ARCHITECTURE

ARCHITEKTURA

TEKA KOMISJI URBANISTYKI I ARCHITEKTURY
O/PAN W KRAKOWIE
URBANISM AND ARCHITECTURE FILES
OF THE POLISH ACADEMY OF SCIENCES
KRAKÓW BRANCH
TOM LI/2023 PL e-ISSN 2450-0038
pp. 339–357 PL ISSN 0079-3450
DOI: https://doi.org/10.24425/tkuia.2023.148982

WALEED BEN SAEED
MArch
King Abdulaziz University
Faculty of Architecture and Planning
Department of Architecture
e-mail: wfutainimousa@stu.kau.edu.sa
ORCID: https://orcid.org/0009-0004-3941-1816

AYAD ALMAIMANI
PhD, Assistant Professor
King Abdulaziz University
Faculty of Architecture and Planning
Department of Architecture
e-mail: ealmaimani@kau.edu.sa
ORCID: https://orcid.org/0000-0002-3251-4511

YASSER ADAS
PhD, Assistant Professor
King Abdulaziz University
Faculty of Architecture and Planning
Department of Architecture
e-mail: yads@kau.edu.sa
ORCID: https://orcid.org/0000-0002-7098-8232

USING DIGITAL TOOLS TO IMPROVE OPERATIONAL PROCESSES IN THE ARCHITECTURAL SPACES OF A HOSPITAL'S OUTPATIENT DEPARTMENT

WYKORZYSTANIE NARZĘDZI CYFROWYCH DO ULEPSZENIA PROCESÓW OPERACYJNYCH W PRZESTRZENIACH ARCHITEKTONICZNYCH POLIKLINIKI SZPITALNEJ

ABSTRACT

Congestion is a significant problem affecting the operational processes of a hospital's outpatient department (OPD). Congestion especially affects the OPD's architectural space, due to the increased number of patients. Recently, digital tools have been used in healthcare systems to reduce congestion and help the OPD improve its operational processes; one of these tools is the virtual examination room. However, patients still need to be examined by physicians in the OPD, and digital tools alone cannot solve all the problems that congestion creates. The authors of this paper conducted a study that offers a new way to alleviate congestion in the OPD by combining physical and digital solutions to increase OPD efficiency and optimize its operational processes. The study created an alternative operational plan that adds virtual examination rooms to reduce congestion. This plan allows the OPD to increase the number of physical and virtual examination rooms by almost 110% and increase the number physically and virtually examined patients by 153% each day. The plan also redesigns some architectural spaces at the OPD to enhance the environment and match the hospital's requirement for authorized bodies.

Keywords: digitalization, architectural spaces, virtual examination room, outpatient department (OPD), operational plan, efficiency, virtual clinic

STRESZCZENIE

Przestoje są poważnym problemem, który dotyczy procesów operacyjnych poliklinik szpitalnych (PS). Dotyczy on zwłaszcza przestrzeni architektonicznych PS, z uwagi na zwiększoną ilość pacjentów. W ostatnim czasie użyto narzędzi cyfrowych w systemach opieki zdrowotnej, aby zmniejszyć przestoje i ułatwić polepszanie procesów operacyjnych w PS; jednym z takich narzędzi jest wirtualny pokój badań. Niemniej jednak pacjenci wciąż muszą być przebadani przez lekarzy w PS i narzędzia cyfrowe same w sobie nie rozwiążą wszystkich

problemów, które powodują przestoje. Autorzy niniejszego artykułu przeprowadzili badanie, które oferuje nowy sposób złagodzenia przestojów w PS poprzez połączenie fizycznych i cyfrowych rozwiązań, które zwiększają sprawność PS i optymalizują procesy operacyjne. Zaproponowano alternatywny plan operacyjny, który dodaje wirtualne pokoje badań celem zmniejszenia przestojów. Plan ten pozwala PS na zwiększenie ilości fizycznych i wirtualnych pokojów badań o niemal 110% oraz na zwiększenie dziennej ilości przebadanych fizycznie i wirtualnie pacjentów o 153%. Plan przewiduje przeprojektowanie wnętrz architektonicznych PS, aby polepszyć środowisko i dostosować szpital do wymogów autoryzowanych instytucji.

Słowa kluczowe: cyfryzacja, przestrzenie architektoniczne, wirtualny pokój badań, poliklinika szpitalna (PS), plan operacyjny, sprawność, wirtualna klinika

1. INTRODUCTION

Defects in how a hospital's outpatient department (OPD) is organized can lead to inefficient processes that decrease patient satisfaction. These defects may arise from equipment, workforce, logistics, or the OPD's organization itself, hampering its overall process and affecting patient care delivery (Pandit, Kulkarni and Kamthe's, 2016).

One of the most challenging issues in the OPD is managing congestion. Several studies have been published about OPD congestion. According to one study, when the number of servers at a clinic falls below a certain threshold, the clinic develops an infinite queue, but when the number of servers exceeds that threshold, waiting times and queues are reduced. Even so, reducing OPD patient congestion and waiting time remains a complex problem for hospital administrators (Javed, 2015).

The consequences of excessive waiting time are clear: patients lose valuable time, hospitals lose patients, and staff experience tension and stress (Biya et al., 2022). In response to OPD congestion, patient flow analysis has become essential for enabling better patient outcomes (Rema and Sikdar, 2021).

In addition to congestion, healthcare systems face many challenges, ranging from demographics to multi-morbidities, all of which contribute to the increasing demand for services. New digital technologies can help solve these problems, but the successful digitalization of healthcare will require the right combination of technologies, integrated work processes, and skilled professionals (Lapão, 2018). Besides technological intervention, a quantitative approach to managing patient queues will improve operational efficiency (Rema and Sikdar, 2021).

Drawing upon a study that the authors conducted about the OPD at the King Abdulaziz University Hospital (KAUH) in Saudi Arabia, this paper analyses data, taken from the KAUH OPD's current operational plan, about the number of patients at the OPD and how that number impacts the shape and function of the OPD's architectural space at the hospital. The paper explores the possibility of creating an alternative operational plan for the OPD that ideally allows it to optimize its services by combining physical and digital solutions.

This study analyses the current operational plan data about the number of OPD patients and the impact of this number on the architectural space in terms of its shape or function within the outpatient building. It explores the possibilities of creating an ideal operational plan based on physical and digital solutions that allow the hospital to realize the optimal benefits of its OPD services.

2. BACKGROUND

Despite efforts to eliminate congestion by reducing waiting times and increasing access to patient services, OPD overcrowding remains a problem that needs to be solved. The negative impact of congestion in clinics has been reported in several studies and examined from various angles (Raadabadi et al., 2017), including an ineffective appointment system, problems scheduling outpatient appointments, antiquated methods of patient follow-up, and inefficient parking (Panaviwat, Lohasiriwat and Tharmmaphornphilas, 2014; Ahmadi-Javid, Jalali and Klassen, 2017; Hunter et al., 2012; Das, 2017).

In particular, the appointment system has been studied by many researchers. An effective appointment system can improve the use of physicians and reduce patient waiting times (Lailomthong and Prichanont, 2017). Efficient parking can also make a positive impact on healthcare facilities (Das, 2017).

However, healthcare providers can also improve the efficiency of healthcare delivery by turning to technology. One of these technological innovations is virtual consultation through virtual clinics (Rutherford et al., 2020).

As a part of digitalization in the healthcare field, virtual consultation broadly refers to nonphysical communication — e.g., over the phone or through an internet video link — between a patient and their medical provider. It may also involve two or more medical practitioners in order to encourage

physicians to collaborate to achieve the best outcome for patients (Rutherford et al., 2020).

Virtual OPDs solve more than delay in the appointments or self-medication problems. Audiovisual consultations can also reduce patients' waiting times by at least 3–4 hours (Bhattacharya et al., 2020), and they are safe and cost-effective (Browne et al., 2017).

Studies have shown that virtual clinics can handle an increase in the number of patients (Tsaousis et al., 2015), and that patient care can be delivered without sacrificing quality or losing the intimacy and benefits of provider–patient relationships (Lavin et al., 2020).

Virtual clinics help reduce congestion in the OPD, help increase the opportunities for health promotion sessions, and help patients follow up with physicians after surgery, review the results of laboratories and radiology, refill medications, and follow up about chronic diseases. Virtual clinics also provide an excellent solution for patients with limited resources who cannot come to the OPD, by allowing them to follow up with their physician without leaving.

The authors' study assumed that an OPD will likely become congested if it increases the number of its patients without expanding or changing its architectural space, and that this congestion will have a negative impact on the function of that space and prevent the OPD from reaching its optimal operating capacity.

The study aimed to solve OPD congestion and increase its efficiency by creating an alternative operational plan that combines physical and digital solutions to avoid congestion and allow the OPD to reach its ideal operational capacity.

Digitalization

In general concept, digitalization is a process of transforming the entire organization's structure, processes, people skills, and culture to use digital technologies to create and offer products, services, and experiences that customers, employees, and partners find valuable (El Sawy et al., 2020).

Besides that, Digitalization is a socio-technical phenomenon that uses digital technologies and their influence on societies, businesses, and personal lives (Frenzel-Piasentin et al., 2021).

Several forms of healthcare digitalization, such as virtual consultation, remote patient monitoring, telemedicine, and other technologies, are considered parts of digitalization in the healthcare field. This paper focuses on examining the patient virtually by using a virtual examination room as a part of the solutions suggested to solve the congestion in the hospital outpatient department.

In addition, by using a virtual examination room, the researchers are seeking to reduce the waiting time in the physical examination room and eliminate waiting time for the patients who will be examined virtually.

Case study

The study was conducted in the outpatient department (OPD) building of the King Abdulaziz University Hospital (KAUH) in Jeddah, in the Kingdom of Saudi Arabia. It was an analytical and comparative study based on the data of the clinical appointments given to OPD patients from 2002 to 2021 through the Phoenix health information system used in the hospital. The study was also based on the current operational plan of the KAUH OPD.

The KAUH is one of the iconic buildings in Jeddah, on the west coast of Saudi Arabia. The first building was completed in 1396 AH / 1976 AD with 200 beds and was opened by King Fahad bin Abdulaziz when he was the crown prince. After that, during the term of King Abdullah bin Abdulaziz as crown prince in 1417 AH / 1996 AD, King Abdullah bin Abdulaziz inaugurated the new medical centre (Hospital, n.d.). With 1,067 beds and about 4,000 healthcare providers and administrators well equipped with the latest technology, the KAUH is the largest tertiary care hospital on the west coast of Saudi Arabia (Hospital, n.d.).

The KAUH building consists of two attached buildings, the main building, which consists of nine floors, and the OPD building, which consists of two floors and one annex floor for infrastructure services (Ill. 1–5).

3. METHODS

Each clinic in the KAUH has a set of services to help it run efficiently and provide adequate patient care. These services can be classified into two types, based on their location: services within the clinic itself, such as examination rooms, screening rooms, nursing stations, and clean utility stores, and services outside the clinic, such as parking, appointment counters, waiting rooms, and toilets (Ill. 6).

The KAUH's policy classifies its clinics, by their function, into two types: general and specialty clinics, four general clinics are on the ground floor of the hospital, and thirteen specialty clinics are on the first floor.

The patient's journey

After patients arrive at the parking area, they head to the clinic's reception counter, where they confirm their appointment and are directed to the waiting room. A nurse then calls on individual

patients to give them a vital signs examination in the screening room before bringing them to an examination room. Physicians use one of two methods to examine patients: they may sit in an examination room and have patients come to them, or they may visit patients by moving from one examination room to another.

Patients and physicians simultaneously occupy only three examination rooms in each clinic. The remaining 129 examination rooms mainly serve as waiting rooms until the physician enters the room where the patient is waiting, or the patient is admitted to the room where the physician is stationed. In some cases, these rooms' functions have been changed to serve as screening or equipment store rooms or as nurse rest lounges. When the physician finishes examining a patient, the patient is directed to the reception desk to complete exit procedures (Ill. 7).

The OPD works in two independent periods, which are separated by a lunch break. The first period starts at 8:00 am and ends at 12:00 pm, followed by an hour-long break; the second period then starts at 1:00 pm and ends at 4:00 pm. There are no activities in the OPD building at night. The OPD building operates seven hours a day and five days a week.

During the first period each day, 17 clinics are open; each clinic has three physicians, so 51 physicians work during this time. The second period consists of 10 clinics with three physicians each, or 30 physicians altogether. In total, 27 clinics are operated by 81 physicians every day. The OPD follows this schedule for 40 weeks a year, while the remaining eight weeks are distributed between national vacations and other non-working days.

The KAUH observes a general standard for how many physicians should be in each clinic. This standard requires one consultant and two specialists.

The researchers tracked all stations that a patient passes through when visiting the OPD. Dubbed 'the patient's journey' by the researchers, the journey stations are parking, the reception counter, the waiting room, the screening room, the waiting room again, the examination room, the reception counter again, and finally parking. The researchers also observed if congestion affects the architectural spaces in which the stations of the patient's journey are located, and they documented the congestion by taking photographs. In the observation process, the researchers noted that parking and waiting rooms are the two architectural spaces affected by congestion (Ill. 8).

4. VIRTUAL EXAMINATION ROOM, CONGESTION CONTROL AND THE PROPOSED SOLUTION

Before starting the congestion control process and explaining the proposed solution, the researchers defined the virtual examination room they suggested as part of the solution.

Virtual examination room

A standard physical examination room equipped with tools and techniques allows the physician to perform all procedures previously prepared and approved by the KAUH to communicate and examine the patient virtually.

Furthermore, it must be in a proper environment. The physician must maintain the patient's privacy, the presence of persons unauthorized as per protocol is not allowed in the virtual examination room, and the physician is to refrain from sharing any data, information, observations, notes, results, etc., with those who are not authorized to access them. The physician must deal with the patient he examines virtually in the same way he does with the patient who examines him physically, so attending to the examination room with professional clothes approved for physicians and refrains from conducting the virtual examination outside the examination room, such as home, car, or a classroom.

The researchers extracted this definition and guidelines based on revising definitions and articles related to virtual clinics, how they work, and the benefits of using them (national health service, 2021; New South Wales Ministry of Health, 2022; Health and Safety Executive, 2020; Virtual Clinic Definition, 2023).

Congestion Control and the Proposed Solution

To measure the impact that congestion has on the architectural spaces of the parking area and waiting rooms and to learn how to avoid it, the researchers analysed the OPD's current operation plan and how it currently uses the architectural spaces in its clinics.

The researchers then designed a new operational plan—the 'maximum operational plan'—to avoid congestion. This plan identifies the needs and requirements of the OPD's current architectural spaces and proposes how these spaces can be used at maximum capacity.

The researchers also designed an alternative operational plan that not only avoids congestion but increases the efficiency of the OPD by increasing the number of examination rooms in the clinic, both physically and virtually, and by increasing the number of patients that can be examined each day by the OPD.

Next, the researchers compared all three operational plans to clarify and evaluate the differences between each one. This comparison process involved two main parameters based on the observed congestion of the stations. The first parameter is the number of car parking spaces required for every physical examination room, and the second is the area (measured in m^2) of the waiting room required for every physical examination room.

The comparison of the plans also involved four other parameters that stood to be enhanced by each plan:

- the number of patients examined each day,
- the number of physical examination rooms in each clinic,
- the number of virtual examination rooms,
- the number of physical and virtual examination rooms together.

The number of car parking spaces required for every physical examination room

The OPD guidelines specify that there should be three parking spaces for every examination room (Hayward, 2018).

The area of the waiting room required for every physical examination room

To determine the total area needed for the waiting rooms, the researchers factored in five variables that relate to a patient's visit: the waiting time, the consultation time, the number of patients in the waiting room each hour, the extra space needed for disabled and patient escorts (e.g., family or friends), and some post-pandemic considerations.

All of these variables were subjected to requirements laid out in the OPD guidelines for waiting rooms: e.g., the rooms must accommodate the needs of disabled patients, and they must provide drinking water sinks for patients (UpCodes, n.d.).

Waiting time

Researchers (Enabulele, J's and Enabulele, 2018) have defined 'waiting time' as the time (measured in minutes) from the moment the patient checks in until the clinician starts the consultation (Patwardhan et al., 2012). According to the Institute of Medicine (IOM), at least 90% of patients should be seen within 30 minutes of their scheduled appointment time (Enabulele, J's and Enabulele, 2018).

Consultation time

Enabulele and associates (Enabulele, J's and Enabulele, 2018) defined 'consultation time' as the time (measured in minutes) from the start of the patient's consultation with the clinician until the end, excluding any waiting time in the examination room (Patwardhan et al., 2012). According to the British Medical Association (BMA), outpatient consultations should be approximately 15 minutes long (Enabulele, J's and Enabulele, 2018).

However, studies show that the actual waiting and consultation times differ from the recommended time (Javed, 2015; Biya et al., 2022; Enabulele et al., 2018; Wafula and Ayah, 2021).

To set a total time for the waiting and consultation process (and for the duration of the patient's journey), the researchers reviewed two studies that showed a waiting and consultation time near the recommended time. The first paper found that the average waiting time for patients is 41 minutes and the average consultation time is 18.21 minutes, resulting in a total of 59.21 minutes for the patient's journey (Ahmad, Khairatul and Farnaza, 2017). The second paper found that the average waiting time is 44.85 minutes and the average consultation time is 17.36 minutes, amounting to a total of 62.21 minutes for the patient's journey (Thapa et al., 2018).

The researchers then calculated average numbers from the two studies:

- The average waiting time in both studies is 42.92 minutes (or 13 minutes longer than the IOM's recommended time of 30 minutes).
- The average consultation time in both studies is 17.79 minutes (or nearly 3 minutes longer than the BMA's recommended time of 15 minutes).
- The average combined time in both studies is 60.71 minutes.

Accordingly, the researchers set 60 minutes as the total time for the patient's journey.

The number of patients in the waiting room each hour

If the average consultation time is 17.79 minutes, a physician can examine at least three patients each hour. And because some patients may spend less time with the physician, the researchers decided to add one more patient per hour, so the total expected number of patients in the waiting room each hour is four. This number is consistent with the OPD code that requires the clinic to accommodate the maximum number of patients (UpCodes, n.d.).

Extra space needed for disabled and patient escorts

Congestion in the OPD waiting room is caused not only by the large number of patients waiting there but also by the friends and family members who have accompanied them to the clinic. This overcrowding results in discomfort for everyone in the

room, due to the limited space in the room itself, too few chairs in the room to seat everyone, and the need for more staff to receive the patients who are visiting (Ngowtanasuwan and Ruengtam, 2013). The researchers determined to add three persons to the waiting room based on the KAUH operational plan, which estimates that 75% of OPD patients come with at least one escort. Moreover, the researchers consider that, at least one patient in the waiting room is likely disabled.

Post-pandemic considerations

People often think that only medicine affects a patient's recovery. But there are other factors that affect their health, including the physical environment and layout of the hospital, which are especially important in limiting the spread of epidemic diseases such as COVID-19. During the COVID-19 pandemic and the post-pandemic period, social distancing played a critical role in reducing the risk of disease transmission (Yuan et al., 2021). Among the challenges for the researchers was how to include social distancing in their designs and improve hospitals so they can better face epidemics like COVID-19 (Mustafa and Ahmed, 2022).

As communities reopen and more people occupy public places, people will likely observe a safe physical distance instead of social distance as the standard for how far apart they stand from others (Maragakis, 2020).

Physical distance refers to keeping a certain distance from other people to prevent the spread of disease (Cambridge Dictionary, 2023). However, this distance varies from one organization to another. WHO defines this distance as at least one meter (World Health Organization, 2021), whereas the Saudi Ministry of Health has set the distance at 1.5 m (Saudi Ministry of Health, 2021).

After the pandemic precautions were cancelled or suspended worldwide, the researchers decided that the minimum physical distance to maintain public health and reduce disease diffusion risks, which is at least one meter according to WHO requirements (World Health Organization, 2021), should be added to the required space around each patient in the waiting room.

To calculate the space allotted to each patient in the waiting room, the researchers designed a waiting room for the pre-pandemic era where no 'physical distance' criteria were applied; the required space per patient in this waiting room was determined to be 2.16 m^2. After the 'physical distance' criteria were added, the required space per patient in the waiting room became 3.00 m^2 (Ill. 9).

With this information, the researchers arrived at the following formula for calculating the space of the waiting room:

*The required space of the waiting room for each physical examination room in the clinic = PE*PA (1)*

where PE is the number of patients and their escorts in the waiting room per hour, and PA is the required space in m^2 per patient in the waiting room.

The number of patients examined each day

Calculating of the number of patients examined each day depends on three factors: the consultation time per patient, the number of examination rooms, and the number of each period working hours.

Consultation time per patient

As mentioned above, the average consultation time is 17.79 minutes, meaning the physician can examine three patients per hour.

The number of examination rooms

This number comes from the OPD operational plan. Currently, there are 180 physical examination rooms in the OPD building.

The number of period hours each day

Also mentioned above, the OPD works in two independent periods: the first runs for four hours from 8:00 am to 12:00 pm, and the second runs for three hours from 1:00 to 4:00 pm, with an hour-long lunch break in between from 12:00 to 1:00 pm.

Drawing on this information, the researchers arrived at this formula to calculate the number of patients examined each day:

*Patients examined each day = PH*ER*PP (2)*

where PH is the number of patients per hour, ER is the number of examination rooms, and PP is the number of the period hours.

The number of physical examination rooms

The OPD building has 180 physical examination rooms, yet the use of these rooms depends on the OPD operational plan.

The number of virtual examination rooms

No virtual examination rooms are currently operating in the OPD.

The total number of physical and virtual examination rooms
This figure depends on the number of physical and virtual examination rooms that were included in each operational plan.

5. DATA ANALYSIS, COMPARISONS, AND SOLUTIONS

To start the data analysis and the comparison process, the researchers set up the three operational plans: the current plan, the maximum plan, and the ideal plan.

The current operational plan (current situation)
This is the current operational plan used in the OPD at the KAUH.

The maximum operational plan (maximum situation)
This operational plan was created by the researchers to avoid congestion in the OPD relying just on physical solutions by using all available architectural spaces in the clinic while applying the guidelines of the parking space and the space of 3 m^2 needed for each patient in the waiting room.

The ideal operational plan (ideal situation)
This operational plan, like the maximum plan, was created by the researchers to avoid congestion in the parking area and waiting rooms; but in addition to applying the parking guidelines and the space needed for patients in the waiting room, the ideal plan combines physical and virtual examination rooms in order to reach the ideal operational capacity of the OPD. The ideal plan has two approaches.

6. APPLYING PARAMETERS TO THE OPERATIONAL PLANS

The researchers applied all six parameters to each operational plan separately, so they might identify the challenges and needs of each plan.

Applying parameters to the current operational plan
To better understand the OPD's current plan, the researchers extracted data from interviews they conducted with the KAUH director and the KAUH deputy nursing director of ambulatory services. They also counted the number of available parking spaces at the hospital, and they calculated from their drawings the size of the existing waiting rooms. The resulting information follows:

The parking spaces required by the number of physical examination rooms
The OPD currently has three examination rooms in each of its 17 clinics, and guidelines stipulate that there should be three parking spaces for each examination room. It follows that there should be 153 parking spaces available for patients:

*The number of parking spaces required for the number of physical examination rooms = number of examination rooms * the number of parking spaces required per examination room = 51 * 3 = 153 parking spaces.*

Because there are only 122 parking spaces currently available for patients at the OPD, the current plan has a shortage of 31 parking spaces (20.27%).

The total area needed for the waiting rooms
For the waiting room area, OPD should have 1,071 m^2 to accommodate the number of patients it currently sees:

*The total area for the waiting rooms = PA (the required space per patient in the waiting room) * PE (the number of patients and their escorts per hour) * the number of the physical examination rooms = 3 * 7 * 51 = 1,071 m^2.*

Because the existing area of the waiting rooms is 383.75 m^2, the rooms in the current plan have a shortage of 687.25 m^2 (64.17%).

The number of patients examined each day
By analysing the data of the KAUH health information department, the researchers determined that the average number of patients examined each day from 2002 to 2021 is 705.17 (Ill. 10).

The number of physical examination rooms
The OPD uses 81 physical examination rooms daily: 51 rooms during the first period (with three rooms for each of its 17 clinics) and 30 rooms during the second period (with three rooms for just 10 clinics).

The number of virtual examination rooms
There are currently no virtual examination rooms.

The number of physical and virtual examination rooms together
In this situation, there are just physical examination rooms. Which are 81.

Applying parameters to the maximum operational plan
With the help of their drawings, the researchers studied how the OPD may operate to achieve maximum functional capacity for each space, which involved the following calculations:

The parking spaces required by the number of physical examination rooms
Because the guidelines require three parking spaces per examination room, 540 parking spaces are needed for the maximum plan to function. In terms of the formula:

*The parking spaces required by the number of physical examination rooms = number of examination rooms * the required number of parking spaces per examination room = 180 * 3 = 540 parking spaces.*

However, there are currently only 122 parking spaces available; this means a shortage of 418 parking spaces (77.40%).

The total area for the waiting rooms
For the waiting rooms, the OPD needs 3,780 m^2 to accommodate patients:

*The total area in m^2 for the waiting rooms = PA (the required space per patient in the waiting room) * PE (the number of patients and their escorts per hour) * the number of the physical examination rooms = 3 * 7 * 180 = 3,780 m^2.*

Because the existing space in the waiting rooms is 383.75 m^2, there is a shortage of 3,396.25 m^2 (89.85%).

The total number of patients examined each day
If the OPD of the KAUH were to meet these requirements and increase the number of parking spaces to 540 and the total waiting room area to 3,780 m^2, it would be able to examine 3,780 patients each day: 2,160 patients in the first period and 1,620 patients in the second.

*The total daily examined patients = PH * ER * PP = the number of patients per hour * the number of examination rooms * the number of the period hours.*

*For the first period, the total daily examined patients = 4 * 180 * 4 = 2,160 patients.*

*For the second period, the total daily examined patients = 4 * 180 * 3 = 1,620 patients.*

All patients examined each day = 2,160 + 1,620 = 3,780 patients.

Because the OPD saw an average of 705.17 patients each day from 2002 to 2021 (Ill. 10), this plan would increase capacity for daily patient visits by 3,075 patients or 536%.

The number of physical examination rooms
According to the researchers' drawings of the OPD, there are 180 physical examination rooms.

The number of virtual examination rooms
There are currently no virtual examination rooms.

The number of virtual examination rooms
In this situation, there are just physical examination rooms, which are 180.

Applying parameters to the ideal operational plan
To achieve the ideal situation, the researchers created two approaches that modify how the clinic currently uses its architectural spaces. One approach works with the existing number of parking spaces (122), while the other increases parking capacity by increasing the number of spaces to 153. Both approaches also add virtual clinics to the OPD operational plan.

The first approach for the ideal plan
The first approach keeps the current number of parking spaces (which is 122) but reduces the number of physical examination rooms to match the existing parking spaces; it also adds virtual examination rooms to make up for the loss of physical examination rooms. This approach decreases the current number of physical examination rooms in each clinic from 3 to 2.35. Instead of having 17 clinics using 51 physical examination rooms, which would require 153 parking spaces, the OPD would have 6 clinics use three physical examination rooms and eleven clinics use two rooms.

This modification reduces the total number of currently used physical examination rooms from 51 to 40 (-27.50%), but it matches the number of examination rooms set by the guidelines, which stipulate that there should be three parking spaces per examination room—or in this case, 120 parking spaces.

To make up for the loss of physical examination rooms, this approach adds two virtual examination rooms to each clinic during the first period, resulting in a total of 74 examination rooms (or an increase of 39.62%): 40 physical examination rooms and 34 virtual examination rooms from 8:00 am to 12:00 pm.

As for the size of the waiting rooms, this approach needs 840 m^2 to accommodate waiting patients. Because the area of the existing waiting rooms is only 383.75 m^2, extra space can be provided by turning the unused physical examination rooms into waiting rooms, with each clinic yielding two or three physical examination rooms to expand the waiting area.

For the second period, which extends from 1:00 to 4:00 pm, there are three options:

Option A for the ideal plan's first approach
This option keeps the current number of clinics as is without adding any virtual examination rooms, so 10 clinics will continue to have 30 physical examination rooms. This scenario meets the OPD guidelines for parking spaces, since option A needs only 90 spaces while 122 spaces currently exist.

In option A, the space required for patients in the waiting room is 630 m^2. Because the area of the existing OPD waiting rooms is only 383.75 m^2, extra space can be provided by turning 2–3 examination rooms in each clinic into a waiting area.

Option B for the ideal plan's first approach
This option also keeps the current number of clinics as is, so 10 clinics will continue to have 30 physical examination rooms, but it adds two virtual examination rooms to each clinic. This scenario raises the total number of examination rooms from 30 to 50 (+66.66%), with 30 physical and 20 virtual rooms. The parking spaces and waiting areas are the same as in option A, since patients who book a virtual examination room have no need to visit the OPD.

Option C for the ideal plan's first approach
This option uses all 17 clinics in the second period the same way they are used in the first period, and it applies to the second period the same solutions that are applied to the first period. But because the second period is shorter by one hour, the number of examined patients is reduced.

The second approach for the ideal plan
The second approach increases the current number of parking spaces (from 122 to 153) to match the OPD standard for the number of physicians in each clinic (which is three) and by adding virtual examination rooms. This approach also has three options.

This approach keeps the total number of currently used examination rooms at 51, and it matches the number of parking spaces required by the guidelines, which is three parking spaces per examination room.

This approach also adds two virtual examination rooms to each clinic during the first period, so the total number of examination rooms is 85 (+66.66): 51 physical and 34 virtual rooms from 8:00 am to 12:00 pm.

As for the size of the waiting rooms, this approach needs 1,071 m^2 to accommodate waiting patients. Because the area of the existing waiting rooms is only 383.75 m^2, extra space can be provided by turning 2–3 examination rooms in each clinic into a waiting area.

For the second period, from 1:00 to 04:00 pm, there are again three options:

Option A for the ideal plan's second approach
This option is similar to option A in the first approach (6.3.1.1).

Option B for the ideal plan's second approach
This option is similar to option B in the first approach (6.3.1.2).

Option C for the ideal plan's second approach
This option uses all 17 clinics in the second period the same way they are used in the first period of the second approach, and it applies to the second period the same solutions that are applied in the first period. But because the second period is shorter by one hour, the number of examined patients is reduced.

7. RESULTS

The results for each operational plan current, maximum, and ideal are presented and discussed below.

Results of applying parameters to the current operational plan
In the current scenario, the parking area and waiting rooms suffer from congestion, and patient waiting time is continuously increasing. Analysis of the data shows that the average patients' presence at the OPD is 63.01% (Ill. 11).

The data the researchers collected about the OPD concerned only officially registered appointments and did not consider patients who were referred to the OPD from other departments like the emergency and intensive care units.

Results of applying parameters to the maximum operational plan
The maximum plan would allow the OPD to examine 3,780 patients daily instead of its current average of 705.17 patients a day. But this scenario would

require significant adjustments to be made to the architectural spaces, such as providing new buildings to serve patients in parking and waiting rooms.

Results from applying parameters to the ideal operational plan

The ideal scenario would allow the OPD to avoid congestion, reduce patient waiting time for the physical examination rooms and eliminate patient waiting time in the virtual examination rooms because it is a pre-scheduled session. in addition, increase the number of patients examined each day as a result of making limited and focused adjustments to the OPD's architectural spaces and repurposing some physical examination rooms to serve as virtual examination rooms.

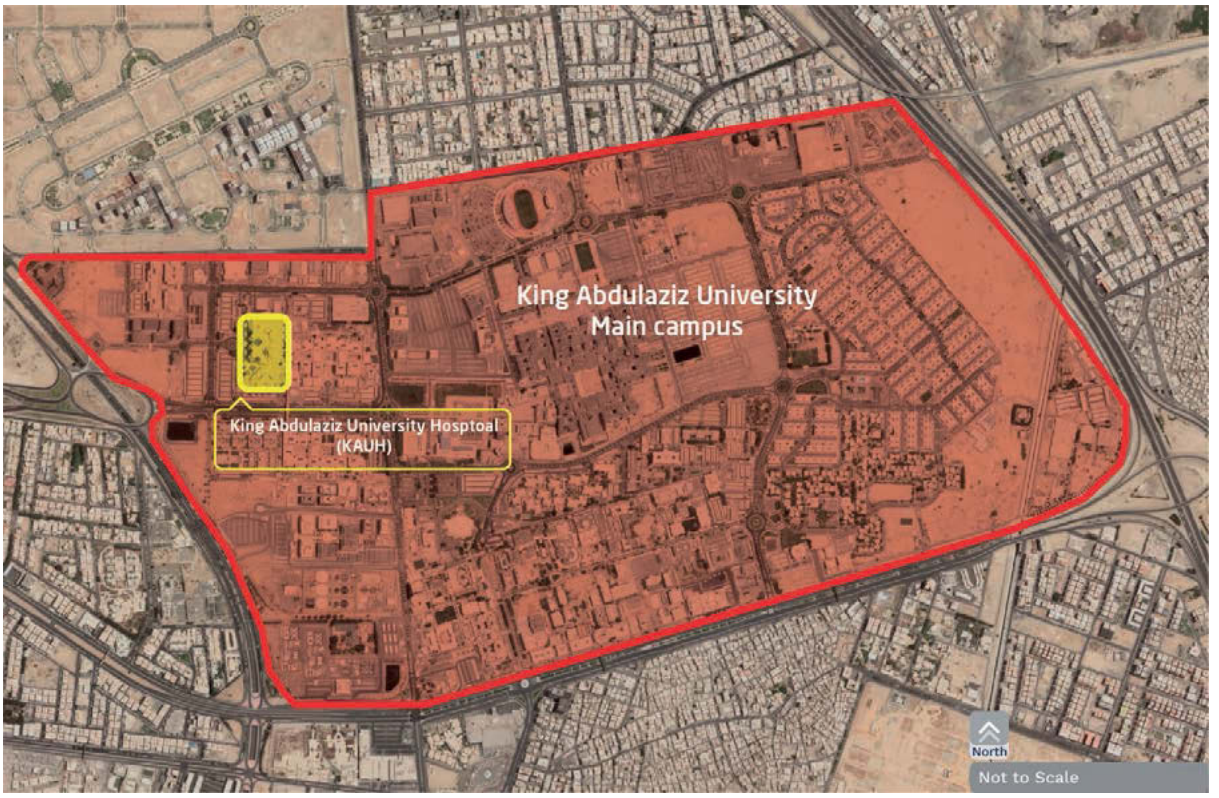
8. CONCLUSIONS

The study showed how adding virtual examination rooms to the OPD can help control congestion inside the OPD building. In the first approach, to comply with the guidelines for the number of parking spaces for each examination room, a group of physical examination rooms are converted into virtual examination rooms, which reduces the number of physical examination rooms by 21.5%. However, this modification results in an overall increase in the number of examination rooms, both physical and virtual, by 28.04–81.72% (Ill. 12), which in turn increases the number of total daily examined patients by 64.21–120.37% (Ill. 13).

In the second approach, virtual examination rooms also help control congestion inside the OPD building. By modifying the waiting area, this approach preserves the current number of physical examination rooms while adding virtual examination rooms, which allows the OPD to increase the total number of examination rooms, both physical and virtual, by 29.56–109.87% (Ill. 12), which in turn increases the number of daily examined patients by 82.93–108.46% (Ill. 13).

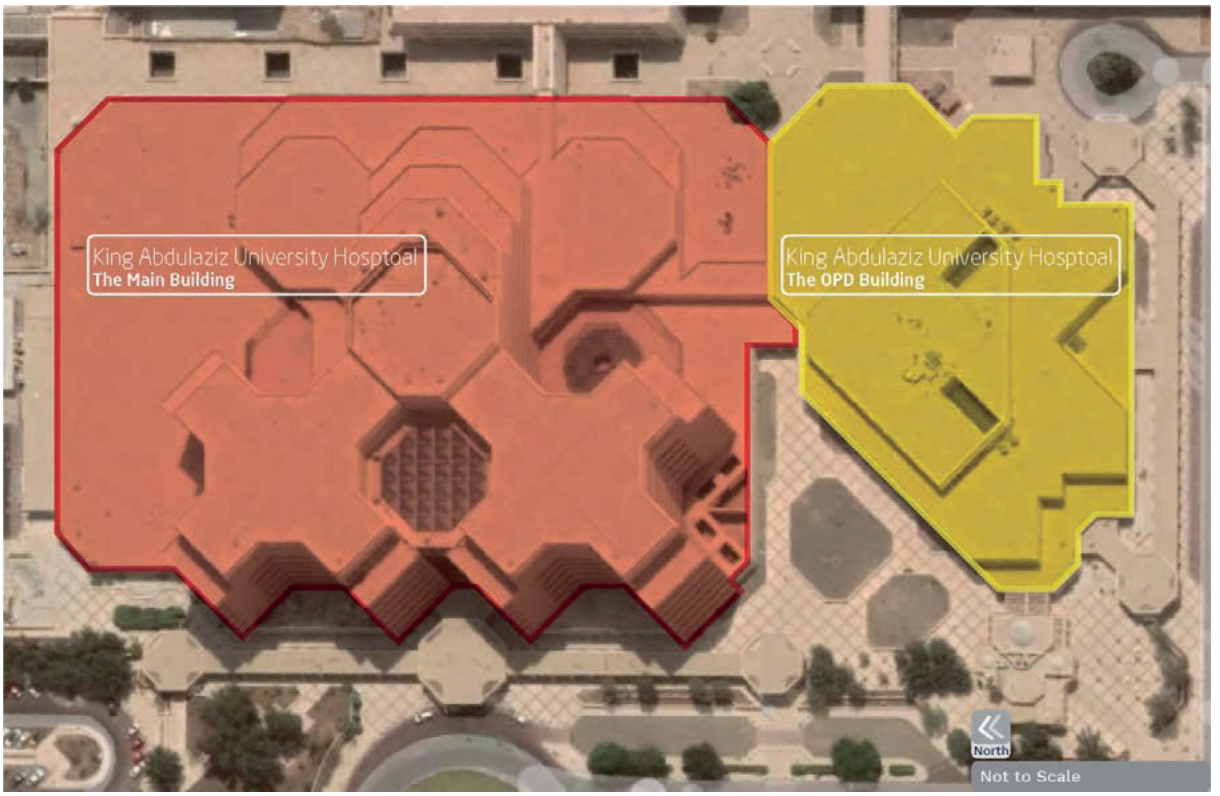
In general, an operational plan that combines physical and digital solutions will allow the OPD to treat more patients without affecting the quality of its services and without changing much the shape or function of its architectural space.

Furthermore, combining physical and digital solutions creates a flexible mechanism at the OPD through which its clinics can use the maximum operating plan that optimizes its use of available space while preparing it to deal with any future disease pandemics.



Ill. 1. The location of King Abdulaziz University Hospital (KAUH) on the main campus of King Abdulaziz University. Source: original work.

Il. 1. Lokalizacja Szpitala Uniwersyteckiego Króla Abdulaziza (KAUH) w głównym kampusie Uniwersytetu Króla Abdulaziza. Źródło: praca oryginalna.



Ill. 2. Top view for King Abdulaziz University Hospital (KAUH) showing the two attached buildings. Source: original work.

Ill. 2. Widok z góry Szpitala Uniwersyteckiego Króla Abdulaziza (KAUH) przedstawiający dwa połączone budynki.

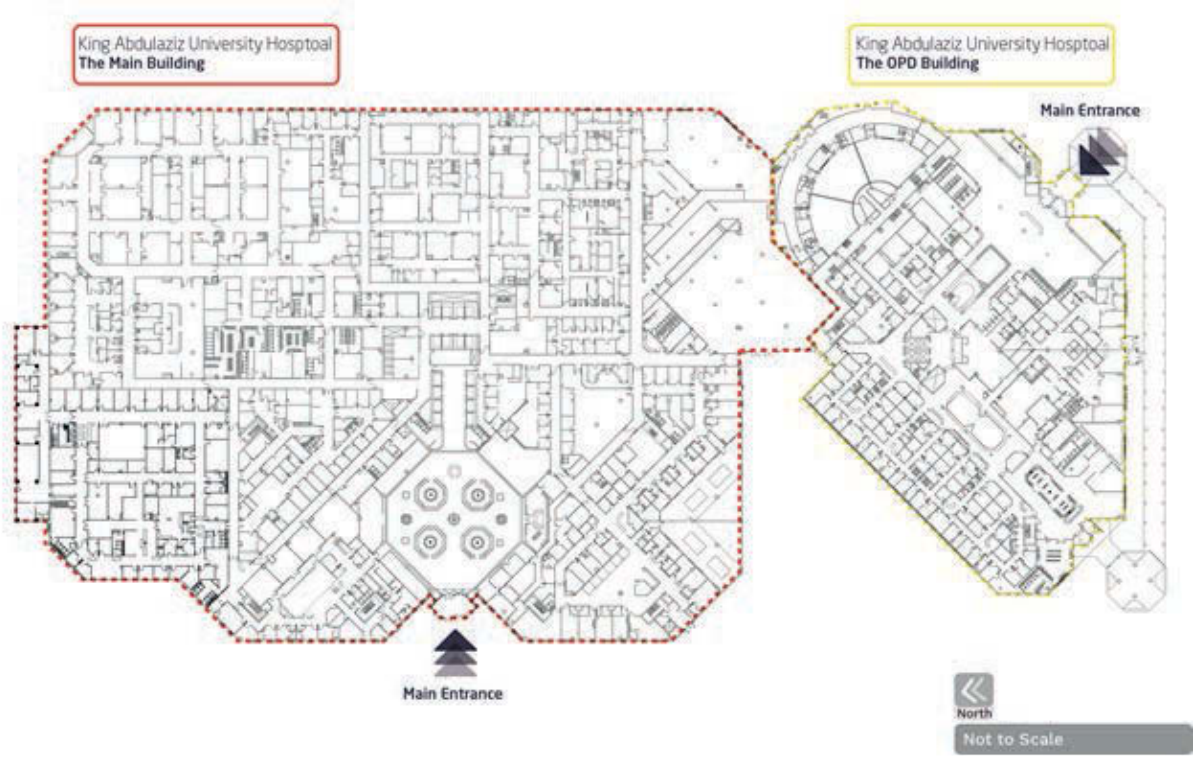
Źródło: praca oryginalna.

Ill. 3. King Abdulaziz University Hospital (KAUH), Main building. Source: original work.

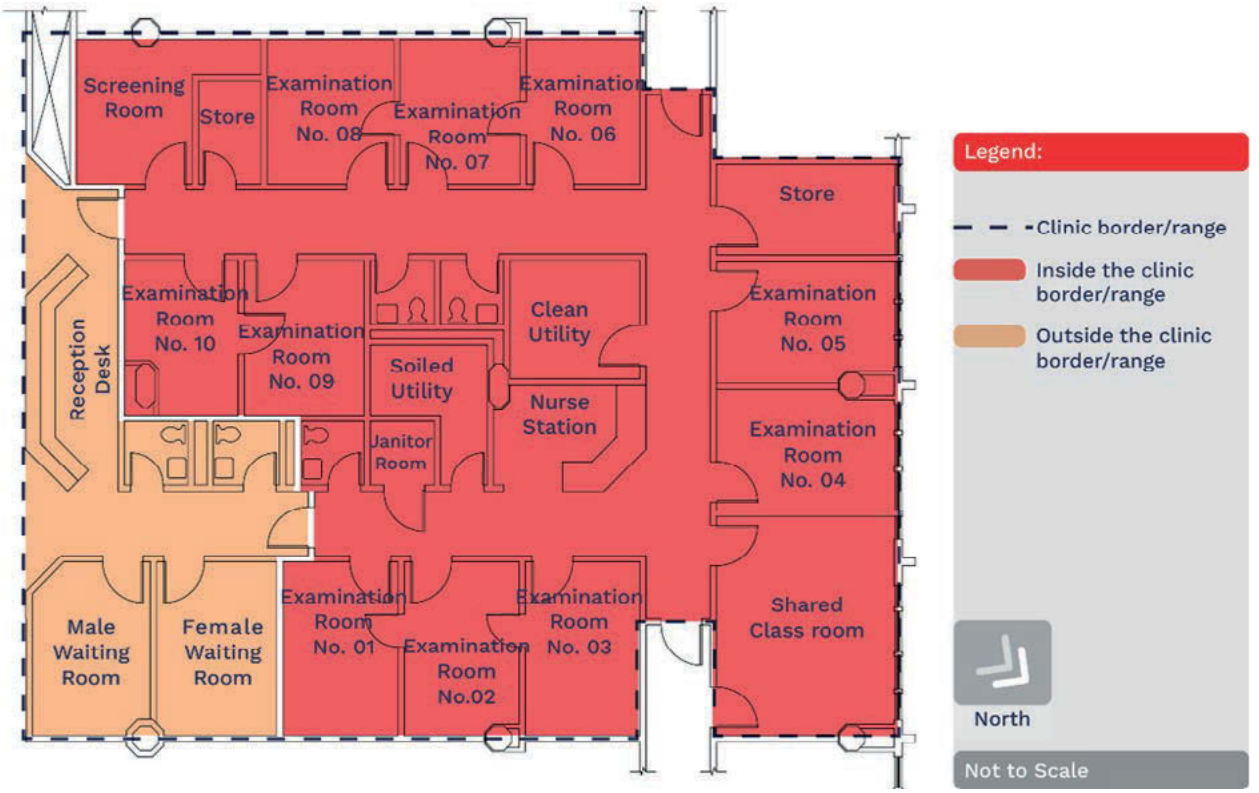
Il. 3. Szpital Uniwersytecki Króla Abdulaziza (KAUH), budynek główny. Źródło: praca oryginalna.

Ill. 4. King Abdulaziz University Hospital (KAUH), OPD building. Source: original work.

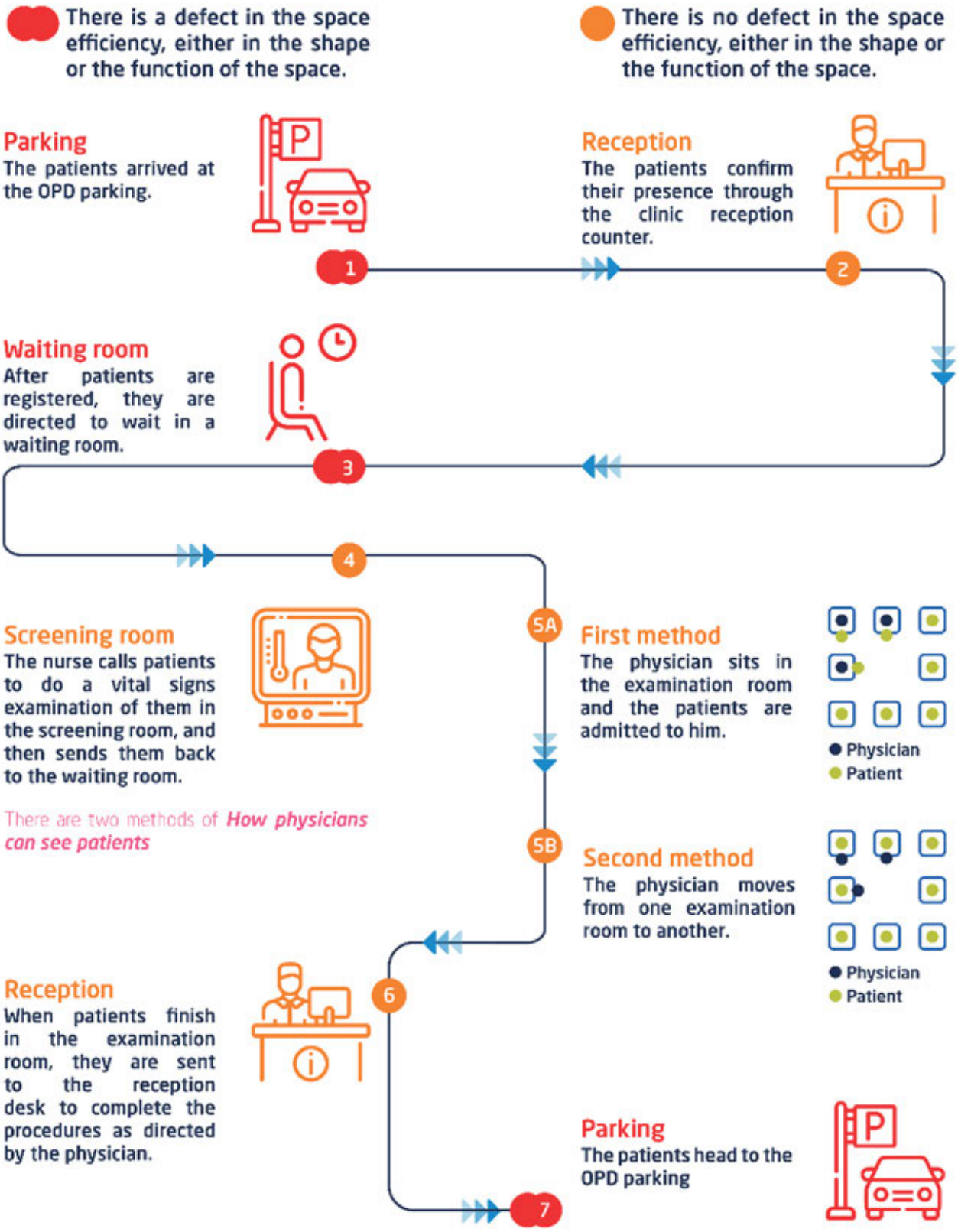
Il. 4. Szpital Uniwersytecki Króla Abdulaziza (KAUH), budynek OPD. Źródło: praca oryginalna.



Ill. 5. King Abdulaziz University Hospital (KAUH), Ground floor layout. Source: original work.
Il. 5. Szpital Uniwersytecki Króla Abdulaziza (KAUH), układ parteru. Źródło: praca oryginalna.



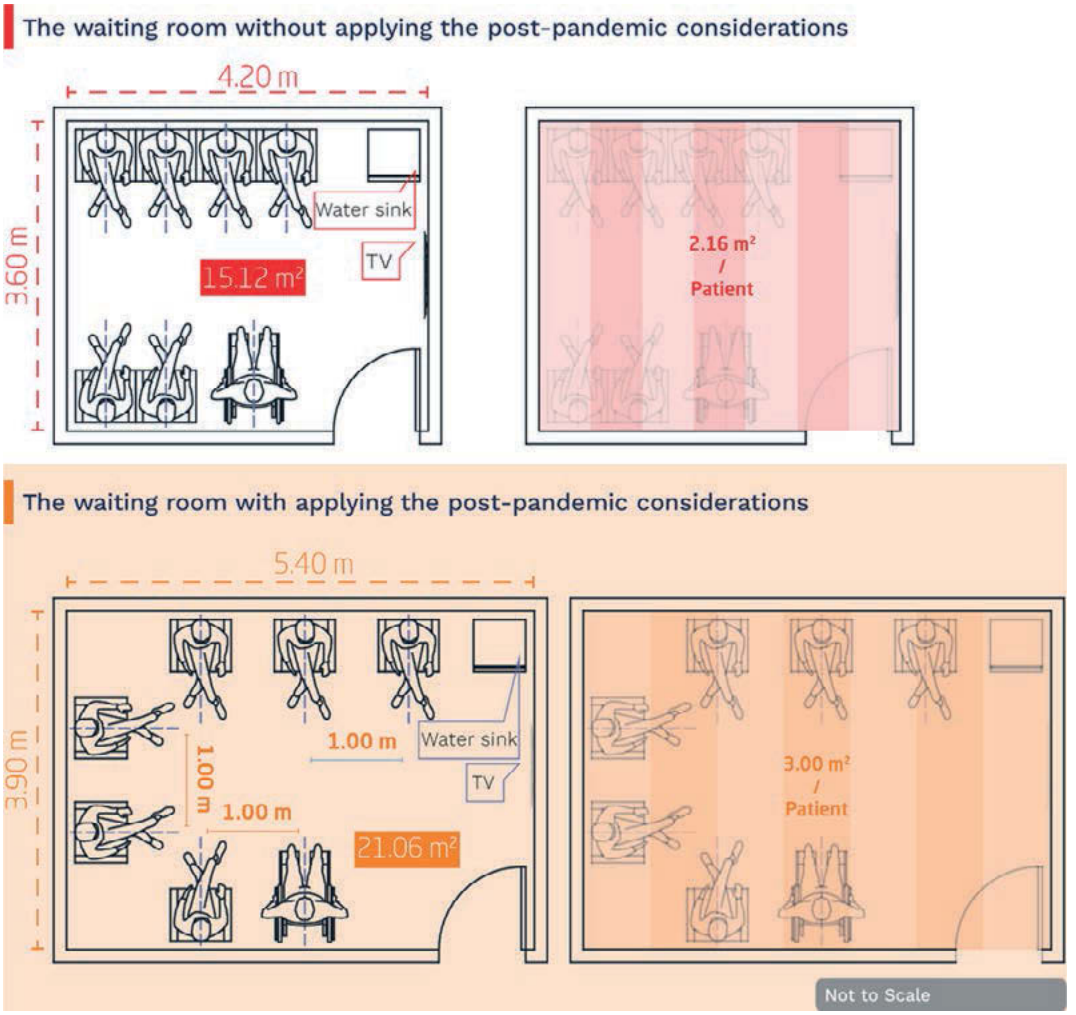
Ill. 6. Types of services that assist clinics based on the location of these services. Source: original work.
Il. 6. Rodzaje usług wspomagających kliniki w zależności od lokalizacji tych usług. Źródło: praca oryginalna.



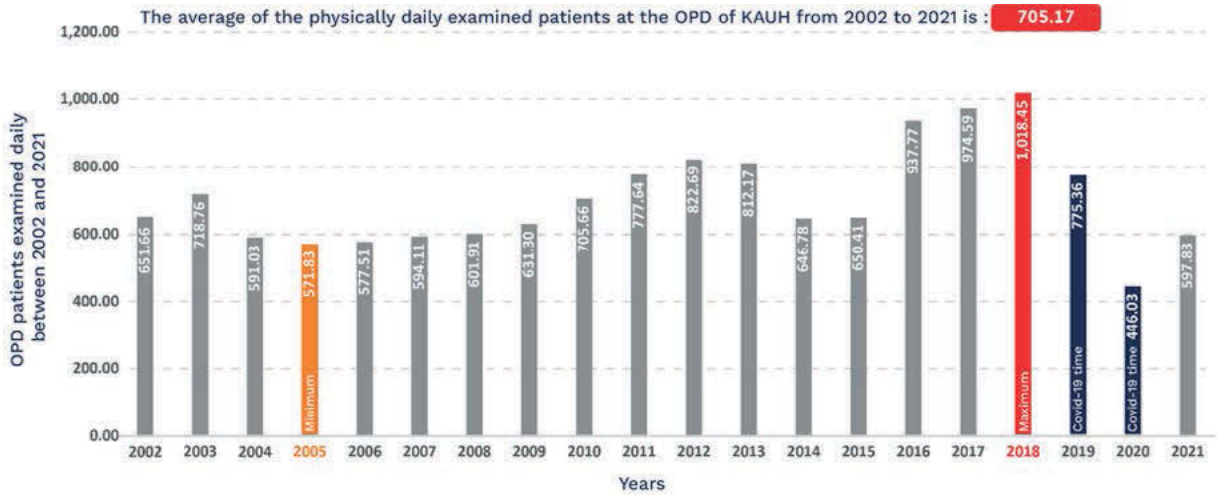
Ill. 7. How the clinic works. Source: original work.

Il. 7. Schemat działania kliniki. Źródło: praca oryginalna.

Ill. 8. The congested stations observed in the OPD. Source: original work.
Il. 8. Zatłoczone stacje obserwowane w OPD. Źródło: praca oryginalna.



Ill. 9. Applying the post-pandemic considerations to the waiting room. Source: original work.
Il. 9. Zastosowanie rozwiązań postpandemicznych do poczekalni. Źródło: praca oryginalna.

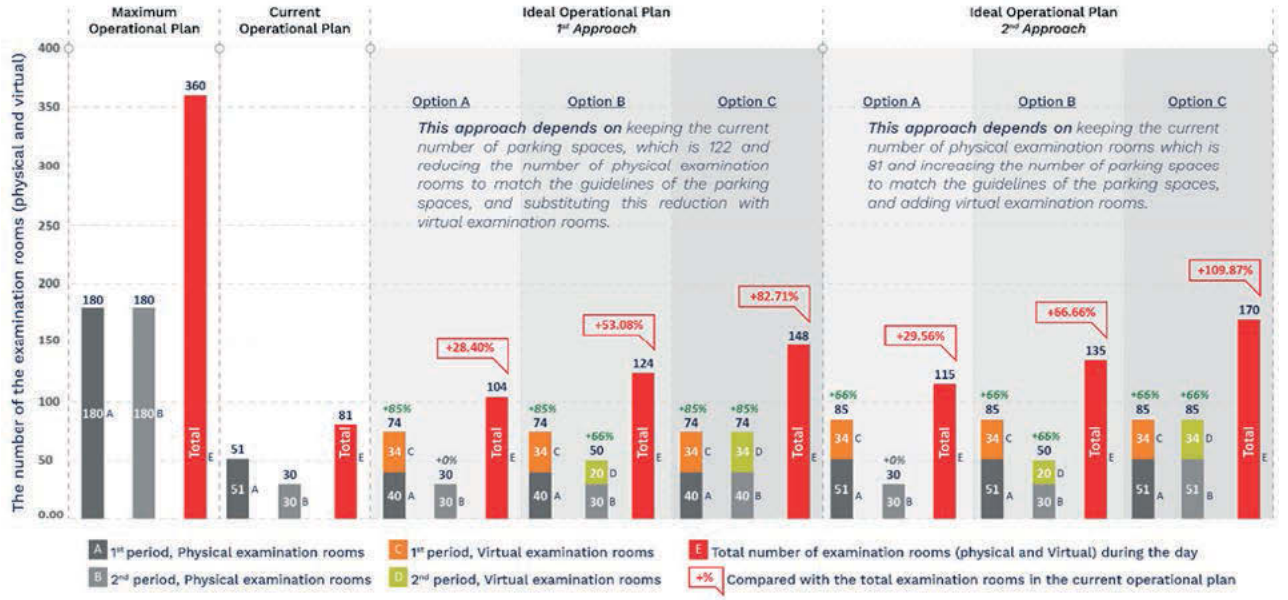


Ill. 10. OPD patients examined daily between 2002 and 2021. Source: original work.

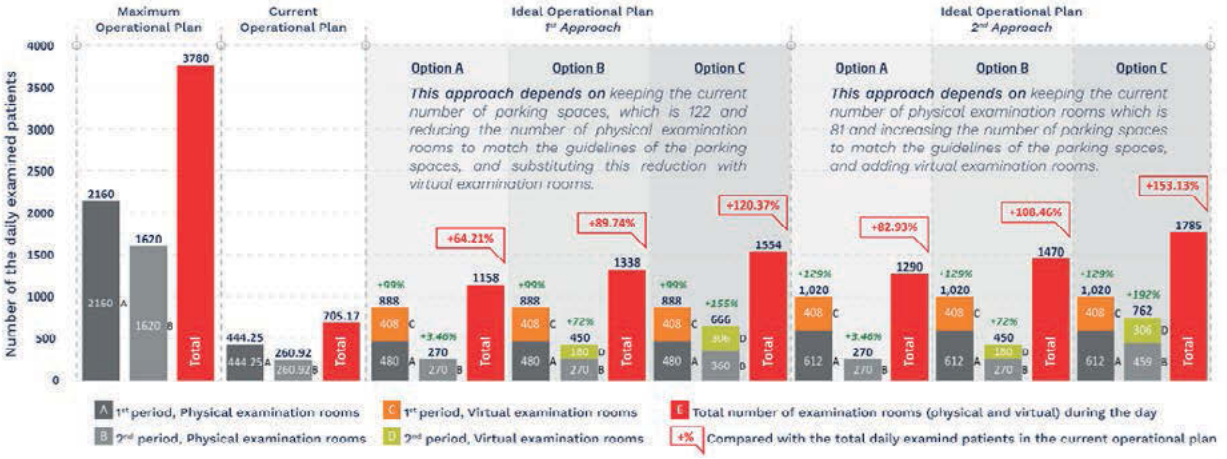
Il. 10. Pacjenci z OPD badani codziennie w latach 2002–2021. Źródło: praca oryginalna.

Ill. 11. The average annual percentage of patients who visited the OPD with official appointments. Source: original work.

Il. 11. Średnioroczny odsetek pacjentów zgłaszających się do POZ w ramach wizyt urzędowych. Źródło: praca oryginalna.



Ill. 12. Summary of the number of examination rooms (physical and virtual) in all operational plans. Source: original work.
Il. 12. Zestawienie ilości sal (fizycznych i wirtualnych) we wszystkich planach operacyjnych. Źródło: praca oryginalna.



Ill. 13. Summary of the number of total daily examined patients in all operational plans. Source: original work.
Il. 13. Zestawienie całkowitej dziennej liczby pacjentów badanych we wszystkich planach operacyjnych. Źródło: praca oryginalna.

REFERENCES

Ahmad, B.A., Khairatul, K., Farnaza, A. (2017), 'An assessment of patient waiting and consultation time in a primary healthcare clinic', *Malaysian Family Physician*, the official journal of the Academy of Family Physicians of Malaysia, 12(1), pp. 14–21. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5420318/ (accessed: 26.08.2023).

Ahmadi-Javid, A., Jalali, Z., Klassen, K.J. (2017), 'Outpatient appointment systems in healthcare: A review of optimization studies', *European Journal of Operational Research*, 258(1), pp. 3–34. Available at: https://doi.org/10.1016/j.ejor.2016.06.064 (accessed: 28.08.2023).

Bhattacharya, S. et al. (2020), 'Health system strengthening during COVID-19 pandemic through virtual out-patient clinics: An experience from India', *Journal of Public Health and Primary Care*, 1(1). Available at: https://doi.org/10.4103/jphpc.jphpc_9_20 (accessed: 26.08.2023).

Biya, M. et al. (2022), 'Waiting time and its associated factors in patients presenting to outpatient departments at Public Hospitals of Jimma Zone, Southwest Ethiopia', *BMC Health Services Research*, 22(1). Available at: https://doi.org/10.1186/s12913-022-07502-8 (accessed: 26.08.2023).

Browne, C. et al. (2017), 'Prospective evaluation of a virtual urology outpatient clinic', *Irish Journal of Medical Science* (1971–), 187(1), pp.251–254. Available at: https://doi.org/10.1007/s11845-017-1615-y (accessed: 26.08.2023).

Cambridge Dictionary (2023), 'physical distancing' @CambridgeWords. Available at: https://dictionary.cambridge.org/dictionary/english/physical-distancing (accessed 3.06. 2023).

Das, A. (2017), 'Private Hospitals' Parking: Health Care's Debated Contribution in Traffic Congestion of Dhaka City', *SSRN Electronic Journal*. Available at: https://doi.org/10.2139/ssrn.3641769 (accessed: 26.08.2023).

El Sawy, O.A. et al. (2020), 'How LEGO Built the Foundations and Enterprise Capabilities for Digital Leadership' [in:] *Strategic Information Management. Theory and Practice*, Robert D. Galliers, Dorothy E. Leidner, Boyka Simeonova (eds.), pp.174–201. Available at: https://doi.org/10.4324/9780429286797-8 (accessed: 26.08.2023).

Enabulele, O., J's, A., Enabulele, J. (2018), 'Patient waiting time in the general practice clinic of the University of Benin Teaching Hospital, Edo State, Nigeria', *Journal of Family Medicine & Community* Health, 5(2). Available at: https://www.researchgate.net/publication/325477520_Patient_waiting_time_in_the_general_practice_clinic_of_the_University_of_Benin_Teaching_Hospital_Edo_State_Nigeria#fullTextFileContent (accessed: 26.08.2023).

Frenzel-Piasentin, A. et al. (2021), 'Digitization or Digitalization? — Toward an Understanding of Definitions, Use and Application in IS Research', Americas Conference on Information Systems, 2021 Proceedings. Available at: https://www.researchgate.net/publication/354402700_Digitization_or_Digitalization_-_Toward_an_Understanding_of_Definitions_Use_and_Application_in_IS_Research?amp%3BenrichSource=Y292ZXJQYWdlOzM1NDQwMjcwMDtBUzoxMDY1MzI3MTA2NDc4MDgwQDE2MzEwMDUxODMxNTk%3D&%3Bel=1_x_2&amp%3B_esc=publicationCoverPdf (accessed: 26.08.2023).

Hayward, C. (2018), 'How Many Hospital Parking Spaces?', SpaceMed Essentials. Available at: https://blog.spacemed.com/estimating-healthcare-facility-parking--requirements/ (accessed: 1.06.2023).

Health and Safety Executive (2020), Procedure for the Management of Virtual Outpatient Clinics, [online] https://www.hse.gov.uk/. Available at: https://www.hse.ie/eng/about/who/acute-hospitals-division/outpatient-services--performance-improvement-programme/procedure-for--the-management-of-virtual-outpatient-clinics.pdf (accessed: 26.08.2023).

Hospital, K.A.U. (n.d.), 'About Hospital' [online] https://hospital.kau.edu.sa. Available at: https://hospital.kau.edu.sa/Content-599-EN-38308 (accessed: 13.07.2023).

Hunter, J. et al. (2012), 'Improving outpatient services: the Southampton IBD virtual clinic', *Postgraduate Medical Journal*, 88(1042), pp.487–91. Available at: https://doi.org/10.1136/postgradmedj-2012-100123rep (accessed: 26.08.2023).

ISD Scotland Data Dictionary (n.d.), ISD Scotland, Information Services Division [online] www.ndc.scot.nhs.uk. Available at: https://www.ndc.scot.nhs.uk/Dictionary-A-Z/Definitions/index.asp?Search=V&ID=954&Title=Virtual%20Clinic (accessed 3.06.2023).

Javed, D. (2015), 'A Time-Motion Study of OPD Services at a State Level Ayurvedic Hospital to Reduce the OPD Congestion', *International Ayurvedic Medical Journal*. Available at: https://www.researchgate.net/publication/331373416_A_TIME-MOTION_STUDY_OF_OPD_SERVICES_AT_A_STATE_LEVEL_AYURVEDIC_HOSPITAL_TO_REDUCE_THE_OPD_CONGESTION (accessed: 26.08.2023).

Lailomthong, N., Prichanont, S. (2014), *Patient's Waiting Time Reduction in Outpatient Department*, International Conference on Advances in Engineering and Technology (ICAET' 2014) March 29–30, 2014 Singapore. Available at: https://doi.org/10.15242/iie.e0314153 (accessed: 26.08.2023).

Lapão, L.V. (2018), 'The Future of Healthcare: The Impact of Digitalization on Healthcare Services Performance', *The Internet and Health in Brazil*, pp. 435–449. Available at: https://doi.org/10.1007/978-3-319-99289-1_22 (accessed: 26.08.2023).

Lavin, B. (2020), 'Bridging the healthcare gap: Building the case for epilepsy virtual clinics in the current healthcare environment', *Epilepsy & Behavior*, 111, p. 107262. Available at: https://doi.org/10.1016/j.yebeh.2020.107262 (accessed: 26.08.2023).

Maragakis, L. (2020), *Coronavirus, Social Distancing and Self Quarantine*, [online] www.hopkinsmedicine.org. Available at: https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/coronavirus-social--distancing-and-self-quarantine (accessed: 26.08.2023).

Mustafa, F.A., Ahmed, S.S. (2022), 'The role of waiting area typology in limiting the spread of COVID-19: Outpatient clinics of Erbil hospitals as a case study', *Indoor*

and Built Environment, p.1420326X2210796. Available at: https://doi.org/10.1177/1420326x221079616 (accessed: 26.08.2023).

National health service (2021), Allows Primary Care Teams to Manage Their Clinics Digitally [online] https://nhshealthcall.co.uk/. Available at: https://nhshealthcall.co.uk/product/virtual_clinic/ (accessed: 28.06.2023).

New South Wales Ministry of Health (2022), What is virtual care? [online] www.health.nsw.gov.au. Available at: https://www.health.nsw.gov.au/virtualcare/Pages/virtual-care-in-NSW.aspx (accessed: 28.06.2023).

Ngowtanasuwan, G., Rengtam, P. (2013), 'Applied Simulation Model for Design of Improving Medical Record Area in Out-patient Department (OPD) of a Governmental Hospital', *Procedia — Social and Behavioral Sciences*, 101, pp. 147–158. Available at: https://doi.org/10.1016/j.sbspro.2013.07.188 (accessed: 26.08.2023).

Panaviwat, C., Lohasiriwat, H., Tharmmaphornphilas, W. (2014), 'Designing an appointment system for an outpatient department', *IOP Conference Series: Materials Science and Engineering*, 58, p. 012010. Available at: https://doi.org/10.1088/1757-899x/58/1/012010 (accessed: 26.08.2023).

Pandit, A., Kulkarni, M., Kamthe's, A. (2016), 'Defects in OPD Process Leading to Patient Dissatisfaction', *International Education Journal*, 2(6). Available at: https://www.researchgate.net/publication/329905880_Defects_in_OPD_Process_Leading_to_Patient_Dissatisfaction (accessed: 26.08.2023).

Patwardhan, A. et al. (2012), 'Comparison of Waiting and Consultation Times in Convenient Care Clinics and Physician Offices', *Journal of Primary Care & Community Health*, 4(2), pp.124–128. Available at: https://doi.org/10.1177/2150131912450030 (accessed: 26.08.2023).

Raadabadi, M. et al. (2017), 'Factors affecting the overcrowding in outpatient healthcare', *Journal of Education and Health Promotion*, 6(1), p. 21. Available at: https://doi.org/10.4103/2277-9531.204742 (accessed: 26.08.2023).

Rema, V., Sikdar, K. (2021), 'Optimizing Patient Waiting Time in the Outpatient Department of a Multi-specialty Indian Hospital: The Role of Technology Adoption and Queue-Based Monte Carlo Simulation', *SN Computer Science*, 2(3). Available at: https://doi.org/10.1007/s42979-021-00595-8 (accessed: 26.08.2023).

Rutherford, E. et al. (2020), 'Potential Benefits and Drawbacks of Virtual Clinics in General Surgery: Pilot Cross-Sectional Questionnaire Study', *JMIR Perioperative Medicine*, 3(1), p. e12491. Available at: https://doi.org/10.2196/12491 (accessed: 26.08.2023).

Saudi Ministry of Health (2021), Health protocols for hospital visitors, [online] انوروك نم ةيافقولا. Available at: https://covid19awareness.sa/archives/10976 (accessed 3.06.2023).

Thapa, R. et al. (2018), 'An Assessment of Patient Waiting and Consultation Time in the Outpatient Department at a Selected Tertiary Care Teaching Hospital', *Journal of Evolution of Medical and Dental Sciences*, 7(08), pp. 984–988. Available at: https://doi.org/10.14260/jemds/2018/225 (accessed: 26.08.2023).

Tsaousis, K.T. et al. (2015), 'The concept of virtual clinics in monitoring patients with age-related macular degeneration', *Acta Ophthalmologica*, 94(5), pp. e353–e355. Available at: https://doi.org/10.1111/aos.12832 (accessed: 26.08.2023).

UpCodes. (n.d.). 2.1: Common Elements for Outpatient Facilities, Pennsylvania Outpatient Facilities Design Code 2018. Available at: https://up.codes/viewer/pennsylvania/fgi-outpatient-facilities-2018/chapter/2.1/common-elements-for-outpatient-facilities#2.1-3.5.10.4 (accessed 3.06.2023).

UpCodes. (n.d.). Chapter 12: Interior Environment, California Building Code 2022 (Vol 1 & 2). Available at: https://up.codes/viewer/california/ca-building-code-2022/chapter/12/interior-environment?query=circulation%20waiting%20room#1225.6.1.1 (accessed 3.06.2023).

Wafula, R.B., Ayah, R. (2021), 'Factors Associated With Patient Waiting Time at a Medical Outpatient Clinic: A Case Study of University of Nairobi Health Services', *International Journal of Innovative Research in Medical Science*, 6(12), pp. 915–918. Available at: https://doi.org/10.23958/ijirms/vol06-i12/1307 (accessed: 26.08.2023).

World Health Organization (2021), *COVID-19 Advice — Physical' Distancing* | WHO Western Pacific. [online] www.who.int. Available at: https://www.who.int/westernpacific/emergencies/covid-19/information/physical-distancing (accessed: 26.08.2023).

Yuan, J. (et al.) (2021), 'An Assessment of Social Distancing Obedience Behavior during the COVID-19 Post-Epidemic Period in China: A Cross-Sectional Survey', *Sustainability*, 13(14), p. 8091. Available at: https://doi.org/10.3390/su13148091 (accessed: 26.08.2023).