Spectrum of Engineering Sciences
ISSN (e) 3007-3138 (p) 3007-312X Volume 3, Issue 8 2025

FROM PREVENTION TO PLANNING: AN EXPLORATION INTO MISSING ROLE OF HEALTHCARE ARCHITECT TOWARDS ENVIRONMENTAL DESIGN & POST COVID19 OPTIMIZATION IN HEALTHCARE SETTINGS

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DOI: https://doi.org/10.5281/zenodo.17852230

Keywords
Healthcare Architect, Architecture, Environmental Protection Agencies, Healthcare Built Environment, Hospital, Future Healthcare Design.

Article History
Received: 15 June2025
Accepted: 25 July2025
Published: 10 August2025

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Abstract
Based on the previously completed research exploring the missing role of architect from post pandemic architecture based interventions in Pakistan, the current study explored the environmental, engineering and medicine based identification of gaps towards highlighting the role of healthcare architecture integration in these domains for critical functional optimization. Since architectural role is critical to hospital optimized design considering the contextual, social and cultural needs, the short fall highlighted gaps towards missing architectural dimensions from these key areas of built environment focusing for sustainable integration in future. Exploration was based on 89 published documents from multiple Environmental Protection Agencies in Pakistan along with Pakistan Engineering Council and Pakistan Medical & Dental Council online resources. The critical keywords were based on the exploration of similar case studies in post pandemic timeline. Major gaps highlighted that the term Architecture has only been used 5 times while architect 156 times out of the total keywords count of 10971 along with evidence based design being completely missing. This gap highlights a serious concern towards lack of architectural design integration into the Environmental, Medicine, Surgical and Engineering based leading institutions framework for design and development of post pandemic architecture to be more sustainable, healthy and context responsive.
Study acts as point of intervention towards highlighted domains to better integrate post pandemic dimensions of healthcare architecture for future challenges of public at large in built environment.

INTRODUCTION

The COVID-19 pandemic highlighted a number of challenges that hospitals had faced leading to re-evaluation of their design, infection control practices, and the degree of flexibility to address possible future challenges (Bhatti et al., 2023). The COVID-19 pandemic, the different isolation measures, or the changed protection measures that accompanied the side effects and complications regarding the corona virus, healthcare facilities were not prepared for these due to the focus on efficiency

and fast processing of patients during the pandemic (Bhatti et al., 2024). The pandemic proved that to cover health-related problems in the future, the healthcare facilities must be flexible, adjustable, and built on contextual findings from experiences. Though healthcare settings and facilities faced critical shortages on supplies and human resources, countries with developed health facilities that subscribed to the WHO and AIA guidelines on the design of hospitals in the setting of isolation zones, airflow, and establishment of new hospitals had fewer issues in coping to these unprecedented challenges. The old healthcare facilities whose design had long been obsolete also experienced serious problems in its operations and overflowing of its waiting rooms and the increased cases of infections and hospital-acquired infections all over the world (Omer Shujat Bhatti & Ghufran, 2020). This imbalance demonstrated that the healthcare facilities should be more flexible in terms of floor layouts, advanced air-filtering installations, environmental design and additional medical units spread across a region to fight back pandemics and forthcoming epidemics (Sarwar et al., 2020). Yet, the pandemic has destabilized the entire healthcare system and capacity of already deficient countries like Pakistan with its already constrained funding, low priority to healthcare by the governments, rapid urbanization, poor socio-economic conditions and its fragmented governmental structure with major lags in optimization of functioning (Mangili et al., 2023). This is illustrating the need to evaluate, reconsider, and reexamine the whole system incorporating designing considerations to achieve futureproofing of hospitals in case of unexpected challenges in healthcare facilities in the context of Pakistan.

As a huge gap has existed in the post-pandemic healthcare system in Pakistan concerning the ability of the current system to address and integrate these factors by specifically defining the role of the architect or architectural design, the process of the evaluation has significantly lacked in terms of available published reports, standards of practice, guidelines and other related procedures / protocols in relation to the healthcare system, system delivery, and system management (Han et al., 2022). The nature of the current study focused on the primary provincial and federal regulatory bodies engaged in the delivery of the system of healthcare facilities and environmental considerations along with medical & engineering associated governing bodies. The study aimed to explore the burden of the disease at national scale since the healthcare system of Pakistan is a complicated, complex, and multi-tiered integrated structure that uses federal and provincial resources of the government alongside non-governmental ones.

Keeping online with the defined targets, two major research based objectives were set forth as stated below:

1. To identify and document the current gaps in the selected explored governmental policies and guidelines with respect to post pandemic timeline with focus on environmental and functional optimization in healthcare settings.
2. To explore the negative shortcoming of these gaps towards the role of architect in design of facilities and its implications towards healthcare design in futuristic Pakistan.

The significance of the current study lies with identification of major gaps in the environmental design and its management based areas lacking major consideration for the role of architect in the design of healthcare facilities in post pandemic Pakistan.

REVIEW OF LITERATURE

With respect to Pakistan in focus and developing countries at large, there has often been a lack of proper health care planning, budgets have been underestimated, and guidelines have not existed on how to develop facility designs incorporating international standards into the planning and design of the hospital facilities and other healthcare facilities (Amran et al., 2022). Before pandemic of COVID-19, it became evident that most of the public hospitals that were built in the past used two decades old models that mainly focused on meeting the basic operational and functional needs without considering the future, unexpected challenges that could happen in near future anytime (Park, 2022). Pandemic was the ice breaker in this context of global disease. With respect to Pakistan, one can mention several examples, but two can be seen as an example of Jinnah Hospital, Lahore, and the Civil Hospital, Karachi. The two hospitals experienced an excessive amount of cases and generally have been

operating beyond their usual optimal capacity, a scenario which created problems to the patients and increased their chances of getting hospital-borne infections due to compromised conditions (Akhtar & Ramkumar, 2023). Nosocomial diseases increased the chances of cross-contamination significantly since there was no visible demarcation between zones where are managing and treating the patients with infectious diseases including COVID-19 patients (Eltarabily & Elgheznawy, 2020). Hospitals built during a period of the past two to three decades are coping with challenges of airborne infections due to poor ventilation system design and artificial lighting. It is regrettable that the absence of medical facilities in the evidence-based design was also observed where such plans which were based on research were neglected, forgetting that they could help the staff and patients deal with the burden of the illness in these very few common healthcare facilities for public at large when patients needed them the most in pandemic and epidemic time (Ahmed Zahran et al., 2023).

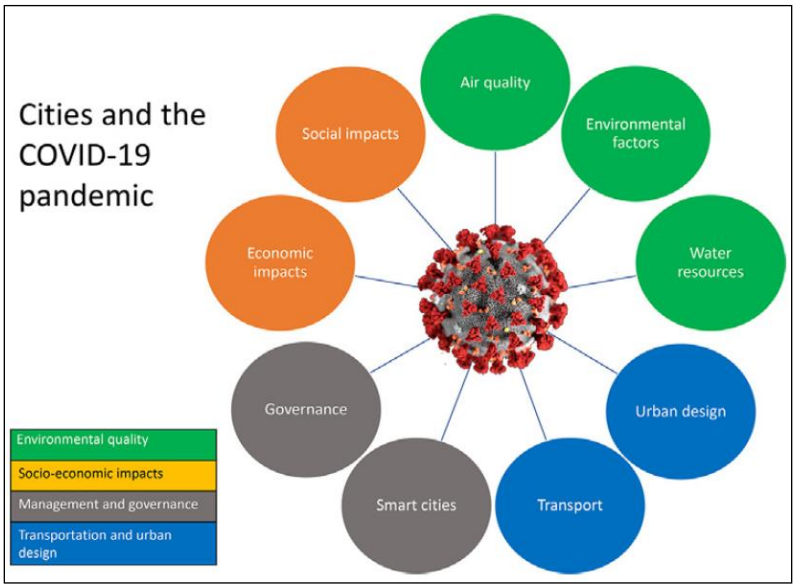

Figure 01 Cities & COVID-19 pandemic (Shari & Khavarian-garmsir, 2020)

Pakistan was not an exception to the poor and fragile healthcare and medical system as the world faced COVID-19. It revealed the key gaps and shortfalls in the healthcare system for the general public at large (Bhatti et al., 2023a). Pakistan's hospitals often did not have the extra capacity to accommodate those surges because of the higher patients influx would require attention at the same time (Bhatti et al., 2022). It was because of crowding in the emergency rooms and no specific places to admit COVID-19 patients in the hospitals that the hospital wards had to be converted too swiftly into COVID-19 wards and isolation units, thus leading to the enhanced risk of being infected among all the involved. Infection control was not as successful because of building design challenges of the existing hospitals, including the uncontrolled airflow movement and insufficient rooms & buffer zones allowing nosocomial infections like COVID-19 spread through wards (Bhatti et al., 2024a). Unlike China and the West that swiftly embraced modular architecture, a large number of countries had a challenge to make the switch by building new intensive care units since hospital layouts were defined and rigid. Healthcare practitioners were forced to utilize digital devices for the first time or without prior training since telemedicine services were not popular in Pakistan previously(Bhatti et al., 2025). This consequently led to the deficiency of solutions that surpassed the problems that continued to rage havoc due to the lack of technology.

COVID-19 emerged in the December of 2019 and continued next few years across the world with multiple waves and mutations. It has now become

global and has reached 592 million plus people afflicted by it and over the 6.5 million deaths (Xu et al., 2020). Although the pandemic had a great influence, most post-pandemic constructional projects had to be based on the previously outlined plans, which is why they overlooked the possibility to adjust architecture of open-plan offices, shared areas, and homes so that they did not allow infectious diseases transmission in future design of healthcare settings (Yang, 2019). Future architecture that integrates nature in the design, compartmentalized spaces for specialized areas (e.g. single use rooms), contact-free technologies, and enhanced ventilation (e.g. modifications of HVAC, natural ventilation, and applying HEPA filters) are recommended to respond to the pandemic due to its growing need as well as successful outcomes (Qing et al., 2020). The flexibility and infection-resistant constructions were needed because of issues in regarding the business, healthcare, and educational sectors, and green areas in urban spaces were perceived as vital in enhancing physical and mental health. The policy changes and the application of the universal design were to be followed and to be executed to guarantee that the buildings will achieve social, environmental, and health objectives of well being in any future pandemic or epidemic since most current facilities do not consider epidemiological considerations (Chandir et al., 2020). Along with these aspects, environmental considerations followed by cultural integration becomes a contextual challenge which required detailed revisit as well as evaluation with respect to the current built form and buildings in healthcare sector.

The COVID-19 pandemic triggered the worldwide reconsideration of the design of the hospitals and healthcare facilities. This crisis demonstrated the necessity of flexible infrastructure that has the potential to meet future needs, often facilitated by the use of tools such as BIM and GIS (Ayyaz et al., 2020). Previous exploration did also revealed the excessive adverse effect on the less privileged community, especially in the developing world, where the sustainable and equitable recovery from disease and critical medical conditions is vital towards survivability (Noreen et al., 2020). Pakistan and other developing countries have been designing hospitals in the past with their major focus being on reducing cost rather than flexibility, this has made them not only very fragile and weak in controlling the infections but also in flexibility towards coping with future challenges of epidemics and infectious diseases (Auerbach et al., 2020). The pandemic has shown how fragile healthcare infrastructure was, particularly in Pakistan, where building architects and spatial design specialists could have played a trivial role in crisis-induced adjustments yet were ignored in these critical times due to lack of integration as well as critical appreciation in the system towards maximizing space, infection control, and effective circulation of patients (Barzilay et al., 2020).

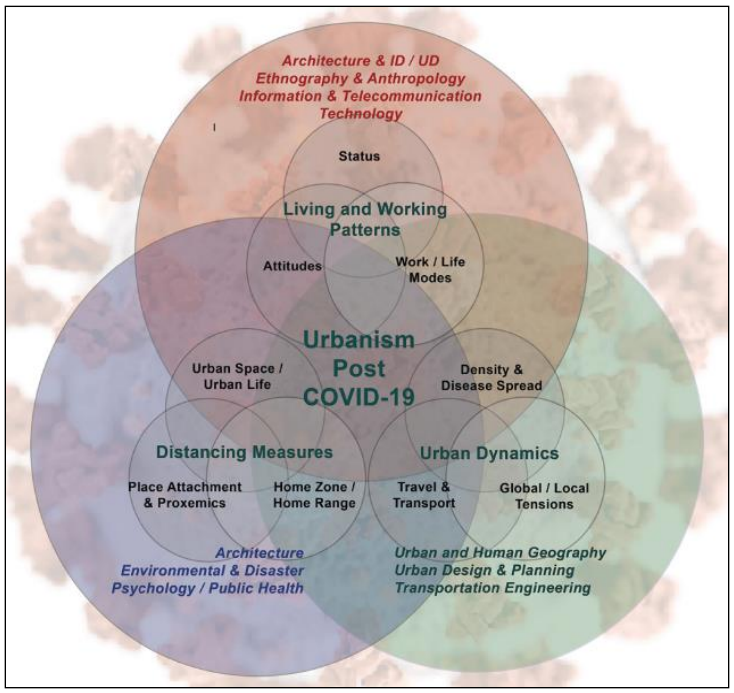

Figure 02 Implication for Life after COVID-19 pandemic (Salama, 2020)

Designing buildings that focus on health, adaptability, and resilience is a major focus of architectural learning, which proved to be of great necessity during the pandemic. While in the world, when in a very short time, global architects revolutionized the use of public spaces and embraced infection-control policies, Pakistan still were lacking back and were forced towards smart lack downs (Gondim & Machado, 2020). Nevertheless, in Pakistan, this potential was insufficiently used because of the disintegrated healthcare administration, insufficient inter-professional cooperation, and the lack of understanding the role of architecture as well as the architect as a healthcare designer and planner in the promotion of the health infrastructure optimization (Ahmad et al., 2020). The designing of healthcare facilities after the pandemic conversely aims at flexibility including the room configurations, isolation, and the provision of separate storage of medical devices and the consideration of the health of healthcare workers, staff and support system. However, such developments are very few in Pakistan due to what is limiting them mainly by budget cuts, difficulty due to climate crisis, maintenance of things like utilities and a high population rate. In the future, the architecture industry in Pakistan will have to incorporate the pandemic knowledge, and architects as healthcare designers will need to be trained and integrated in the design specific to healthcare facilities, epidemiology, and cooperation with governmental health organizations to design resilient, adaptive, and human-oriented buildings (Bhatti et al., 2025b). Environmental design has become an indispensable element of controlling transmission of infections within a hospital as the design of the building and the integration of environmental design and evidence-based design into architectural planning and engineering controls is considered the key goals of reducing infection transmission and managing spread of disease (Sepe, 2021). The architecture of modern-day healthcare is increasingly using Infection Prevention and Control (IPC) mechanisms like negative pressure isolation rooms, High-Efficiency Particulate Air (HEPA) filtration systems, ultraviolet germicidal irradiation (UVGI) as well as enhanced mechanical ventilation strategies to ensure adequate maintenance of air change rates per hour (ACH). The process of spatial zoning which partitions the hospital into multiple

categories based on protocols and procedures i.e. clean, semi-contaminated and contaminated areas makes sure that the direction of patient, staff, and visitor traffic minimizes the chances of cross-contamination (Megahed & Ghoneim, 2020). Biofilm prevention: materials choice (e.g. non-porous, antimicrobial surface finishes and seamless flooring) also removes the barrier to decontamination practices. Infection control is also facilitated by the touchless technologies, decentralized nursing workstations, and modular design plans that help minimize touchpoints and allow the efficient reconfiguration of spaces to adjust to surges in patients (Morone et al., 2022). These key strategies not only combat airborne transmission but also reduce air-based and droplet-based transmission, thus environmental design acts as an indispensable layer of hospital epidemiology resilience at large.

In the context of COVID-19 pandemic, hospitals with advanced principles enforced in their environmental design showed much more substantial capability of coping with nosocomial (hospital-acquired) infections (Barouki et al., 2021). Hospitals that had optimized their systems of ventilation, had separate areas of triage and isolation, and had flexible layouts of desirable surge capacity were capable of effectively separating suspected and confirmed COVID-19 patients into general patient populations. However, in Pakistan, much of the healthcare infrastructure did not have such infrastructural protections as their budgets were limited, their hospitals were old, and they focused a lot of effort on cost containment instead of resilience planning (Faedda et al., 2022). Wards that are overcrowded, a lack of isolation capacity, and a low quality of indoor air, caused the viral spread to be an additional burden on overwhelmed healthcare systems (Shari & Khavarian-garmsir, 2020). The pandemic informed a sense of urgency to (1) ensure that environmental design intervention responses to climate needs in Pakistan are climate appropriate and resource-efficient, (2) that air dilution in energy-efficient, hybrid natural-mechanical ventilation must be provided; (3) that modular isolation rooms and spaces must be low-cost; and (4) that spatial planning should be flexible, adaptable, and deployable even in low-resource settings. Such actions do not represent empty architectural aesthetics but effective public health remedies, whose systematic execution would considerably decrease the infection level as well as the hospital preparation in case of further outbreaks.

RESEARCH METHODOLOGY

Based on the current exploration of the research, the previous based research methodology was continued based on exploration, documentation and analysis of the key documents from multiple departmental and agencies associated with healthcare and hospitals towards optimization for post pandemic architecture for future. Hence following below approach was used.

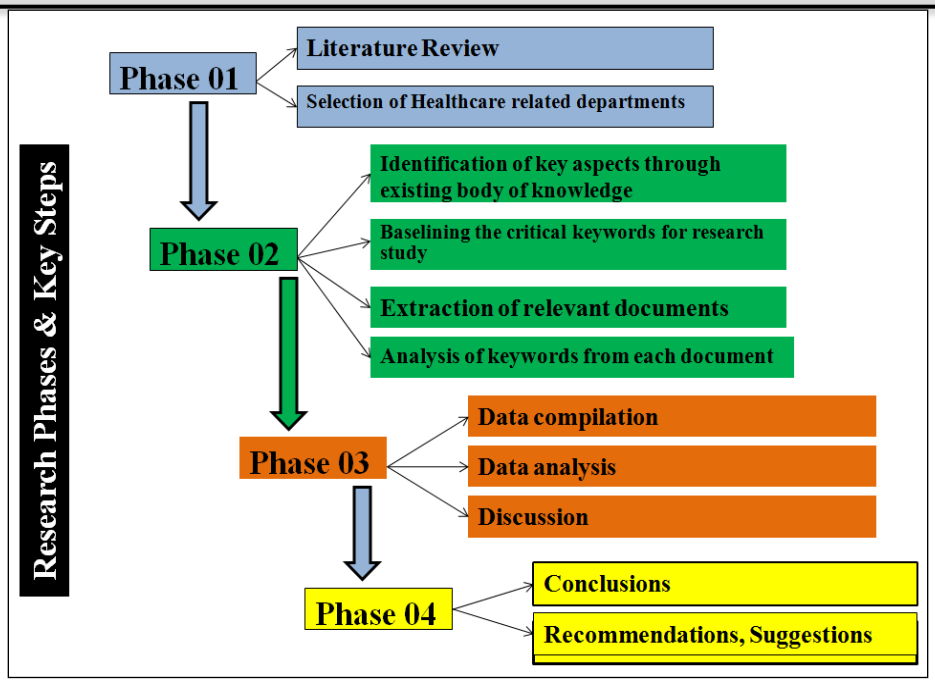

Figure 03 Overall research phases and major components

The key steps and phases have been outlined as indicated above through the definition of the research methodology. It gives attention on identification of pertinent segments of healthcare administration and management of healthcare in governmental resources and allied departments which are directly linked and connected to the administration of healthcare facilities like hospitals. In later phase, based on the literature review, the majority of key relevant terms and keywords were discussed employing the previous research publications highlighting the importance of architects in the pandemic and the post pandemic design of buildings. The above keywords were subsequently probed using various themes and hence led to the derived clarity in defining the purpose of the architects when it comes to designing the healthcare buildings in Pakistan in the pre and the post pandemic timelines.

DATA COLLECTION & ANALYSIS

Based on the previous part of the research exploration (Zahra et al., 2025), following ten most critical keywords were based on the following shown below keywords with higher frequencies.

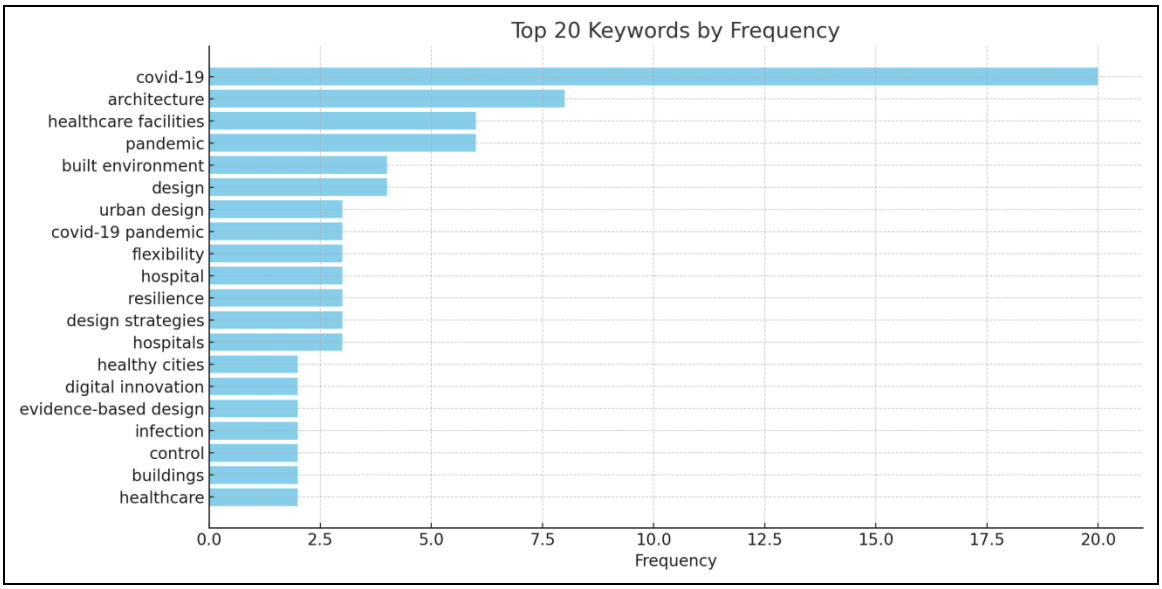

Figure 03 Frequencies of most critical highlighted keywords

Along with keywords, following major themes were identified as shown below:

Figure 04 Major themes and relevant keywords

With help of review of literature and identification of critical methodology based on the phase 01 of the project, the most critical keywords for further exploration were mainly covid-19, architecture, architect, healthcare facilities, pandemic, built environment, design, hospital, design strategies, evidence-based design, design and building/s i.e. 11 in total. With current phase of the project, following major departments and domains were explored:

1. Environmental Protection Agency (EPA) of Pakistan.
2. EPA Punjab.
3. EPA Balochistan.
4. EPA Gilgit Baltistan.
5. EPA Khyber Pakhtoon Khawa.

6. EPA Azad Jammu Kashmir.
7. Pakistan Engineering Council.
8. Pakistan Medical & Dental Council.

These departments were explored through their online published data including but not limited to published reports, guidelines, Act, standards as well as applicable SoP's. These were mainly downloaded between the timeline of May-August, 2025. All major documents along with the frequencies of their keywords from each documents is shared below in table 01.

Table 01 Collected data and its details

Selected Healthcare Documents Details		Selected Keywords											
S. No	Documents	covid-19	architecture	architect	healthcare facilities	pandemic	built environment	design	hospital	design strategies	evidence-based design	buildings	Total
	EPA Azad Jammu Kashmir												
1	State Environmental Quality Standards (Self-Monitoring and Reporting by Industry) Rules, 2009	0	0	0	0	0	0	0	0	0	0	0	0
2	AJK Climate change Policy 2017	0	0	0	0	0	0	15	0	0	0	22	37
3	AJK-EPA Review of Initial Environmental Examination 2009	0	0	0	0	0	0	4	1	0	0	3	8
4	Azad Jammu and Kashmir ACT	0	0	0	0	0	0	5	7	0	0	9	21
5	Bio-safety Rules 2009	0	0	0	0	0	0	0	0	0	0	0	0
6	Certification of Environmental Laboratories) Regulations, 2009	0	0	0	0	0	0	1	0	0	0	1	2
7	Environmental Checklist (Final) for PC-1	0	0	1	0	0	0	1	1	0	0	0	3
8	Environmental Sample Rules 2009	0	0	0	0	0	0	0	0	0	0	0	0
9	National Climate Change Policy 2011	0	0	0	0	0	0	9	0	0	0	18	27
10	NEQSs for Industrial & Muncipal effluents	0	0	0	0	0	0	0	0	0	0	0	0
11	Pollution Charges for Industries 2019	0	0	0	0	0	0	0	0	0	0	0	0
12	Prohibition of Non-degradable Plastic Products AJK 2013	0	0	0	0	0	0	0	0	0	0	1	1
13	Sustainable Development Fund Board 2009	0	0	0	0	0	0	0	0	0	0	0	0
	EPA Baluchistan												
14	Building prototypes Health Sector	0	0	0	0	0	0	20	0	0	0	0	20

15	Kachi Abadi Reulations	0	0	0	0	0	0	1	1	0	0	7	9
16	THE BALOCHISTAN HEALTH FOUNDATION Act 2014	0	0	0	0	0	0	0	0	0	0	0	0
17	THE BALOCHISTAN HEALTH FOUNDATION Private Hospital Act 2004	0	0	0	0	0	0	0	42	0	0	2	44
18	The-Balochistan-Rules-of-Business-2012.-Amendment-2020Service-Rules-2020	0	0	0	0	0	0	0	0	0	0	0	0
	EPA Gilgit Baltistan												
19	Analysis of drinking water quality to investigate reasons	0	0	0	0	0	0	0	0	0	0	0	0
20	Contamination-and-Health-RisK-Assessment-in-DW-of-GB	0	0	0	0	0	0	0	0	0	0	0	0
21	Draft-GB-Environment-Policy	0	0	0	0	0	0	4	2	0	0	15	21
22	EIA Draft	0	0	0	2	0	0	158	23	0	0	14	197
23	GB Environment Rules	0	0	0	0	0	0	0	0	0	0	0	0
24	Gilgit-Baltistan Climate Change Strategy and Action Plan 2023	0	0	0	0	0	2	38	2	0	0	28	70
	EPA KPK												
25	EPT-rules-2016	0	0	0	0	0	0	0	0	0	0	0	0
26	Gazetted-KP-EP-Act-Amended-2022	0	0	0	0	0	0	0	0	0	0	0	0
27	Gazetted-new-Administrative-Penalty-Rules-2017	0	0	0	0	0	0	0	0	0	0	0	0
28	Gazzetted-Scanned-Khyber-Pakhtunkhwa-Environmental-Assessment-Rules-2021	0	0	0	0	0	0	0	0	0	0	0	0
29	Housing schemes	0	0	0	0	0	0	8	0	0	0	1	9
30	KP-EIF-Board-Rules-2022	0	0	0	0	0	0	0	0	0	0	0	0
	EPA Pakistan												
31	Ambient Air Quality in Pakistan	0	0	0	0	0	0	0	1	0	0	0	1
32	BRIEF OF ENVIRONMENTAL CONCERNS-PAKISTAN SCENARIO	0	0	0	0	0	0	0	1	0	0	15	16
33	BRIEF ON ENVIRONMENTAL IMPACT ASSESSMENT	0	0	0	0	0	0	0	0	0	0	0	0
34	Brief on Solid Waste Management in Pakistan	0	0	0	0	0	0	0	1	0	0	0	1
35	Clean Development Mechanism	0	0	0	0	0	0	5	0	0	0	0	5
36	DRAFT HAZARDOUS SUBSTANCES RULES, 2024	0	0	0	0	0	0	2	0	0	0	25	27
37	EIA GUIDELINES - AN OVERVIEW	0	0	0	0	0	0	0	0	0	0	3	3

38	EIA GUIDELINES - Graphics AN OVERVIEW	0	0	0	0	0	0	0	0	0	0	0	0
39	Guidelines for Public Consultation	0	0	0	0	0	0	13	0	0	0	12	25
40	Guidelines For Sensitive And Critical Areas	0	0	0	0	0	0	0	4	0	0	75	79
41	Guidelines for the Preparation and Review of Environmental Reports	0	0	0	0	0	0	41	2	0	0	7	50
42	Hospital Waste Management Rules, 2022	0	0	0	3	0	0	0	90	0	0	1	94
43	Hospital Waste Management Rules 2005	0	0	0	0	0	0	0	75	0	0	3	78
44	INDUSTRIAL EFFICIENCY AND ENVIRONMENTAL MANAGEMENT SECTOR	0	0	0	0	0	0	0	0	0	0	3	3
45	Initial Environmental Assessment Regulations 2022	0	0	0	0	2	0	0	0	0	0	3	5
46	NATIONAL BIOSAFETY GUIDELINES	0	0	3	0	0	0	48	0	0	0	0	51
47	NATIONAL ENVIRONMENTAL POLICY 2005	0	0	0	1	0	0	1	3	0	0	0	5
48	National Resettlement Policy	0	0	0	0	0	0	4	2	0	0	0	6
49	Pakistan BIO Safety Rules 2005 (Amended2024)	0	0	0	0	0	0	0	3	0	0	0	3
50	PAKISTAN CLEAN AIR PROGRAMME	0	0	0	0	0	0	0	0	0	0	4	4
51	Pakistan Environmental Protection Act, 1997	0	0	0	0	0	0	1	0	0	0	0	1
52	PEPA Act 1997	0	0	0	0	0	0	0	0	0	0	1	1
53	Policy and procedures for the filing, review and approval of environmental assessments	0	0	0	0	0	0	7	2	0	0	6	15
54	Sectoral guidelines for Environmental Reports Housing Sector	0	0	0	0	0	0	3	5	0	0	12	20
	EPA Punjab												
55	Assessment and Optimization of Rainwater Harvesting Potential	0	1	1	0	0	0	7	0	0	0	4	13
56	Climate Resilient Punjab Vision 2024	0	0	0	0	0	0	18	11	0	0	15	44
57	CM Punjab Smog Mitigation Plan 2024 ROADMAP FOR SMOG	0	0	0	0	0	0	2	15	0	0	2	19
58	CONTROL FUGITIVE DUST IN LAHORE	0	0	0	0	0	0	0	0	0	0	0	0

59	Environmental and Social Systems Assessment 2018	0	0	0	0	0	0	75	0	0	0	61	136
60	EPA KPK Rural Schools and Basic Health Units	0	0	0	0	0	0	0	0	0	0	0	0
61	EPA KPK Small and Medium Size Road Construction	0	0	0	0	0	0	15	3	0	0	12	30
62	EPA KPK Small Housing Schemes	0	0	0	0	0	0	12	0	0	0	8	20
63	Health Advisory system for critical air pollution	0	0	0	0	0	0	1	0	0	0	1	2
64	HOSPITAL WASTE MANAGEMENT RULES, 2005	0	0	0	0	0	0	5	11	0	0	5	21
65	Housing Estates and New Town Development	0	0	0	0	0	0	47	17	0	0	43	107
66	Initial EE and EIA	0	0	0	0	0	0	0	6	0	0	0	6
67	NATIONAL CLIMATE CHANGE POLICY	1	1	1	0	2	0	23	1	0	0	21	50
68	POLICY ON CONTROLLING SMOG 2017	0	0	0	0	0	0	11	0	0	0	11	22
69	Punjab Environmental Protection Act 1997 with all amendments Draft 01	0	0	0	0	0	0	3	1	0	0	3	7
70	PUNJAB GREEN DEVELOPMENT PROGRAM 2018	0	0	0	0	0	0	24	0	0	0	21	45
71	Punjab Hazardous Substances Rule 2020	0	0	0	0	0	0	5	0	0	0	5	10
72	Punjab Hospital Waste Management Rules, 2014	0	0	0	0	0	0	0	0	0	0	0	0
73	Remote Sensing Analysis of Smog-Inducing Aerosol Optical Depth	2	0	0	0	0	0	1	0	0	0	1	4
74	Report of the Smog Commission 2018	0	0	0	0	0	0	4	8	0	0	3	15
75	SMOG Prevention and Control Rules 2023	0	0	0	0	0	0	0	0	0	0	0	0
76	SOPs to control fugitive dust on construction project 2024	0	0	0	0	0	0	0	0	0	0	0	0
77	THE BIO-SAFETY RULES 2014	0	0	0	0	0	0	2	0	0	0	2	4
78	TOWARDS A SUSTAINABLE FUTURE A CRITICAL REVIEW OF INTERNATIONAL	2	0	0	0	0	0	0	0	0	0	0	2
	Pakistan Engineering Council												
79	Building Code of Pakistan 2007	0	1	26	0	0	0	486	3	0	0	912	1428
80	Building Code of Pakistan 2021	0	0	38	0	0	0	845	21	0	0	1485	2389

81	Building-Code-of-Pakistan-Fire-Safety-Provisions-2016	0	0	3	0	0	0	450	9	0	0	794	1256
82	Building energy code of Pakistan	0	0	11	0	0	0	370	1	0	0	465	847
83	Energy conservation Building Code	0	0	2	0	0	0	322	6	0	0	421	751
84	Energy conservation Building Code 2023	0	2	18	0	0	4	328	8	4	0	345	709
85	PEC-Policy-Guidelines-for-OnlineTLA-Implementation-during-COVID-19-Pandemic-Ver1	9	0	0	0	13	0	215	0	0	0	245	482
86	Pre-Final-Draft-OSH-CSP-2024-dated-29_November-2024-Updated_	0	0	8	0	1	0	163	2	0	0	222	396
87	Standardization-of-building-codes-standards-and-specifications-for-low-cost-affordable-units-2021	0	0	44	0	0	0	250	0	0	0	325	619
	Pakistan Medical & Dental Council												
88	Accreditation Standards Inspection Performa for Teaching Hospital (100 MBBS Students) - 2024.	0	0	0	0	0	0	0	297	0	0	6	303
89	Accreditation Standards Inspection Performa for Teaching Hospital (150 MBBS Students) - 2024	0	0	0	0	0	0	0	268	0	0	4	272
	Total	14	5	156	6	18	6	4073	956	4	0	5733	10971

As evident from the table 01, a total of 8 major departments or agencies were explored as shared previously. For each category, the number of documents downloaded and used for data analysis was different. For EPA Azad Jammu Kashmir, there were 13 documents used. For EPA Balochistan, it was 5 documents and for EPA Gilgit-Baltistan as well as EPA KPK was 6 simultaneously. Both EPA Pakistan and EPA Punjab, each has 24 documents. Two major allied councils i.e. PEC & PMDC consisted of 9 and 2 documents simultaneously. Hence a total of 89 documents were used for analysis based on the defined 11 keywords as mentioned earlier.

With respect to keywords, COVID-19 was identified 14 times, architecture 5 time, architect 156 times, healthcare facilities 6 times, pandemic 18 times, built environment 6 times, design 4073 times, hospital 956 times, design strategies 4 times, building/s 5733 times while evidence based design was not reported at any point. The keyword stats are shown below in figure 05.

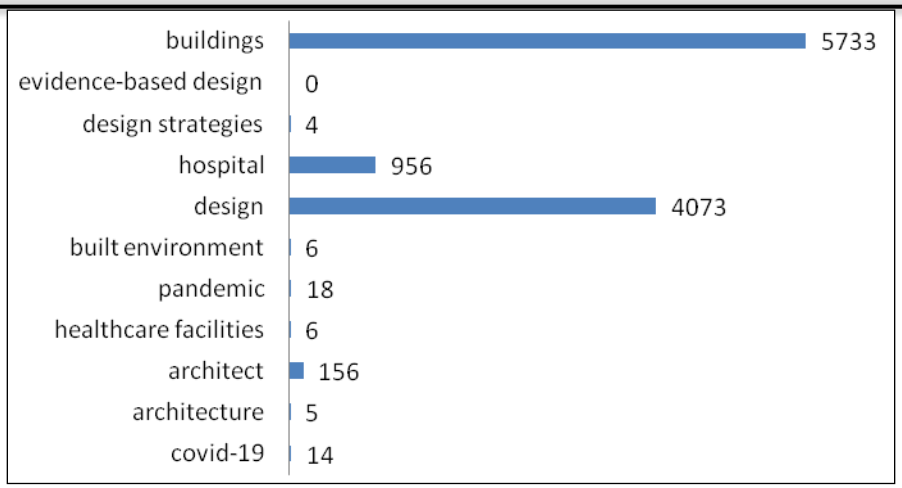

Figure 05 Keywords frequency analysis from 88 explored documents

Hence based on the overview of the data, it can be concluded that Building/s was the major keyword with a 52.256% followed by Design with 37.125% and later at third position was Hospital with 8.714%. Detailed analysis with respect to each department / council vs each keyword is shown below in figure 06.

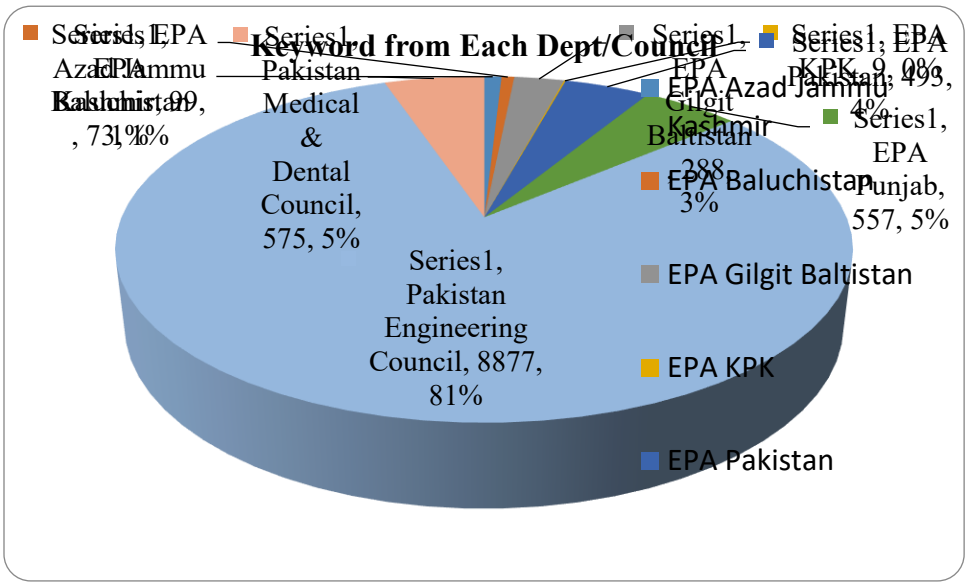

Figure 06 Keyword frequency from each dept / council

As shown above in the figure 06, major department / council share are shown. With respect to values, Environmental Protection Agency (EPA) of Pakistan had 493 keywords, EPA Punjab had 557 keywords, EPA Balochistan had 73 keywords, EPA Gilgit Baltistan had 288 keywords, EPA Khyber Pakhtoon Khawa (KPK) had 9 keywords, EPA Azad Jammu Kashmir (AJK) had 99 keywords, Pakistan Engineering Council (PEC) had 8877 keywords and Pakistan Medical & Dental Council (PMDC) had 575 keywords.

DISCUSSION

Based on the data collected and analysis done, it was evident that with respect to major medical facilities associated organization i.e. PMDC and engineering/construction related body i.e. PEC has not been a major key role players towards engaging or critically appreciating the role architects or

architecture need to have based on the learning from the shortfalls of pandemic. The keyword "Design" is reported 4073 times and the keyword "Buildings" was reported 5733 times. This shows a strong focus of the concerned authorities towards structural and functional aspects in policies, defined codes and standard guidelines i.e. almost 80% of the keyword "design" came from Building code of Pakistan. The next most extensive keyword identified was "Hospital" with 956 mentions prominently from PMDC Accreditation Manual as well as EPA Hospital Waste Management rules but unfortunately were not found to be linked with architecture or spatial planning of the facilities. The remaining keywords had very little ground for reporting i.e. Architect with 156 mentions and architecture only 5 mentions.

The key finding of these 10 critical keywords reviewed systematically in 89 policy documents of key policy organizations of the environmental protection agencies (EPAs) of the country and two governmental bodies of Pakistan, the Pakistan Engineering Council (PEC) and the Pakistan Medical and Dental Council (PMDC), opens major research gaps, biases, and potentials in the incorporation of the architectural and healthcare designs at the national policymaking level in Pakistan. It became evident that terminologies pertaining to healthcare infrastructure, pandemic resilience, evidence-based design, and the synonyms of planning-healthcare are mainly ignored, neglected, misinterpreted, or nowhere to be found which in its essence is a larger issue between built-environment planning and returning to health.

There is a severe policy gap in planning of healthcare infrastructure within Pakistan, as the lack of almost any mentions of the term of COVID-19 in EPA and PMDC documents demonstrates the inability to implement pandemic-resistant policy designing approaches in the post pandemic timeline in Pakistan. Administrative changes such as remote work were covered by PEC, whereas such architecture-related precautionary measures as advanced ventilation, movable hospital layouts, and modular treatment rooms were not incorporated at all into any regulatory body. Such a reactive approach fails to incorporate important lessons taught by COVID-19, which can render a healthcare system susceptible to crisis in the future and may demand an increased focus on preventive, design-based policymaking.

Architecture is still made insignificant to national environmental and healthcare planning and its role is marginalized as a posteriori technical accessory. The Rainwater Harvesting Assessment by the Punjab EPA cites architecture in a superficial manner and fails to refer to architecture in connection with aspects of resilience of healthcare facilities and the use of design to address infection prevention, healing spaces and patient safety. By not involving architects at the policy level in health infrastructure, Pakistan is excluded of interdisciplinary innovations that can show a convergence between clinical efficiency and environmental sustainability.

The fact that the policy aspects related to design and its application does not mention the term "healthcare facilities" indicates a profound systemic neglect that continues to place the Pakistan policies decades behind the international best practices. Although other global policies such as the WHO Health in All Policies incorporate health into policy development in infrastructure, Pakistan fails to put forward a coherent policy, as the country has policies that tackle health-related issues to waste management despite ignoring patient flow, accessibility, or surge capacity during emergency events. After the pandemic and based on the explored documents from the selected websites of the concerned departments mentioned above, no hospital guidelines were amended to include design-based crisis preparedness, and thus systems remained unprepared in the case of future outbreaks.

Obsolete paradigms of design & planning still define hospitals in the generic building category as opposed to health-enhancing environments which compromises recovery of patients as well as prevention of infections. The way the Building Code from PEC was explored, it highlighted that it does not differentiate the design of a hospital as opposed to the design of a commercial office, overlooking the WHO and the CDC recommendations on how to achieve evidence-based layouts, way-finding, and the incorporation of environmental design or allied contextual health concerns in the future buildings of Pakistan.

RESEARCH FINDINGS

As per the defined research methodology, a critical policy-document keyword analysis of 89 environmental protection-related documents/reports/guidlines of the Pakistani Environmental Protection Agencies (EPAs), Pakistan Engineering Council (PEC), and Pakistan Medical & Dental Council (PMDC) reveal a major mismatch between modern paradigms of architectural design processes and healthcare provision-related to planning of the future of healthcare in Pakistan. The critical identified keywords analysis showed that words like design (4073 times) and buildings (5,733 mentions) are predominant in the vocabulary and there use is mostly limited to the technical codes of PEC with all of the focus on structural integrity, as opposed to functional, health-based spatial strategies. Very disparately, key healthcare-specific terminologies, e.g. the terms "healthcare facilities" (6) and the term "evidence-based design" (0), are barely evident, or dealt with peripherally. Even in the cases when it refers to the word "hospital" (956 times), it is limited to administrative parameters of PMDC (e.g., the number of beds) or rules of waste management in EPA without any references to space organization, patient experience, or the capability to survive a pandemic. This demonstrates an urgent policy blind spot that fails to recognize globally proven design practices that could significantly improve patient recovery, efficient work flows and even enhance infection control through defining and aligning role of healthcare architects in the domain of healthcare planning and design of healthcare facilities in future as well as for the existing transformations.

Of equal concern is the minimal policy inclination with pandemic responsive architecture. The words like the one referring to COVID-19 (14) and pandemic (18) are used mostly in detailing the adaptations in the procedures as remote work policies, but there is no significant translation into the architectural design or in the spatial design. Neither of EPA or PMDC frameworks has updated hospital design standards to reflect post-pandemic insights, like negative-pressure isolation rooms, scale-able ICU layout, or surge planning in current facilities towards epidemic planning and proactive management. The professional designation of architect (156 mentions) is also highlighted in PEC load-bearing and structural performance compliance codes, having had no forays into healthcare or environmental design policy-making. This kind of segregation or isolation itself overlooks the ability of architecture to act in the form of an interdisciplinary interface between the built environment and the need to address population health challenges. Also, although the built environment is mostly mentioned briefly within currently EPA climate policies (6 times), it does not invoke its possible contribution to better healthcare access, resilience, or adaptive capacity under changes in environmental stressors.

Based on this analysis, three critical gaps were identified that have tremendous implications when it comes to the healthcare resilience of Pakistan. To begin with, a gap in evolution between research and policy is exemplified by a lack of evidence-based design, which would be the foundation of high-performance healthcare building design. Innovations in design like single-bed rooms to minimize infection or incorporating environmental design in a construction/design/operation to reduce patient stress are routine in other parts of the world. However in case of the current exploration in Pakistan, hospital waste management regulations in place through PMDC and hospital accreditation processes carefully regulate the staffing ratio, but completely leave out spatial regulations on the same, whereas, the waste management portion of EPA regulation of hospitals also does not consider the role of spatial planning in controlling contamination. Second, pandemic-readiness design is mainly lacking; whereas developed countries have updated building codes in the wake of 2020 pandemic to include mandates in modular hospital capacity and crisis-responsive utility networks, the policy response in Pakistan is to view pandemics as a temporary transformation in the system, and not a test case towards an overhaul of their resiliency infrastructure.

Lastly, these gaps are reinforced by continual isolation of architects when it comes to improving the policy making related to healthcare-environmental nexus. Although the word architect repeated 156 times, more than 95 percent of uses merely refers to the rigidity-oriented structural codes promoted by PEC, thereby perpetuating the

obsolete paradigm of equating architect to aesthetic consultant as opposed to strategic systems thinker. Such marginalization is very sharp in the climate-sensitive districts like Gilgit-Baltistan where climate action plans focus on housing resistant to floods but not on co-designing healthcare infrastructure by architects that particularly addresses hazard-prone populations. Moreover, such concepts as "human-centered design or spatial adaptation that are essential in advancing aging populations, promoting disability inclusivity, and epidemiological safety are persistently absent in the vocabulary of the explored documents.

CONCLUSIONS

In this current research endeavor, the analysis identifies an extreme structural and conceptual discordance within the policy landscape of healthcare infrastructure in Pakistan, where architectural design-though delivering proven global added value as a determinant of resilience, operational efficiency and wellness-has remained sidelined and linguistically constricted. The analytical comparisons of the keywords used systematically in the EPA, PEC, and PMDC texts indicate the compliance engineering dimensions in the regulatory discourse with thousands of occurrences of the words design and buildings occurring in explored texts but being nearly entirely within the codes of PEC structural inspections of buildings. Ironically, healthcare- specifically oriented and evidence-based design principles, e.g., healthcare facilities or evidence-based design, are not mentioned or are mentioned on the periphery. This omission is not an subtle detail, it is a potentially policy blind spot undermining the ability of healthcare systems to make proactive plans to meet both chronic shortages and public health emergencies. Pakistan also has no progressive international models, like the WHO Health in All Policies, or let alone the post-2020 revision of the code in developed countries, requiring modular and surge capable healthcare infrastructure. When encapsulating the term architect to in-flexible engineering regulatory provisions, one can expose a long-established paradigm that excludes designers in inter-disciplinary integrative levels and consequently loses their potential to encompass spatial, environmental and clinical needs into a congruent health-supportive infrastructure solution. Such marginalized governance system divides the institutional priorities, promotes inefficiencies, and leaves facilities, especially those in climate-vulnerable or high-density areas, structurally satisfactory but functionally outdated. This study provides evidence that indicates a shift in paradigm is warranted: a paradigm shift that would change not only the way healthcare infrastructure is viewed (as a fixed asset or regime to be regulated), but as a dynamic, flexible system of which architectural innovation and inter-disciplinarity becomes core to national health planning for future built environment.

Moving forward, the healthcare infrastructure strategy in Pakistan will need to revisit architectural design as a primary health resilience, sustainability, and equity factor, instead of the secondary technical issue. Inclusion of principles of evidence-based design into regulatory systems of EPA, PMDC and PEC can serve as crucial aspect in narrowing the existing gaps between intent of policy/regulated and global best practices. Features like optimized patient flow, flexible isolation zones, elaborate ventilation systems, day lighting plan, environmental design integration and flexible floor planning need to be enacted as essential provisions. Most importantly, architects need to be institutionally integrated into healthcare and environmental policymaking, not as an incidental after-the-fact task complete with code compliance but during the formation of coherent health-infrastructure policies through collaboration with clinicians, engineers, epidemiologists and urban planners. The evidence provided by the COVID-19 crisis has established all around the globe that healthy healthcare settings should not only be technically well-grounded but also human-friendly and also be able to tolerate epidemiological overload and sustain a minimum of operations even in times of epidemiological pressure, promote healing, and resilience in psychological terms. Context-sensitive, design-led solutions can provide this

resilience in a resource-constrained environment of Pakistan and may take the form of modular and prefabricated treatment units, hybrid natural-mechanical ventilation solutions, and climate-resilient rural clinics sited in high-risk areas.

FURTHER RESEARCH DIRECTIONS

Such systemic gaps require a threefold response: (1) the incorporation of the evidence-based design principles at the stages of PMDC and EPA accreditation, (2) the creation of interdisciplinary task forces that program health infrastructure at the intersection of architecture, clinical practice, and engineering, and (3) amendment of building code that would lay the emphasis on flexibility and resilience of the model of disaster-ready hospitals. Without these reforms, there is a risk that Pakistan continues to build infrastructure which is still structurally compliant but functionally out-dated in addressing the challenges of demography, epidemiology and the climate challenges of the future decades to come.

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