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Optimizing Healthcare Spaces In Post-Covid19: An Environmental Evaluation Of Outpatient Department Design At DHQ Teaching Hospital, Sahiwal.

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Abstract: *All modern healthcare facilities focus on environmental and functional optimization. The repeated OPD closures and lockdowns during the COVID-19 pandemic exposed the requirement for assessing what environmental factors influence user satisfaction along with health service provider satisfaction in post COVID-19. District Headquarter Hospital in Sahiwal which experienced previous such challenges was chosen to study these variables. Hence scope and direction of research was defined. During data collection, 5-point Likert scale was used to obtain 104 responses both in summer and winter seasons after conducting site examinations and user interviews. The research implemented data assessment along with findings and recommended environmental design interventions. The facility at OPD catered to limited patient numbers so space became inadequate even though specialty days were established. The identified major issues in this setting included inadequate temperature comfort for patients and visitors, missing disabled access, poor conditioned public washrooms, missing storage capacity, diagnostic equipment within the outpatient department, inadequate airflow ventilation and high building moisture levels with limited patient seating options together with inferior visual color schemes. HVAC systems were absent. The summer survey involved 104 respondents and indoor signage emerged as the only favorable aspect. Winter study included 72% male and 28% female participants and OPD facility experienced problems with artificial lighting alongside noise issues as well as concerns about space design and seating arrangements and cleanliness standards and air freshness and humidity levels. New design solutions have been proposed to improve issues currently found in the OPD building.*

Keywords: Environmental Design, User Satisfaction, Out-Patient Department, COVID19 pandemic, District Head Quarter Hospital

Introduction

Health is a true gift of nature. Keeping healthy is challenge in the modern mechanized world where food, lifestyle patterns and daily routine miss the integral components of staying healthy. Though healthy or in a state of medical need or treatment, visiting a healthcare facility is part of modern day life (Ellingsen, 2009). People visit these spaces with respect to consultation with physicians and specialists to keep them healthy and free from medical treatment. Visiting these spaces without emergencies mainly start from Out Patient Department (OPD) (Allegranzi et al., 2011). These consultations were not only for healthy people but also who need medical advise and treatment on regular visits (Shah et al., 2023). It turns out to be the most visited place in the hospital premises.

Visiting OPD can be source of consultation and guidance to avoid pain and disease but

sometimes it turns out to be not that welcoming and may lead to having some unwanted diseases which were not mainly acquired by the people, attendants or patients before visiting the premises of hospital (Welfare, 2012). One of such is Healthcare Acquired Infection (HAI). Its also called as Nosocomial Infection in medical terminology. It is a form of infection acquired within the premises of a hospital once visited or got admitted (Goel et al., 2013).

Modern day healthcare facilities mainly rely on environmental and functional optimization for better experience and services provision along with spatial and architectural design (Shah et al., 2023b). These aspects occupy the center for any healthcare facility but are highly related and critical to better performance of the facility specially when it is open for the general public and the people or the local public has limited access to any other facility (Sahamir & Zakaria, 2014). Hence highend performance is directly related with managing the clinical, psychological and medical stress that a patient, attendant, visitor has to go through along with doctors, paramedic staff and support staff who have the responsibility to ensure these aspects were addressed through define line of actions and protocols (Organisation World Health, 2017).

Pakistan is one of the most promising and developing country from South Asia with 7th most populated on the globe. With recent COVID-19 pandemic, OPD were closed across the nation for multiple times and faced with lockdowns. With decline in the pandemic cases and towards regular shifting of lives, it was need of the hour to explore the OPD environmental variables with respect to end users and service providers satisfaction since they will be there together and will be at risk of cross contamination and exposure of allied Healthcare Acquired Infections (HAI) (Sattar et al., 2019). It is a much needed exploration area in the context of Pakistan and its urban centers to explore in the post COVID-19 context, how far the OPD environmental variables have been accepted by the end users (World Health Organization, 2016). The research aims to explore the OPD of Sahiwal Teaching DHQ hospital to ensure better users satisfaction, safety and help people able to serve the patients through better environmental conditions.

Design of healthcare facilities like OPD needs to be explored with respect to environmental design to ensure user satisfaction and environmental quality. Due to lack of healthcare facilities, staff, infrastructure and higher population and influx of patients to be taken up for treatment, environmental conditions and hygiene conditions can get compromised leading to spread of infections and poor user satisfaction and spatial quality (Bhatti et al., 2022). It is need of the hour to explore and evaluate the environmental design of OPD department in Sahiwal DHQ hospital with a higher influx patient rate to ensure end user satisfaction and improved quality of setting through improved environmental design.

Hence following major research objectives were defined to proceed ahead with research exploration:

1. To observe, using modern day tools and equipment document the facility and explore existing Out Patient Department facility based on protocols for operational facility management.
2. To engage the diversified users from service provider and service seeker side towards end user satisfaction with focus on selected environmental variables applicable to functional optimization of OPD in the selected context.
3. Based on the analysis of data collected, propose environmental and architectural design interventions and solutions that may help in resolving the identified issues to enhance workability of the selected OPD facility.

Healthcare facilities serve as essential centers that advance human life quality levels. These facilities need adequate patient assistance along with treatment quality improvement for delivering better services to achieve patient comfort. OPD maintains its position as the central working department in order to provide fast patient consultations for diagnosis as well as

post-operative care that enables patients to regain their normal activities (Bhatti et al., 2023). Research studies have identified the primary environmental challenges faced by users at the outpatient department (OPD) of the DHQ Teaching Hospital Sahiwal along with specific solutions that design modifications could apply to address these challenges. This project proved the significance of environmental elements and how they aid performance while maintaining healthcare services to higher levels of quality.

REVIEW OF LITERATURE

One of the most important factors to consider when assessing the prosperity and well-being of any civilization is human health. A fundamental human right is the right to health. It has been reinforced by all of the primary dominating societal pillars, including the political, religious, social, and economic systems (Zaidi et al., 2005). Human life is among the most valuable resources to have ever existed on Earth, and any society's primary duty is to ensure its safety and well-being in order to ensure its survival and long-term viability (Tasneem et al., 2010).

Health is a condition of complete well-being on all levels, not only the absence of sickness or illness (Bhatti et al., 2024). However, in the present age, a hospital is one of the greatest and most appropriate places to go for advice and assistance if one is dealing with one of these problems. Depending on the typology/function and size of the hospital, it serves as a provider of healthcare and wellness amenities/necessities under one roof, including emergency response, long-term treatment, and related facilities (Zhao & Mourshed, 2017). It serves as a hub where healthcare professionals are on hand to assist those looking for care and offer them pertinent consultation (Ider et al., 2012).

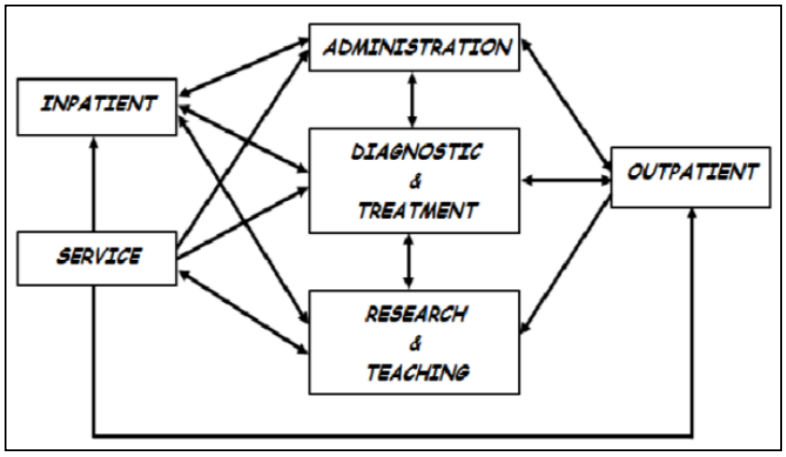


Figure 01 Departmental relationship diagram of a general hospital (Health & Guidelines, 2017)

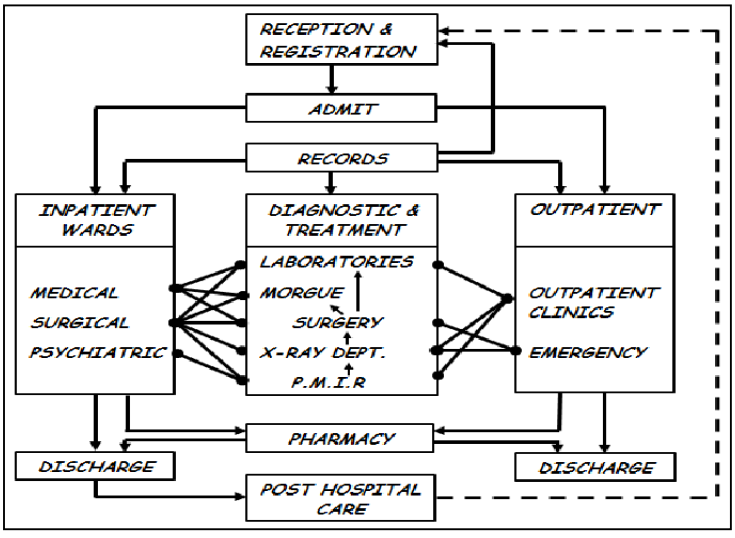


Figure 02 Clinical relationship diagram of a general hospital (Health & Guidelines, 2017)

As evident from figure 01 and 02 above, any major general hospital will mainly consist of the following major components as listed below with respect to their functional and operational usage:

a) A&E Department - Accident & emergency department.

b) OPD - Out-Patient Department.

c) IPD – In-Patient Department.

d) Facilitation for medication provision - Pharmacy.

e) Operations & Interventions - Surgical facilities and allied.

f) ICU, CCU, NICU - Intensive care units and allied.

g) HDU - Specialized units.

h) Exploratory studies - Diagnostics, Radiology and diverse medical laboratories.

i) Oversee & guidance - Administrative and services department.

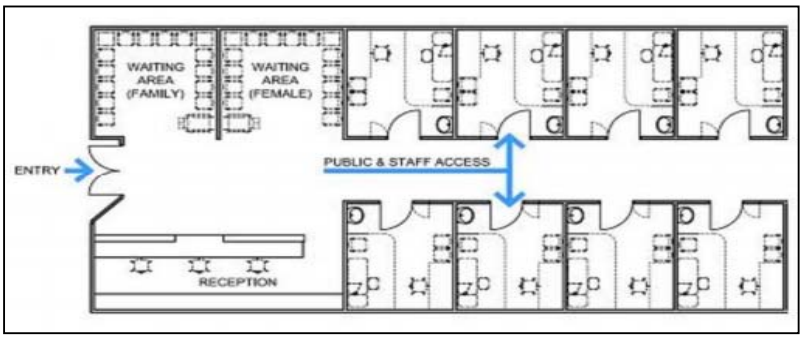
j) Operational technical facilitation - Engineering and Biomedical support department.

k) Operational support - Allied support departments.

As evident, hospital is a complex functional building with a highly optimized infrastructure and has diverse and integrated operational and highly dependent units which comprise of multiple systems and components working together all the same time with overlapping functions and responsibilities lead and headed by the medical, surgical, support administrative and support teams. It acts as one of the most critical, complex and complicated building type yet optimizes to help mankind and society opt for wellness through targeted services of health treatment and medication (Health & Guidelines, 2017).

Rapid urbanization, an increase in global population, climate change, population vulnerabilities, an increase in per capita age, a decline in the death rate and an increase in the birth rate, poverty, and many other related problems and challenges have changed how hospitals and healthcare systems currently operate and how effective they are. The existing population is now constantly dealing with health difficulties due to the large patient influx, low socioeconomic backgrounds, rise in accidents, incidents, and crime, as well as other factors (Zhao & Mourshed, 2017). No matter what the issue is, whether it be physical, social, psychological, or emotional, people require support and care. As a result, the burden of disease has increased while the institutions are struggling with severe funding, cost, human, and non-human resource shortages, facility, infrastructure, finance, financing, etc. challenges (Srinivas & Ravi Ravindran, 2017).

This dual problem has made it more difficult for both those who seek to use medical services and those who supply them (Sharjee et al., 2016). The current scenario is significantly worse in underdeveloped nations, where people generally suffer from severe medical service shortages and even when able to access them, were unable to afford them due to a lack of facilities, skilled personnel, and low awareness (Ider et al., 2012).



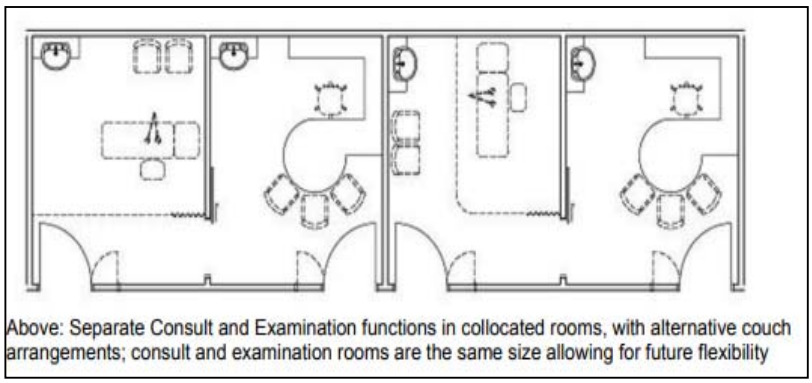


Figure 03 Typical Layout Plans for OPD units / department (Health & Guidelines, 2017)

OPD units require two essential elements which are a reception counter for patient enrollment and a waiting area located near hospital facilities that include restrooms and cafeterias and diagnostic services along with allied clinical services for core functions. Consultants receive patients based on the medical needs expressed by patients. Patients can use the single corridor to depart or continue to diagnostic tests after their consultation. Single-corridor facilities maintain small size with efficient management capabilities though they provide limited spatial boundaries between patient groups. Twin or dual hallways provide enhanced privacy whereas they need extensive space, energy and dedicated resources to ensure indoor air cleanliness and temperature comfort levels (Nadeem et al., 2021).

Patients can access multiple services through the Outpatient Unit such as medical specialist, consultation, same-day treatment, minor procedures, follow-ups and perioperative screenings in addition to health education sessions and ongoing care referrals. Various healthcare specialty services such as GP clinics, primary care, women and child health, surgical and medical specialties (including diabetes, chronic disease clinics) and pain management and genetic services exist alongside health promotion services within the outpatient unit (Zhao & Mourshed, 2017). Specialist outpatient services are managed through individual functional units which provide care for community health, dental treatment, day operations, oncology treatments, mental health care, radiotherapy therapy, rehabilitation services, renal dialysis and urgent care services(Tarar et al., 2020).

The review of literature identified important environmental factors that affect healthcare facilities. The use of natural light in healthcare facilities provides health advantages through concentrated lighting but inadequate illumination can lead to patient exhaustion. The requirements for thermal comfort coupled with air quality demand appropriate ventilation systems as an effective method to reduce infection transmission. The acoustic conditions of healthcare facilities directly influence the process of patient healing together with staff workplace strain (Waroonkun, 2018). Design measures serve two main purposes: it reduces the risk of infections and errors while minimizing both patient falls. Strategic space planning together with accessibility standards improve the way people move about the healthcare facilities and enables easy access to everyone. Patient accessibility depends on buildings that use proper signage systems alongside spatial design features and color-based navigational indicators. The design of furniture elements with ergonomics serves both comfort purposes together with safety enhancement needs. The coordinated selection of colors helps patients find their way through the environment while also promoting peace. Indoor space based functional materials with features that improve both safety through their slip-resistant qualities and functionality through their reduced glare and simplified maintenance procedures are considered most appropriate for functional optimization in OPD clinics and

departments (Samah et al., 2013).

The medical learning institution Sahiwal Medical College (SLMC), found its base in Sahiwal of Punjab Province in Pakistan in 2010, exists to provide educational opportunities within the area. The medical institution operates in collaboration with Sahiwal Teaching Hospital (originally named DHQ Hospital) which now has 1,158 hospital beds and also works with Government Haji Abdul Qayyum Teaching Hospital which has 72 beds and Ghalla Mandi Mini Hospital that has 10 beds. Each year the college selects 120 new students while supervising the Nursing Teaching Institute that operates at Sahiwal Teaching Hospital. The hospital has launched a new hospital block building project which will occur at its new campus.

RESEARCH METHODOLOGY

Overall methodology developed to complete the research was follows:

a) Visit to the OPD department for observational study.

b) Developing its detailed architectural plans and take pictures for documentation.

c) Developing a checklist based on the review of literature about critical factors observed.

d) Complete checklist through observational study.

e) Development of a questionnaire for critical factors to gather data from respondents and end users.

f) Piloting the questionnaire.

g) Data collection from the respondents.

h) Data compilation and analysis.

i) Research findings, conclusions and recommendations.

j) Proposed design interventions.

One of the most critical aspect of any research exploration is to clearly define the research problem. Without a research problem, the research activities remain meaningless and would not be focusing on the research objectives, research questions and hence the research outcomes will fail to deliver any logical outline for future or current situation explored. Formulation of a research problem aimed to resolve what the research exploration is all about and how it would contribute to the betterment of the research area if completed successfully. Based on the explored review of literature it was evident that Out patient Department (OPD) is one of the most critical component of the hospital or healthcare facilities. It welcomes patients with diverse departments and medical teams who require specialized consultation related to their medical conditions and treatment requirements. Apart from emergency & accident department, OPD is one of the most openly and extensively visited department with specialized medical teams serving under their specialty to help manage the disease, help diagnose the disease and later opt for its treatment. Hence patients are always openly accessing these areas and their interaction with medical facilities, medical teams and their spaces is vital towards managing the diseases and treatment of the sick people.

Environmental variables have a strong role to play in these areas and spaces. These variables invariably impact the users in these spaces. Either be patients, attendants, children with people visiting these spaces, medical doctors, paramedic staff, support staff, administration, etc are all in these spaces interacting with environment. These variables like temperature, humidity, cross ventilation, natural light, fresh air, noise, artificial lighting, furniture, comfort level, cleanliness, accessibility, etc have a strong impact on the user behavior and their acceptance of the space as well as user satisfaction. If end users were not satisfied with these variables, both ends i.e. medical teams and patients side, suffer and hence one cannot perform their duties well which leads to poor job satisfaction while the people seeking medical attention and treatment will also go through issues of lack of facilitation and improper treatment due to lack of proper spaces with insufficient human comfort conditions. Hence environmental

variables observation and exploration was one of the key principles towards ensuring people satisfaction with the provided services and their ample usage towards their functional optimum usage as well.

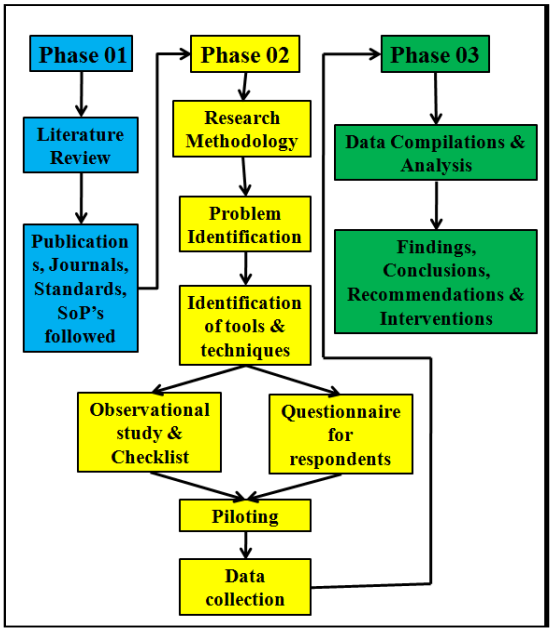


Figure 04 Major research steps and phases

As shown above, research exploration was carried out the shared phases and steps. Research populations of the research exploration mainly included the people using the OPD facility in the DHQ Teaching Hospital, Sahiwal city. Such a population is so large that a true population based data completion and collection in its true sense cannot be completed within the stipulated resources and timeline of the academic research. Hence it was opted to go for a sample selection which can be a true representation of the population at large. Sample mainly consisted of 80 respondents with 60 as the end users availing the facility in the form of patients, visitors and attendants. 20 respondents were from the service provision side i.e. medical and allied teams consisting of doctors, nurses, paramedic staff, support staff and administration. On a whole the OPD facility looked after 250 to 300 patients in a week in the selected DHQ Teaching Hospital, Sahiwal city. The data was collected on multiple days and true representation from all major end users were ensured. In order to carry out the research within the time and costing constraints, purposive sampling method was used to access the most immediate associated people engaged with utilization of OPD facility and those who were willing to participate were mainly contacted and with permission data was collected.

DATA COLLECTION & ANALYSIS

Observational studied followed by data collection got initiated with help of a developed tool for observational study through review of literature focusing on the key environmental variables to be explored. Later it helped in developing a questionnaire based on the same observational study. In order to carry out with facility documentation, AutoCAD and measuring tools were used to help develop existing facility Architectural plans as well as photography was done. Data was collected in both seasons i.e. Summer and Winter for an extensive data analysis. Timeline followed for the research exploration is shared below in table 01.

Table 01 Time of Data collection & Observational Study

S.No	Activity	Tools used	Time Duration
01	Site documentation	Photography, measuring tools, AutoCAD for developing architectural plans.	May, 2021 (10 days) December, 2021 (14 Days)
02	Observational study & Respondents data collection	Checklist & Questionnaire	May, 2021 (14 days) December, 2021 (14 Days)
03	Observational study & Respondents data collection	Checklist & Questionnaire	May, 2021 (14 days) December, 2021 (14 Days)
04	Data Compilation	MS Excel	January, 2022

OBSERVATIONAL STUDY:

Researcher initiated the site documentation through photography along with taking measurements of the existing facility and developing its architectural plans. These took almost 10 days to ensure the directions given were followed with ample visits to complete the assigned task. The architectural plans of the departments is shown below in figure 05:

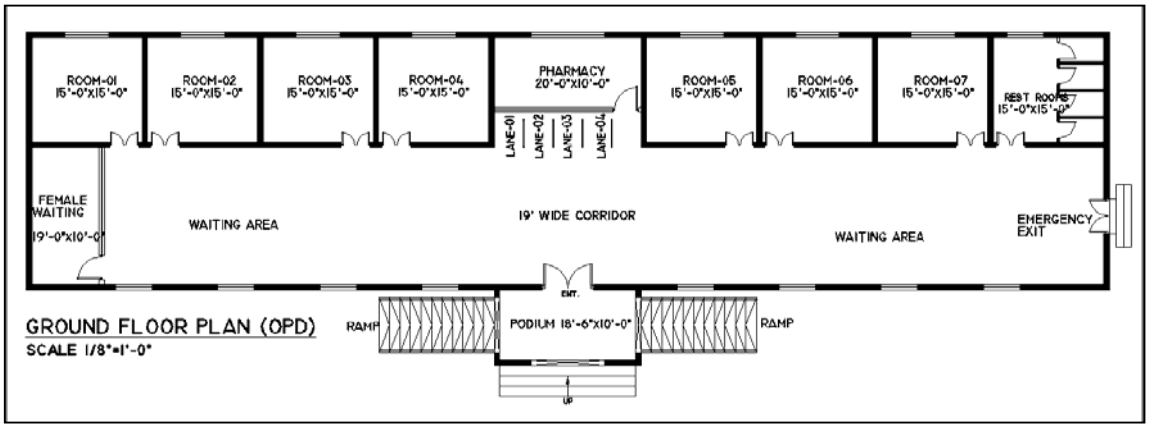


Figure 05 Architectural Plan of OPD facility

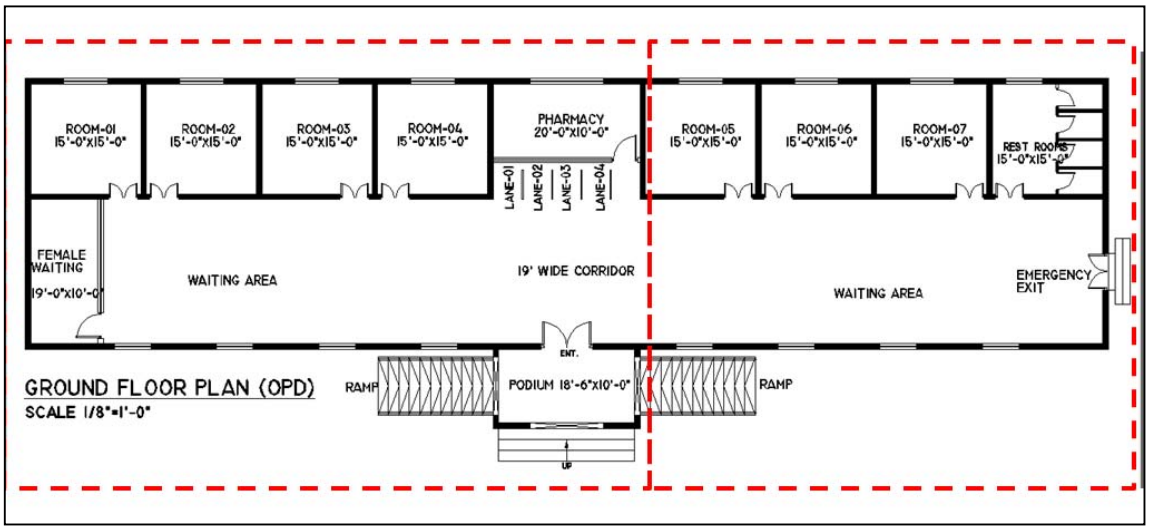


Figure 06 Architectural Plan of OPD facility with Blowup marking

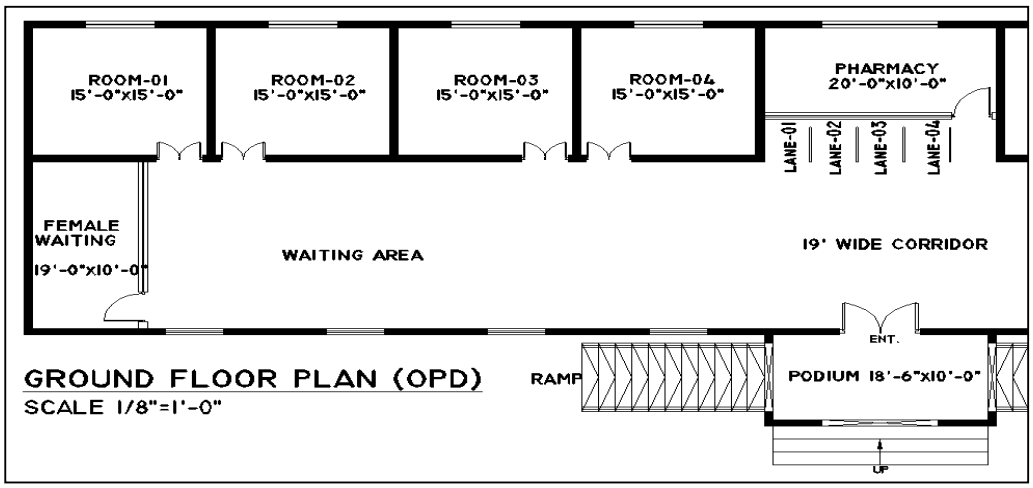


Figure 07 Left wing of OPD facility – Blow up architectural plan

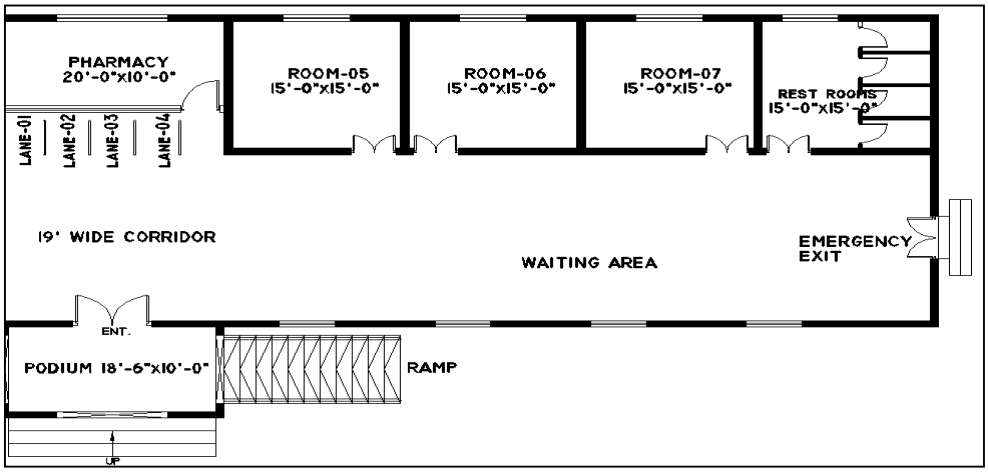


Figure 08 Right wing of OPD facility – Blow up architectural plan

As shown above in the figure 05 – 08, the overall OPD facility constitutes of 07 main OPD rooms as consultants rooms with spatial sizes of 15 feet by 15 feet. The central corridor was of 19 feet depth and the width was 136 feet long. On the left wing of the OPD facility, there was a separate waiting room for females while the overall corridor was mainly used by both genders. The main entrance of the OPD was facilitated by ramps on both sides and on the end of the right wing from the main entrance, an emergency exit was also available. The four rest rooms were provided on the right wing end. Four central bays were created in front of the entrance from where the pharmacy was accessed and patients were able to collect their prescripted medicines. The overall location of the OPD facility in the overall hospital complex is shown below in figure 09:

Figure 09 Location of OPD facility in the DHQ complex, Sahiwal city Punjab (Google Earth Maps, 2021)

Figure 10 Blow up plan of Google Earth location map of OPD facility in the DHQ complex, Sahiwal city (Google Earth Maps, 2021)

The documentation through photographs and figures are shown below:

Figure 11 Main entrance of the DHQ medical complex Sahiwal city

Figure 12 Main entrance of the OPD at DHQ medical complex Sahiwal city

As shown above in the figure 09-12, the overall location of the OPD is shown in the DHQ complex and the main entrance of the hospital as well as the OPD department is shown above in the figures respectively. From the location map, it is evident that the current location is not readily closed to the main entrance of the hospital and is around 400 feet away from the main entrance as well as the main central parking for all the visitors, staff and patients / attendants.

Figure 13 Main pharmacy in front of OPD entrance

As evident from figure 13, there are four bays created for the people to receive the medication from the pharmacy as per prescribed by the physicians after consultation. It was a better plan to keep it in front of the main door so that those who come from outside and only have to get medicines do not have to get in to the main OPD hustle with patients and attendants. It was also a good choice so that people after getting medication may leave right away back without getting in the public again. However with reference to the environmental and cultural perspective, bays were not segregated on gender basis, there was no cross ventilation and natural light provisions and people had to wait in long queue and create issues of infecting other people while in the bays.

Figure 14 Left side / Eastern indoor space of OPD

As shown above in the figure 14, Eastern wing of the OPD is visible. It is evident that even at the later half of the day there was high influx. People were not following the COVID-19 SoP's (Standard Operating Procedures) and were having trouble getting there turn. It was also evident from the picture that OPD reception / counter for getting patients / attendants slips for better managing the operations were kept inside of the OPD consultant room and as a result have created issues for the people outside. They have to stand up in long queue and have to wait before finally their turn comes up. Here it was observed a lot of mismanagement was happening and hence it crated issues for the operational side as well as for the patients and attendants. The space was highly occupied and got very congested during the observational study as well as during the data collection phase.

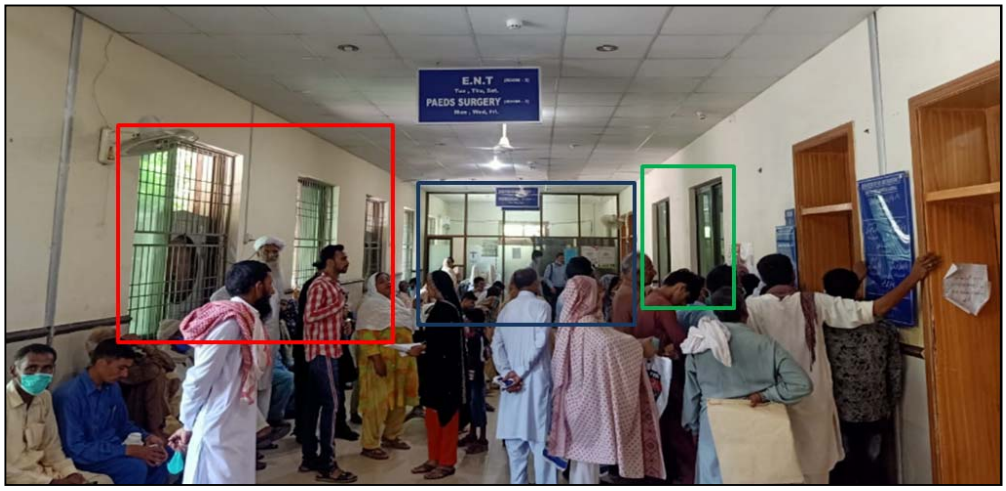


Figure 15 Left side / Eastern indoor space of OPD analysis rectangles

As shown above in the figure 15, three rectangles identify some of the most crucial issues observed. As evident in the red rectangle, there were two local desert coolers (Lahori coolers) installed to facilitate the people with only one wall bracket fan. The ceiling fans installed were used but were not facilitating the people in the long queue. The space was highly congested and was having issues of cross ventilation and very uncomfortable environment due to higher humidity. Though outside of the building humidity was not that high. With the number of windows installed on the wall, it was evident still they needed more natural light and in order to keep it working they have to turn on the artificial lights even during the day hours.

As shown in blue rectangle, there was a separate space provided for female patients at the end side which did helped the gynecology and obstetrics patients but it was seen there was no properly exhaust provided and it had only one ceiling fan which made it a very difficult space to occupy. Patients and attendants got highly congested and even some of the patients during observational study was observed to came out in the main hall as it got highly occupied and was not able to easily breathe inside. Another issue was from the operational side that even some sales representative were always there and no specific time slot was provided to them and hence crated issue of privacy for the patients as well. As observable from the green rectangle, there were some windows provided to facilitate the patients with specific needs related to managing the patient turns and getting them lined up but these were not used and only doors were opened when they have to take the patients inside.

Figure 16 Right side / Western indoor space of OPD

As shown above in the figure 16, the Western wing is shown. Here the situation was similar to the Eastern wing but more issues were evidently visible. No desert coolers were installed, dependence on natural lighting was even more higher, seating was created on both sides of hall, the main emergency exit now has another operational office in front of it and hence overall emergency exit was close for people in the main hall. This space acted as a point for the OPD patients to get the Dental consultation clips but had impacted the overall flow of the patients in the hall. As evident, the moment influx was lower at the later half of the day. During the early half, photography was not allowed but influx was very high and faced issues of higher congestion, humidity and temperature control, seating availability and poor working conditions for service provision end as well as availing end.

Figure 17 Two sided seating for patients next to OPD clinics

As shown above, the surgical OPD clinics and gynecology clinics next to separate waiting of female side gets congested and people have to move outside to common sitting creating segregation issues along with managing indoor space cleanliness and hygiene conditions.

Figure 18 Waste management conditions inside

space of OPD

As shown above in the figure 18, the three baskets kept for multiple forms of waste to manage it were not having any proper signage and hence people look into each one of these and the one which had less waste, they throw their garbage into it. Hence there was no proper segregation taking place and lead to high issues of waste management specially when no separate waste bin was designated for medical waste at all.

Figure 19 Western wing conditions inside space of OPD admin office

As evident from the figure 19, the people serving in the clinic side for registration and slip preparation and assigned tasks were bound to open the rear emergency gate through out the day to enable cross ventilation. Even the front wall was only raised till 7 feet so that air may move across the hall and four wall bracket fans along with one ceiling fan was used. Yet the conditions were not conducive at all and the people serving had sever issues towards better working conditions.

Figure 20 Too steep ramps and wrong parking at main entrance of OPD

As shown above in the figure 20, the two ramps provided were very steep as compared to the 1 feet six inches height and as a result have created issues while taking any patient on bed or wheel chair. Another issue was lack of ample landing space which created issues for such people on wheels as when there was no ample space for indoor sitting, people will come out and will block these ramps. Another aspect which was surprising for the researcher was that during some high influx timeline, even OPD functions are shifted towards and they were later used as OPD. The phenomena was usually practiced during some high influx days while patients count has raised to a higher number from an average of 350-400 to a raise level of 600 or above in one day. This situation is shown below in figure 21 & 22.

Figure 21 Temporary OPD facilitation in wards areas

Figure 22 Temporary OPD facilitation in emergency area

As shown above in figure 21 & 22, this temporary transformation / transition resulted in more complications and issues for the people specially patients and attendants. The targeted people for these spaces like surgical patients, medical patients and other critical patients requiring these core facilities did also suffered. As a result, this transition was carried out during pandemic time and also during epidemic time of dengue fever.

Based on observational study, the identified major problems within explored facilities consisted of minimum toilet facilities shared between patients and attendants alongside excessive humidity which caused thermal discomfort, accessibility issues due to inadequate resources for patients, attendants required together with absent integrated facilities, no storage options, failure to have appropriate diagnostic tools for OPD needs, high temperatures throughout the space alongside insufficient patient seating and a lack of privacy and unsatisfactory sanitary conditions. The hospital faced several additional problems because there was no HVAC system even though a false ceiling had been installed with inadequate color schemes and design choices resulting in patient and attendant discomfort.

RESPONDENTS DATA:

Data collection from respondents got initiated in May, 2021. The overall distribution of the respondents is shared below. In order to calculate the sample size for the population, following formula was used as shown below and www.calculator.net website was accessed for finite population sample size calculation:

Finite population: $$n' = \frac{n}{1 + \frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2 N}}$$

where
z is the z score
ε is the margin of error
N is the population size
p̂ is the population proportion

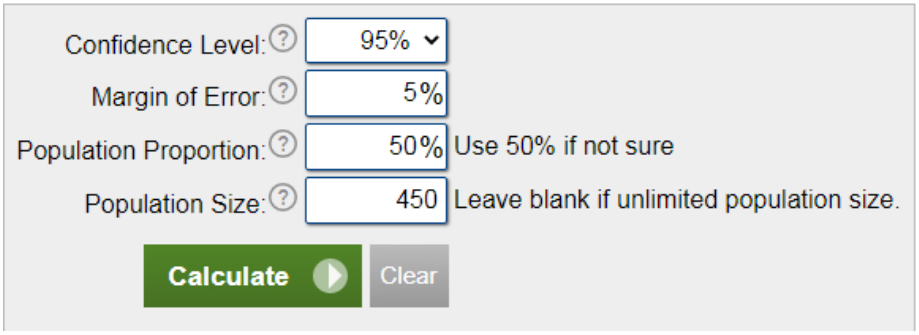
EX: Determine the sample size necessary to estimate the proportion of people shopping at a supermarket in the U.S. that identify as vegan with 95% confidence, and a margin of error of 5%. Assume a population proportion of 0.5, and unlimited population size. Remember that **z** for a 95% confidence level is 1.96. Refer to the table provided in the confidence level section for **z** scores of a range of confidence levels.

Based on the above assumption, keeping a daily based influx of average 450 patients in the OPD complex, following details were opted for:

Result

Sample size: 208

This means 208 or more measurements/surveys are needed to have a confidence level of 95% that the real value is within ±5% of the measured/surveyed value.



As a result, Confidence level was kept at 95% with margin error of 5% and population size of 450. Sample size was identifies at 208. Hence 104 sample was taken for summer and 104 was taken for winter season with multiple days of data collection including both patients and doctors side.

Table 02 Summer Respondents Data

Variables	Count	Age category	Count
Male	71	Less than 20	12
Female	33	20-30	20
Doctors	12	31-40	29
Nurses	17	41-50	31
Patients	40	51-60	9
Attendants	20	61 & above	3
Visitors	15		

Variables	Count	Age category	Count
Male	67%	Less than 20	12%
Female	32%	20-30	19%
Doctors	12%	31-40	28%
Nurses	16%	41-50	30%
Patients	38%	51-60	9%
Attendants	19%	61 & above	3%
Visitors	14%		

With a total number of 104 respondents in summer, 29 mainly were from the service provider and medical team side while 75 were from the patients, attendants or service seeker

side. With an average influx of 450 patients, sample represented 23.11 % of the targeted based population true representation with 67% male and 33% female along with 28% sample between the age group of 41-50 followed by 30% from 31-40 age group as shared above in the table 02. Respondents data graphical representation is shown below in figure 23.

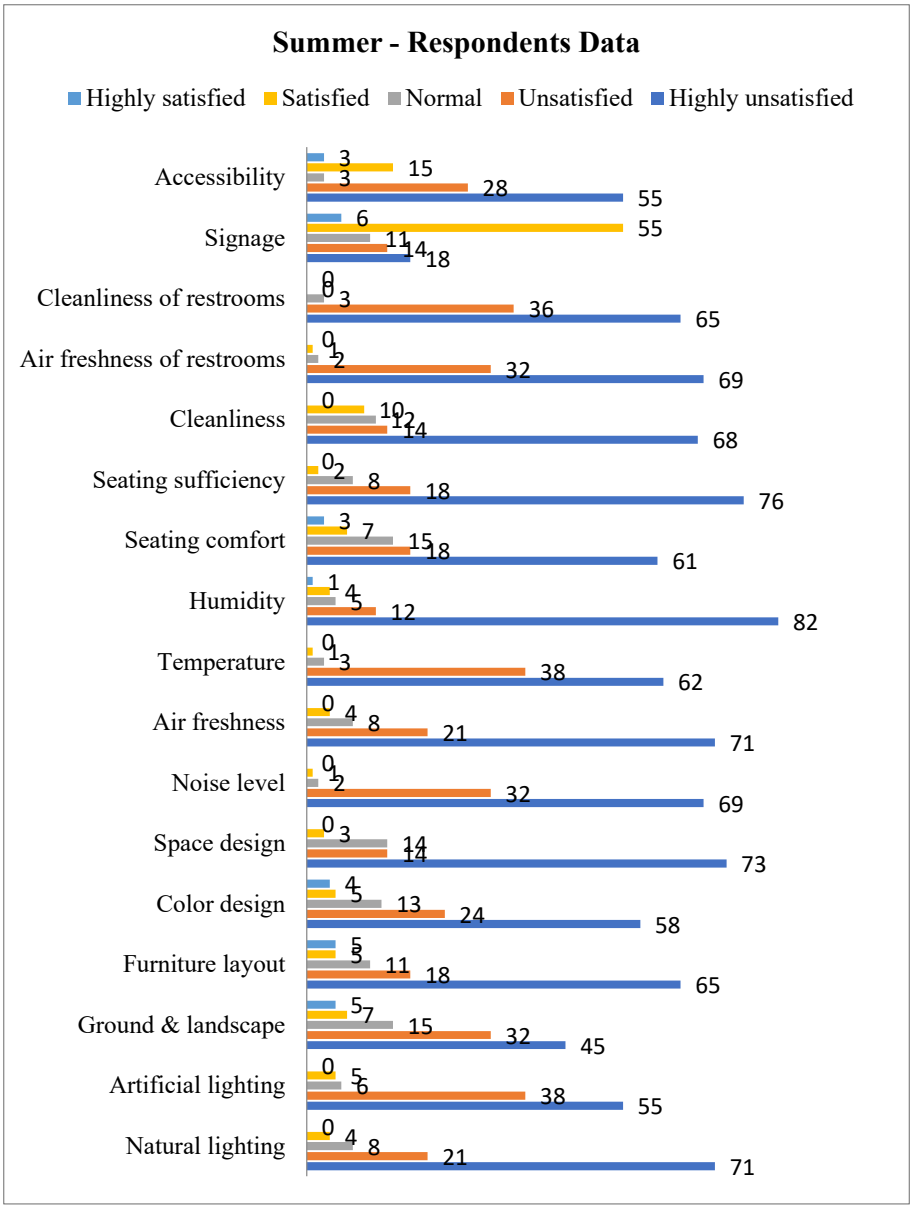


Figure 23 Respondents Data – Summer Season

The data indicates that most variables position within the highly unsatisfactory category. The researcher shared these environmental aspects with survey respondents who demonstrated significant dissatisfaction along with multiple obstacles affecting the specified variables. The rural visitors valued both emergency medical services outside their villages and thanked healthcare teams while more regular users witnessed unmet needs in facilities that required attention.

Table 03 Winter Respondents Data

Variables	Count	Age category	Count
Male	75	Less than 20	10
Female	29	20-30	18
Doctors	10	31-40	36
Nurses	15	41-50	29
Patients	47	51-60	10
Attendants	18	61 & above	1
Visitors	14		

Variables	Count	Age category	Count
Male	72%	Less than 20	10%
Female	28%	20-30	17%
Doctors	10%	31-40	35%
Nurses	14%	41-50	28%
Patients	45%	51-60	10%
Attendants	17%	61 & above	1%
Visitors	13%		

With respect to winter season respondents data, male representation was 72% while that of females was 28%. Major chunk of the respondents belonged to patients category with 45% (47 patients out of 104 sample). Major age representation was from 31-40 age group i.e. 35%.

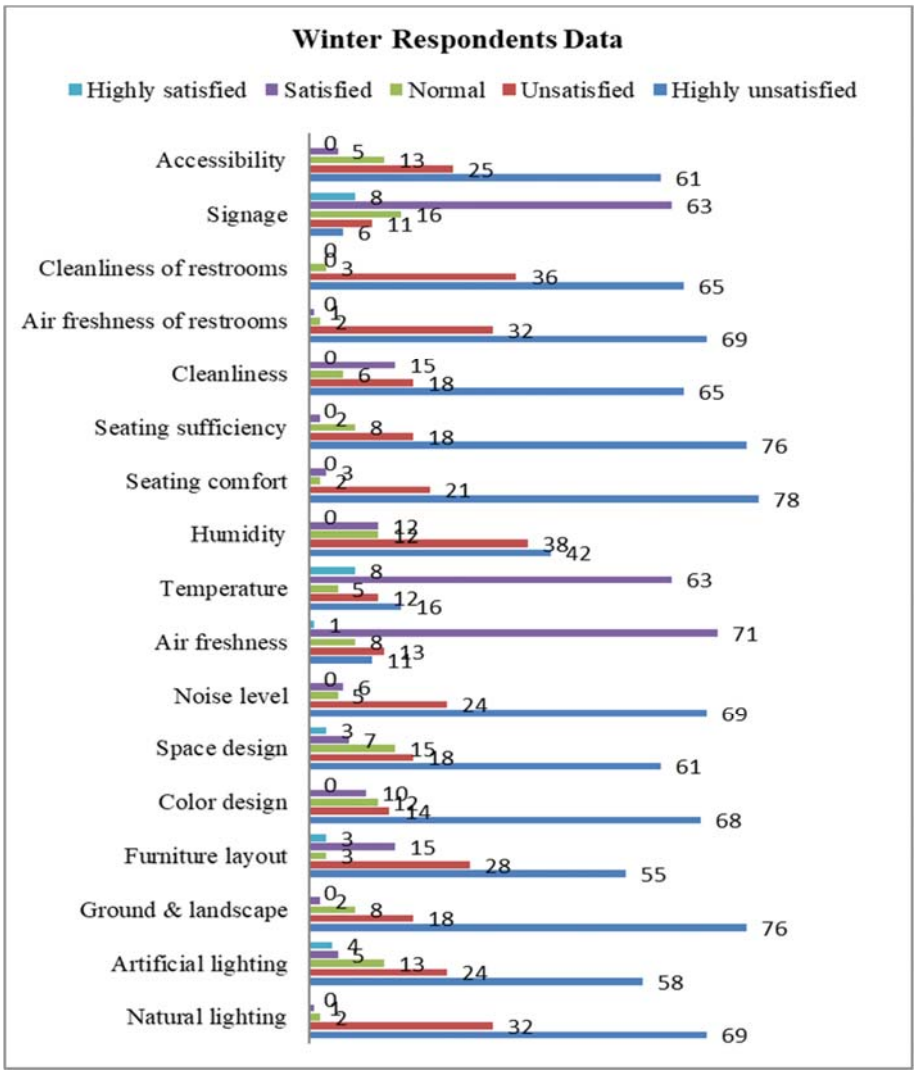


Figure 24 Winter Respondents Data

The monthly patient numbers during Winter months in December 2021 exceeded Summer numbers based on respondent data. OPD patients mostly remained dissatisfied or highly dissatisfied with artificial lighting, landscape, coloring, space design, noise level, seating sufficiency, cleanliness, furniture layout, humidity, seating comfort and accessibility. Air freshness and temperature alongside signage rate as satisfactory factors in patient satisfaction. Observational data collected by the researcher matched with summer findings but the data collection during winter season produced varied results. The results indicate seasonal variation in the explored variables because Sahiwal city maintains moderate conditions during the winter period. Hence averages for both seasons were taken and compared as shown below in Table

04. Average was taken using the following stated formula:

A. Highly Unsatisfied =1

B. Unsatisfied = 2

C. Normal = 3

D. Satisfied = 4

E. Highly Satisfied = 5

Formula = ((A*1)+(B*2)+(C*3)+(D*4)+(E*5))/N

Table 04 Respondents data comparison for both seasons - Averages

S.No	Variables	Summer Average	Winter Average
1	Natural lighting	30.6	28.6
2	Artificial lighting	33.8	37
3	Ground & landscape	41.4	28.8
4	Furniture layout	35.8	39
5	Color design	37	34.4
6	Space design	31	37
7	Noise level	28.6	31.2
8	Air freshness	30.6	70
9	Temperature	30.2	69.4
10	Humidity	28.4	40.4
11	Seating comfort	37	27.6
12	Seating sufficiency	28.8	28.8
13	Cleanliness	34.4	35.8
14	Air freshness of restrooms	28.6	28.6
15	Cleanliness of restrooms	29.2	29.2
16	Signage	65.8	73.6
17	Accessibility	39	34

The data shown above in table 04 show better performance of the explored environmental variables in Winter as compared to Summer season. The same is shown graphically below in figure 25:

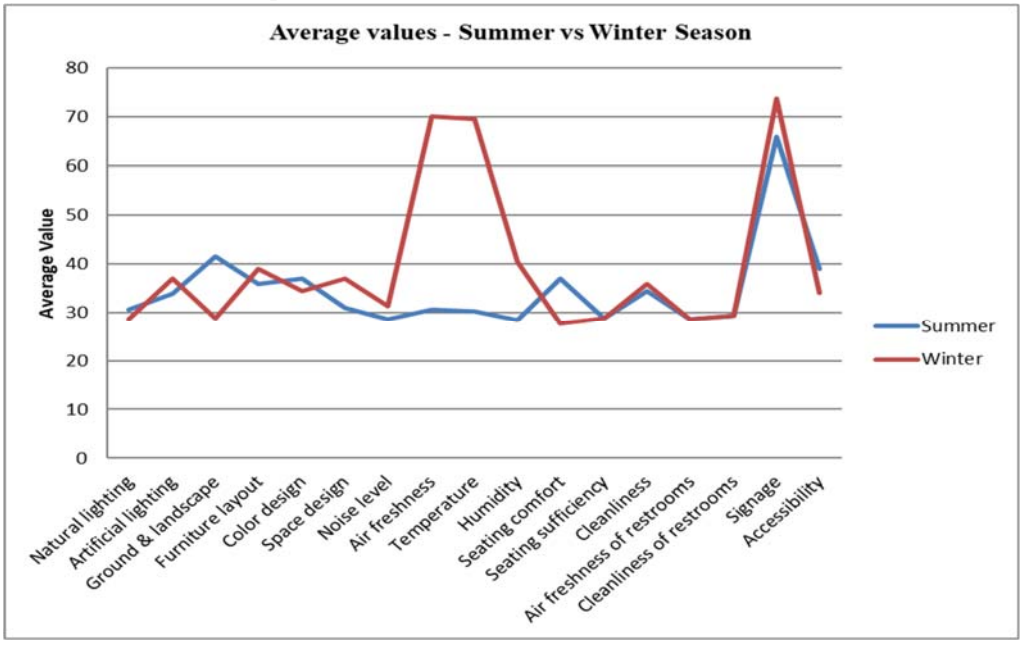


Figure 25 Comparison of averages between Summer and Winter

As shown above in figure 25, the overall environmental performance in Winter was better as compared to Summer. In almost every explored aspect Winter had better performance except for Noise level, Seating sufficiency and accessibility. It was also observed during both the data collection phases that there was more influx of patients in Winter as compared to Summer. Hence analysis shows that the observed issues during documentation and observational study highlighted the weak performance environmental parameters correlated with summer data and few exceptions did occur during the winter data collection as season change and higher influx of patient had a different impact on the building performance. Here the overall spatial usage increased with respect to available space per person and hence saturation was prevalent across the OPD hours. With respect to service providers separate opinion about the overall spatial environmental variables satisfaction level, the data is shared below in table 05.

Table 05 Service Providers Data

S.No	Service Providers (Doctors, Nurses & paramedics = 29)	Highly unsatisfied	Unsatisfied	Normal	Satisfied	Highly satisfied
1	Natural lighting	15	6	2	6	0
2	Artificial lighting	17	8	3	1	0
3	Ground & landscape	12	12	5	0	0
4	Furniture layout	11	12	4	2	0
5	Color design	8	6	15	0	0
6	Space design	12	14	2	1	0
7	Noise level	17	6	6	0	0
8	Air freshness	9	7	6	6	1
9	Temperature	18	7	4	0	0
10	Humidity	21	5	3	0	0
11	Seating comfort	9	6	4	10	0
12	Seating sufficiency	18	8	3	0	0
13	Cleanliness	22	5	2	0	0
14	Air freshness of restrooms	21	6	2	0	0
15	Cleanliness of restrooms	8	12	7	2	0
16	Signage	2	4	5	18	0
17	Accessibility	11	0	14	4	1

As shown above in the table 05, the overall data mainly falls in to the unsatisfactory and highly unsatisfactory domain in most of the explored aspects except for accessibility, signage and seating comfort. These differences exist as the service providers were given better furniture, more space and have better deployment for space utilization as compared to service seekers and allied.

DISCUSSION

The OPD hours welcomed every arriving patient with multiple attendants at their side. The patients were most often left at the gate of main OPD by their transport vehicle. The existing entrance pathway was insufficient to handle large morning crowds thus causing problems for patients accessing it through the ramp. According to Sharjeel et al., 2016 the entrance stage brought detrimental effects to the overall

accessibility of the OPD facility.

Patients need to pass through reception counter which locates in the Western wing section before continuing to their checkup process. After waiting outside the main clinic patients need to stand in queue until the OPD clinic nurse calls them for consultation with the physician or consultant. According to Hussain et al., 2019 the medical observation and treatment facilities provided all necessary functional requirements. The medical procedure completed as prescribed but the desired physical and environmental situations failed to support visitors, patients and care givers.

The patient can be transferred to another department at Emergency or IPD units or will be directed to Diagnostics before going to Radiology or given another appointment at OPD. Due to the fact that different days have diverse OPD clinics, the allocation of spaces shifted between typologies until each treatment area obtained its designated standard allotment. The duration required for this procedure varies from 30 minutes to 2 hours mainly because of patient demand and consultant staffing availability. Several difficulties arose when Emergency and Surgery departments and IPD repeatedly contacted OPD consultants to deal with complex medical situations thus prolonging OPD patient waiting time during the observational phase. The availability of OPD clinicians depended on their involvement with other departments after being summoned by the protocol mentioned by Jameel et al., 2019.

The building maintained internal temperatures 4-7 Centigrade lower than normal during Summer collection. The extended distance between main gate and main OPD entrance at 400 feet caused difficulties for patients and their escorts due to COVID19 spread restrictions. Patients faced access problems due to the steep ramp at the entrance of OPD after reaching the site. Dependent patients need to search for assistance during their visit. Patients faced the most difficult challenge when seeking empty seats while waiting to use the restrooms during winter period when queues exceeded fifteen minutes. The access difficulties affected all hospital visitors from patients to attendants and visitors.

Both patients' waiting area along with consultant rooms offer inadequate natural and ambient lighting conditions. The lighting in artificial areas of waiting areas combined with corridor spaces offered less illumination than the clinics and office sections. The integral design component of any OPD that includes outdoor space and landscape has received total neglect leading to poor management throughout both facilities. The clinic and patient seating arrangements suited their functions but did not follow planning guidelines for managing patient amounts. The end users from both groups displayed dissatisfaction because of excessive noise levels and unappealing decorations and inadequate spatial planning. Both doctor team members and patient sides felt dissatisfied with the limited comfort and poor air conditions through open doors and windows in the summer months. Insufficient waiting space in OPD forces patients to stand while the previous individuals either receive medical attention or free up their seats for newer patients with critical needs. The major environmental variables failed to meet the satisfaction requirements of doctors team members and patients as reviewed through Samah et al., 2020, Nadeem et al., 2021 and Zhao & Mourshed, 2017.

The deficiency of sufficient toilets combined with storage areas and dirty and clean linen racks and associated facility rooms presented major obstacles to all users including medical staff in the OPD facility. The steep ramp proved challenging for orthopedic patients as well as patients who were gynecology patients and those who needed help from the senior group. Signs proved beneficial for all users of the health facility.

The weather conditions in addition to indoor conditions of the winter season provided an improved environment compared to the summer season. A higher number of patients became the primary observed change. An increased number of patients generated additional operational hurdles for both staff members and the building structure. Less daylight availability in winter led to heavy usage of artificial lighting systems which performed poorly because of limited

usable space and increased patient numbers during that season. The landscape together with outdoor elements showed no variance throughout this period. Temperature and air freshens improved after specialized staff closed all doors and windows to warm up internal rooms and spaces. The averages for all accessibility and cleanliness measures in addition to rest rooms and storage facilities and noise level and space design and color design stayed the same but improved slightly. According to Samah et al., 2013 the design required fundamental adjustments because of the problems reported.

The process of utilizing interior spaces depends heavily on how the service provider selects interior colors. When spaces use dark color schemes the serving personnel experiences congestion which leads to reduced mood and diminished performance. The main corridor features light colors which creates an open atmosphere but the doctors, nurses and paramedics serving in the OPD clinics with their limited ventilation complain of fatigue that affects their performance during eight-hour shifts. Their work performance levels decrease because of this condition.

The created respondent categories enabled the researcher to understand the specific needs and functional needs of those participants. Multiple nurses and medical team members confirmed that these environmental issues have persisted since construction of the building while creating obstacles for top-quality work due to inadequate indoor environment standards. The OPD clinics would deliver their best services with improvements made in lighting design and accessibility and thermal comfort combined with more rest area facilities and space segregation. Better acceptance of OPD services and improved quality of patient care depended on patient-related critical factors such as accessibility and rest room availability and seating capacity and thermal comfort. The attendants placed significant value on seating areas and outdoor seating under protection together with accessible ramps and appropriate parking facilities with waiting spaces.

FINDINGS

Through a methodology that combined literature review with site investigation the research conducted all major stages such as observational studies as well as data collection and digital analysis. The research discoveries showed essential deficiencies in the OPD facility involving uncomfortable climate conditions and insufficient space and diagnostics as well as inadequate design which demonstrated non-compliance with user requirements. The documentation process of the OPD facility revealed overcrowding and lacking toilets and poor ventilation and lacking heating ventilation air conditioning systems on specialty days. The second assessment objective revealed user dissatisfaction throughout all environmental factors yet detected positive satisfaction with indoor signage. Data collection in summer and winter seasons involving 104 respondents demonstrated that poor air quality along with excessive noise levels, high humidity and insufficient seating continued throughout the studied seasons. The proposal included solar-powered heating ventilation and air conditioning units along with expanded clinic and diagnostic space verification combined with new ramps together with prefabricated structures for better facility performance and operation.

CONCLUSIONS

The research findings demonstrated insufficient space allocation between patient care zones and area distribution for attendants and visitors within the OPD facility design which prevented the fulfillment of social and environmental requirements. The facility designers overlooked weather circumstances resulting in inadequate thermal comfort despite having desert cooling systems installed. People showed a strong level of dissatisfaction with the facilities during summer and winter periods because essential environmental requirements and functional elements were not handled appropriately. There were insufficient waiting spaces for attendants and visitors while privacy needs received no attention from the design planners. The medical care services took priority at the facility leading to expansion needs due to the absence of consideration for long-term usability and public

needs. Health risks from COVID-19 transmission worsened because poor ventilation led to several environmental issues like inadequate natural light and noise, along with poor air quality and high temperature and humidity along with poor cleanliness. Environmental design solutions must be implemented in open spaces and corridors and passages to achieve necessary improvements.

RECOMMENDATIONS

The research demonstrates that both improved cross-ventilation and renewable energy-powered HVAC systems should be deployed to enhance ventilation in entranceways and seating and corridors. Patients and visitors and attendants need sufficient seating arrangements and space buffers for effective management throughout the facility. The development of more OPD clinics and better patient access combined with advanced artificial lighting systems and colorful interior decoration using design elements remain essential for improvement. The operational improvements focus on placing nursing stations and reception counters close to entrances while adding more exits and building additional toilet facilities throughout the facility. Solar power systems should be utilized for better building lighting and Heating Ventilation and Air Conditioning control systems. All upcoming facility expansions require design elements which match the current building framework for successful development and functionality.

PROPOSED DESIGN INTERVENTIONS

Following were the major design interventions proposed:

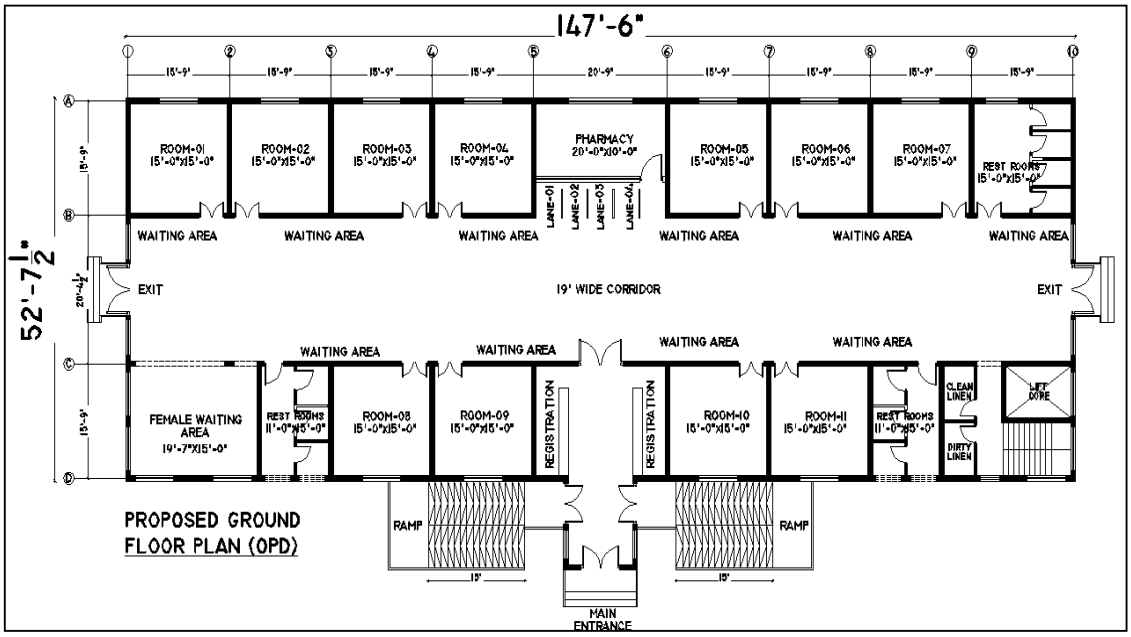


Figure 26 Proposed OPD future extension plan

As shown above in the figure 26, a whole revised proposed plan for OPD facility is proposed. It added four OPD clinics, two sets of toilets, clean and dirty linen, staircase with lift for first floor accessibility, ramps get revamped with design improvement, reception and counter desks have been added, spate waiting areas for women has been set forth and two exist have been proposed so that one way direction may facilitate the patients, staff and visitors movement. Blow up details of each added facility is shown below:

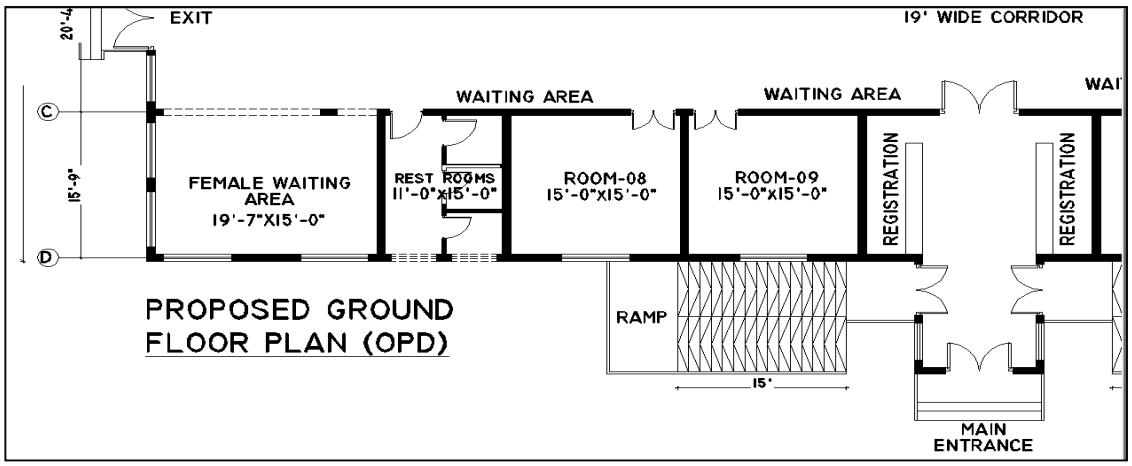


Figure 27 Proposed Left wing extension and facilities added.

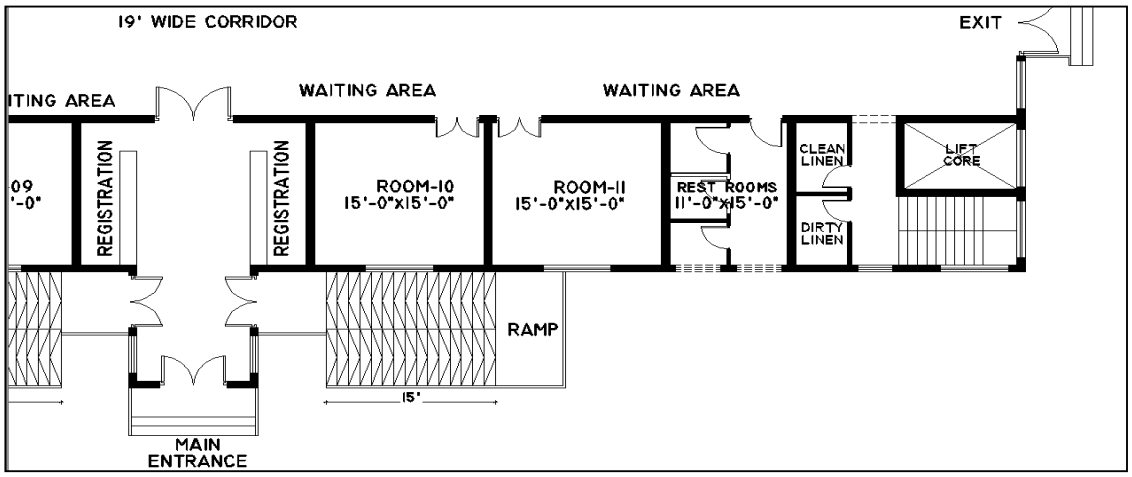


Figure 28 Proposed Right wing extension and facilities added.

As shown above, the new right and left wing can facilitate higher influx and can also be helpful in vertical expansion of the facility.

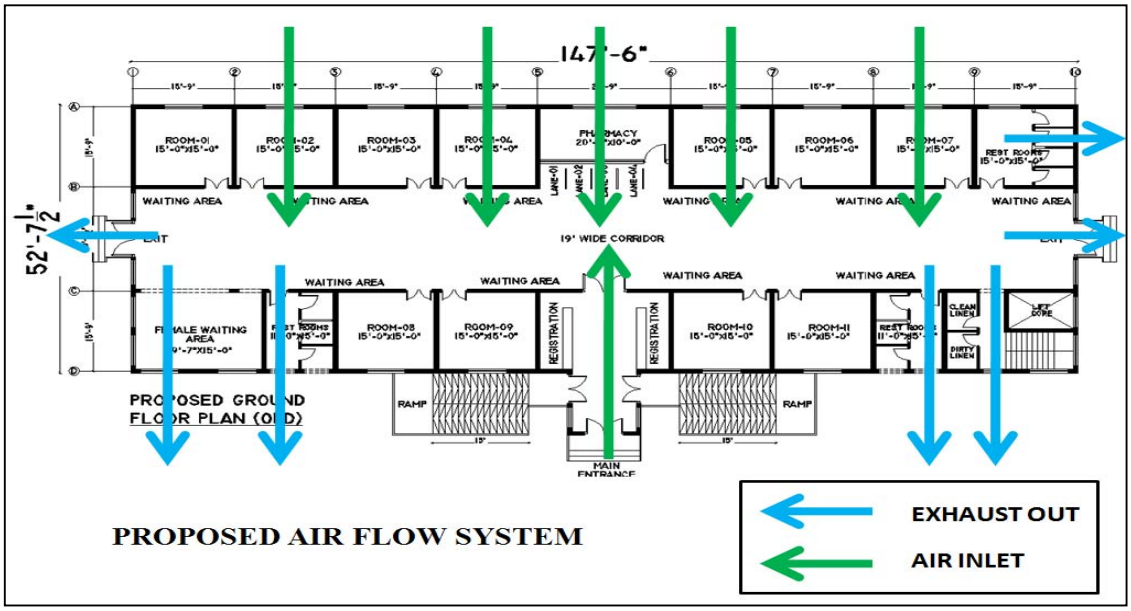


Figure 29 Proposed Air Flow System using HVAC

As shown above in figure 29, proposed air flow system using multiple ducts through forced ventilation in the false ceiling could help manage the indoor air quality as well as thermal comfort management in the OPD extension. As per shown above expansion plan, the overall grey structure anticipated cost @ Rs.4500 /Sft / floor will confine a basic budget of Rs. 16,537,500/- as per the added area of 3675 Sft (Added covered area on ground floor = 25 ‘ x 147’).

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