morocco and International Solutions, own work

The first aspect of this analysis focuses on **spatial functionality**. Medical schools must integrate diverse learning environments, including lecture halls, seminar rooms, simulation labs, and clinical spaces. These areas should not only accommodate the theoretical aspects of medical training but also facilitate practical skills

acquisition. Simulation labs, for example, require careful attention to layout and design to replicate real-world medical environments, enabling students to practice procedures in a controlled, yet realistic setting. Interviews with medical educators and students will provide further insights into how well these spaces meet educational needs and how architectural features, such as lighting, acoustics, and room layouts, impact learning outcomes [7] (Fig. 2).

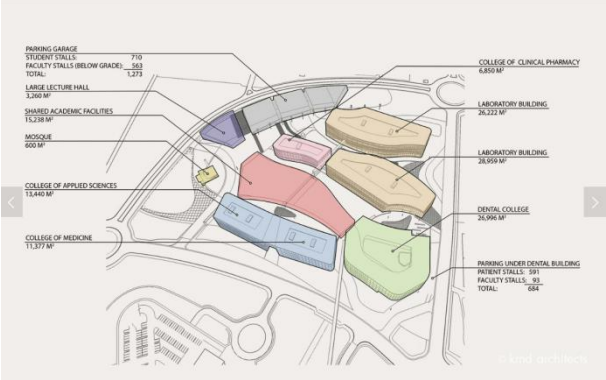

Fig. 2 – King Faisal University Medical Colleges Complex (by KMD Architects [7])

The study did also explore how **proximity** to healthcare facilities influences the synergy between medical education and patient care. Medical schools located near hospitals or healthcare centers allow students to seamlessly transition from classroom learning to clinical training. The design of such campuses often involves a strategic integration of both educational and healthcare functions, where buildings are interconnected to allow easy movement between lecture halls, labs, and hospital wards. The methodology will include interviews with medical students to understand the benefits and challenges of studying in such integrated environments [8].

2. Designing Healthcare Facilities for Efficiency

A central part of this study is to examine how architectural design can optimize the efficiency of healthcare facilities, making them conducive to both patient care and medical training. Hospitals and healthcare centers in Morocco face a variety of challenges, from overcrowding to inefficient layouts that hinder the delivery of care. By conducting a detailed analysis of hospital design, this study aims to identify key architectural features that enhance both the operational efficiency of healthcare providers and the learning environment for medical students.

The study focuses on **functional zoning** within healthcare facilities, analyzing how the separation of clinical, administrative, and educational areas can reduce operational conflicts and streamline patient care processes. For example, clear demarcation between patient wards, surgical areas, and educational spaces ensures that students can observe and participate in clinical activities without interfering with patient care (Fig. 3). Additionally, a flexible design that accommodates evolving medical technologies is essential for ensuring the long-term viability of healthcare facilities [9].

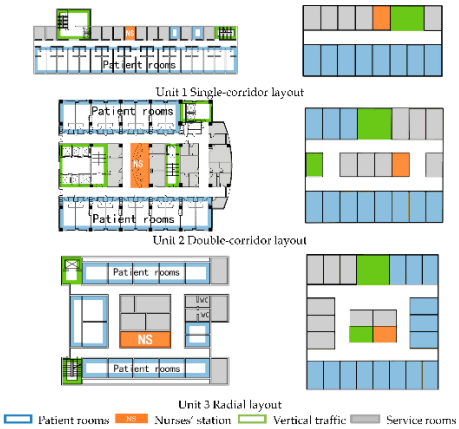

Fig. 3 – Three types of floorplan analysis: single-corridor, double-corridor, and radial layout (by Qingtan Deng [9])

Another important aspect of this analysis is **sustainability**. Morocco, like many other countries, faces environmental challenges, and healthcare facilities must be designed to minimize their environmental impact. The study will look at how hospitals incorporate sustainable practices such as natural ventilation, energy-efficient materials, and water-saving systems. Interviews with architects and hospital administrators will help understand the extent to which sustainable design principles are being integrated into healthcare infrastructure in Morocco [10] (Fig. 4).

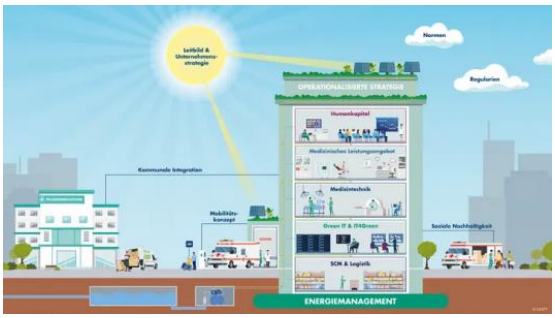

Fig. 4 – Sustainable Healthcare System with Energy Management and Efficiency (from https://www.unity-consulting.com/en/industries/green-hospital/)

The study also examined wayfinding **and accessibility** in healthcare environments, which are critical for ensuring that patients and visitors can navigate

the facility with ease. In large, complex hospitals, poor signage and confusing layouts can increase patient stress and disrupt the smooth operation of medical teams. The research will analyze hospital designs in Morocco to assess how effective current way-finding systems are, and how architectural elements such as signage, lighting, and open spaces contribute to a user-friendly environment. By gathering feedback from healthcare professionals, patients, and medical students, the study will identify improvements that could be made to better accommodate the diverse needs of the community [11].

3. Case Studies in Morocco and Beyond

Examining successful international models reveals adaptable design principles that enhance medical training and healthcare delivery. One notable example is the Hertfordshire Intensive Care & Emergency Simulation Centre (HICESC) in the UK. Established in 1998 at the University of Hertfordshire (Fig. 5), HICESC has undergone several developmental phases to become a leading multiprofessional simulation teaching environment. The center provides advanced simulation-based training for a range of healthcare students, including nursing, paramedic sciences, pharmacy, and more. Its design includes adult and pediatric intensive care unit (ICU) simulation areas, a simulated pharmacy with an automated dispensing robot, and clinical skills labs equipped with state-of-the-art manikins and audiovisual equipment. This comprehensive setup facilitates realistic, hands-on training, improving both educational outcomes and patient care practices.

Fig. 5 – University of Hertfordshire, UK (by Johannes Knabe [12])

Another example is the National Health Innovation Centre (NHIC) at the University of Huddersfield in West Yorkshire, UK(Fig. 6). Opened in January 2025, the NHIC combines advanced simulation technologies with real-world training to address NHS staff shortages and regional health inequalities. The center utilizes lifelike mannequins in realistic scenarios, including virtual reality, to train healthcare students across various disciplines. This innovative approach not only enhances the quality of medical education but also contributes to community health and regeneration efforts [13].

Fig. 6 – University of Huddersfield in West Yorkshire, UK (from AHR Architects, https://www.ahr.co.uk/projects/daphne-steele-building)

The **Shirley Ryan AbilityLab** in Chicago (Fig. 7), affiliated with Northwestern University, is a leading example of integrating rehabilitation, medical education, and research (Fig. 6). The facility brings together doctors, therapists, and researchers to provide interdisciplinary care for conditions like spinal cord injuries, brain trauma, and stroke. It is also a key educational resource for students from Northwestern's Feinberg School of Medicine, offering hands-on experience and direct involvement in research and treatment development. The center's design incorporates specialized therapy spaces, advanced technologies, and collaborative research labs, making it a model for combining patient care, education, and cutting-edge medical research [14].

Fig. 7 – The Shirley Ryan AbilityLab in Chicago, USA (from Architect:HDR, https://www.hydrotechusa.com/projects/rehabilitation-institute-chicago-shirley-ryan-abilitylab)

From these case studies, several adaptable design principles can be outlined:

Multidisciplinary Focus: HICESC accommodates a wide range of healthcare professions (nursing, paramedic sciences, pharmacy, etc.), promoting interdisciplinary collaboration and learning. The design

of the facility allows for different healthcare roles to train together.

Advanced Technological Integration in Clinical Skills Labs: Clinical skills labs are equipped with state-of-the-art technology, including high-fidelity manikins and automated systems that replicate real-world medical conditions. This advanced technological integration ensures hands-on, realistic training, allowing medical students to experience and practice clinical scenarios in an environment that mirrors actual healthcare settings. By combining cutting-edge technology with realistic simulations, these labs contribute to better retention of skills and more effective preparation for real-life clinical situations.

Community-Centric Design: Develop facilities that not only serve educational purposes but also address local healthcare needs, contributing to regional health improvements.

Morocco's medical infrastructure faces challenges such as uneven healthcare distribution, outdated hospital designs and a disconnect between education and practice. To address this, new architectural approaches integrate medical schools with hospitals, as seen in the Mohammed VI International University Hospital in Rabat, enhancing both training and patient care. Decentralized and modular healthcare facilities, including prefabricated medical units and Community Health Centers (CHCs), improve accessibility in rural areas.

Sustainability is key, with hospitals incorporating passive cooling, natural ventilation, and renewable energy solutions. In response to the 2023 Haouz earthquake, new hospitals feature seismic-resistant designs. Additionally, Morocco is repurposing historic riads (a Riad is a traditional Moroccan house or palace with an interior garden or courtyard, designed for privacy and natural cooling, often featuring intricate tilework and ornate woodwork (Fig.8)) into healthcare facilities, blending heritage with modern medical needs.

Fig. 8 – Moroccan Riad Courtyard with Traditional Architecture (from Riad Melhoun, https://riad-melhoun-marrakech.com/fr/)

Smart healthcare infrastructure is also transforming medical spaces, with AI-optimized patient flow systems, telemedicine rooms, and automated check-ins improving efficiency. By prioritizing integration, sustainability, and digital innovation, Morocco is reshaping its medical architecture to enhance both education and healthcare delivery nationwide.

Conclusions

The study highlights the key position that architecture takes in bringing medical education and healthcare delivery together in Morocco. The study identifies key challenges including old infrastructure, uneven distribution of resources, and lack of integration of educational and healthcare facilities. Addressing these has to be through architectural means that bring functionality, sustainability, and technological innovation together.

Purposefully designed medical facilities, such as simulation centers, clinical training rooms, and strategically located healthcare facilities, enhance medical education and patient care. Functional zoning, green building practices, and smart healthcare infrastructure make the hospitals not only a place for the patients but also as optimum learning centers.

Morocco's efforts to enhance healthcare architecture like seismic-resistant hospital design, adaptive reuse of existing buildings, and AI-driven patient flow systems indicate a shift towards a more resilient and technologically connected medical infrastructure. Case studies of international models also lend strength to the benefits of multidisciplinary training facilities, community-oriented hospital designs, and advanced simulation centers.

To construct a future-ready system of medical education, Morocco must strengthen collaboration between health care providers and medical schools and implement architectural solutions prioritizing hands-on learning, accessibility, and efficiency. By placing integrated, sustainable, and resilient design strategies first, the country can both enhance medical education and health care delivery to have a more robust, equitable system for generations to come.

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МЕДИЧНА АРХІТЕКТУРА В МАРОККО: ПОЄДНАННЯ ТЕОРІЇ ТА ПРАКТИКИ

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Стаття досліджує архітектурну еволюцію медичної освіти та медичних установ у Марокко, наголошуючи на важливості поєднання теоретичних знань із практичним навчанням. Автори аналізують, як архітектурний дизайн впливає на якість навчального середовища для студентів-медиків, ефективність надання медичних послуг та загальну функціональність закладів охорони здоров'я.

Однією з головних проблем медичної освіти в Марокко є недостатня інтеграція навчальних закладів із лікарнями, особливо в менших містах. Багато медичних університетів розташовані у великих урбанізованих центрах, що ускладнює доступ студентів з регіонів до якісної клінічної підготовки. Крім того, лікарні в малих містах і сільській місцевості часто не мають належної просторової організації для навчальних цілей, що створює бар'єри для здобуття практичного досвіду.

Ще одним викликом є застаріла інфраструктура багатьох медичних установ, що не відповідає сучасним вимогам до навчання та лікування. Брак спеціалізованих навчальних приміщень, таких як симуляційні центри, інтерактивні аудиторії та лабораторії, обмежує можливості студентів для розвитку професійних навичок у реалістичних умовах. Відсутність ефективного функціонального зонування в лікарнях ускладнює процес навчання, оскільки студенти не можуть безперешкодно поєднувати теоретичні заняття з практичною роботою.

У цьому дослідженні аналізуються сучасні міжнародні практики проектування медичних закладів та їхній потенційний вплив на Марокко. Основну увагу приділено адаптивним архітектурним рішенням, які можуть сприяти покращенню навчального процесу та медичних послуг. Зокрема, дослідження розглядає такі ключові концепції:

Гнучкі навчальні простори – створення багатофункціональних аудиторій і симуляційних центрів, які дозволяють студентам проходити навчання у наближених до реальних умовах. Моделі інтегрованих університетських лікарень – проектування медичних закладів, що поєднують освітні, дослідницькі та клінічні функції в єдиному просторі. Функціональне зонування медичних установ – оптимізація простору лікарень для зручності студентів, лікарів та пацієнтів. Стійкий дизайн та екологічні рішення – використання енергоефективних матеріалів, природного освітлення та вентиляції для створення комфортного середовища. Дослідження пропонує комплексний підхід до вдосконалення медичної освіти та охорони здоров'я через архітектурне планування. Інтеграція лікарень та навчальних закладів може забезпечити студентам доступ до сучасного навчального середовища, сприяти підготовці кваліфікованих лікарів та підвищити загальний рівень медичних послуг у країні.

Застосування доказових архітектурних рішень дозволить Марокко розвивати інноваційні медичні установи, які відповідатимуть сучасним вимогам якості, доступності та ефективності. У підсумку це сприятиме не лише покращенню підготовки майбутніх медиків, але й загальному зміцненню системи охорони здоров'я, особливо в малих містах та сільській місцевості.

Ключові слова: *медична архітектура, інфраструктура охорони здоров'я, освітні заклади, медичний університет, урбаністичний дизайн*