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Future Healthcare Facility Design: Fixing the broken healthcare system post COVID-19

Diseño de futuras instalaciones de atención médica: reparar el sistema de atención médica roto después de COVID -19

Md Haseen Akhtar[1*], Janakarajan Ramkumar[2]

1 Prime Minister Research Fellow, Department of Design, Indian Institute of Technology, Kanpur

email: mdhaseendw20@iitk.ac.in

2 Professor, Department of Design, Indian Institute of Technology, Kanpur

email: jrkumar@iitk.ac.in

*Author for Correspondence: mdhaseendw20@iitk.ac.in

ABSTRACT

Design-Shift Alert: Moving away from "rigid and constrained facilities" towards "flexible and adaptable facilities" that can be built up fast in an emergency. At the time of COVID-19, there was a dire need for facility renovations. Immediate facility adaptations were required all around the world to cope with the inflow of patients infected with highly contagious virus and to segregate hospitalized patients using negative pressure chambers for respiratory isolation. Never has healthcare design changed as swiftly as it had during the COVID-19 epidemic. Although it is impossible to provide better health in these times, the healthcare facilities could be designed flexible to accommodate the needs of handling and caring for huge numbers of patients while still providing the bare minimum of care. This paper attempts to discuss different parameters to improve the Indian healthcare system. The method includes state of the art analysis of collapsible systems and then future forecast some ideas for more complex scenarios. The study opens a discussion for the facility planners and designers in the field of health care. It aims to find future solutions for healthcare design in the country. “It is all about connecting the unconnected” – Author

Keywords: future healthcare design, modular design, future thinking, forecasting skills, plug and play design, healthcare innovation, Covid-19

RESUMEN

Alerta de cambio de diseño: alejarse de "instalaciones rígidas y restringidas" hacia "instalaciones flexibles y adaptables" que se pueden construir rápidamente en una emergencia. En el momento de COVID-19, había una gran necesidad de renovaciones en las instalaciones. Se requirieron adaptaciones inmediatas de las instalaciones en todo el mundo para hacer frente a la afluencia de pacientes infectados con virus altamente contagiosos y segregar a los pacientes hospitalizados utilizando cámaras de presión negativa para el aislamiento respiratorio. El diseño de la

atención médica nunca ha cambiado tan rápido como lo hizo durante la epidemia de COVID-19. Aunque es imposible brindar una mejor salud en estos tiempos, las instalaciones de atención médica podrían diseñarse de manera flexible para adaptarse a las necesidades de manejo y atención de una gran cantidad de pacientes y al mismo tiempo brindar el mínimo de atención. Este documento intenta discutir diferentes parámetros para mejorar el sistema de salud indio. El método incluye análisis de última generación de sistemas plegables y, a continuación, pronostica a futuro algunas ideas para escenarios más complejos. El estudio abre un debate para los planificadores y diseñadores de instalaciones en el campo de la atención de la salud. Su objetivo es encontrar soluciones de futuro para el diseño de la salud en el país. “Se trata de conectar lo desconectado” – Autor

Palabras clave: diseño de atención médica futura, diseño modular, pensamiento futuro, habilidades de pronóstico, diseño plug and play, innovación en atención médica, Covid-19

INTRODUCTION

The built environment is an important part of the pandemic solution and disaster preparedness. Traditional capacity is finite, and rapid remedies come with a plethora of issues, including unintended consequences with unacceptably negative implications. Policymakers could consider forming a task force of trained specialists to come up with acceptable and readily deployable choices for housing the medical treatments required to combat the problem and making such solutions available globally. Practical and rapid solutions are offered based on existing and emerging design and construction technology. Designers must be leveraged and engaged in the development of future state solutions to prevent repeating our current sloppy impromptu approach (Hercules et al., 2020). The purpose of this article is to highlight and provide solutions to critical problems about care environments as the COVID-19 crisis continues to affect more people throughout the world, as well as to discuss what specific factors are related to this design.

Architectural environment has a larger effect on injured soldiers during a battle, according to history. The architectural environment, for example, has a bigger effect on the injured troops than their initial wounds, as Florence Nightingale revealed (Hercules et al., 2020). We believe that the built environment is an important part of pandemic and catastrophe preparedness. Architects and designers are crucial instruments for making swift adjustments to existing hospital and non-hospital infrastructure, such as repurposing outdated healthcare facilities and erecting temporary structures. These experts can quickly examine how hospitals are currently using their space to make the most of what they have (Waldman et al., 2020). With the rapid global spread of the SARSCoV-2 virus and the resulting COVID-19 disease, utilizing a wide range of professional expertise and specialties is critical to quickly resolving the crisis, avoiding unintended consequences in the short term, and building long-term resilience in our health systems. We must rely on nonpharmacologic methods such as social distancing, isolation, and quarantine, all of which are dependent on the built environment, due to the lack of a current vaccine or effective medication (Budds, 2020).

Our homes, neighborhoods, healthcare settings, infrastructure, and cities all play a role in emergency preparation and response. Due to an extraordinary influx of patients, COVID-19 has entirely depleted the system's resources. Current hospitals, houses, nursing homes, and motels, as well as swiftly erected alternative facilities such as unoccupied spaces in office buildings, prisons, and tents in unused parking lots, among others, all have varied degrees of suitability to house this surge of patients. In terms of life safety and building services, each has its unique set of challenges. Assessing them will involve careful triage by experts such as designers, architects, and engineers, as well as rationing of available caregivers, therapies, environments, equipment, and other resources, all of which are subject to change over time. Due to a labor shortage, existing hospitals are limited in terms of capacity, services, and infrastructure. Hotel rooms in cities may be another option, but they must provide a minimal sterile environment. Office buildings, prison cell blocks, cruise ships, and other infrastructure alternatives are available (Hercules et al., 2020). When it comes to movable foldable infrastructure in general, space is the resource that is the most asset. If it is managed in an efficient and effective manner, space can serve a variety of purposes, including the construction of buildings and other structures, the cultivation of crops, the operation of institutions and sports facilities, and the generation of a steady stream of income (Atkin, 2017).

The space is the catalyst for the cost of other operation (Lawrence, 1989). It helps in smooth functioning of other activities and programs in a facility (Pheng et al., 2019). The goal of space management is to effectively manage available space to maximize both productivity and efficiency while simultaneously lowering the cost of unused space (Ibrahim et al., 2011). One component of facility management is space management, which encompasses a variety of disciplines to ensure that a working environment functions properly through the integration of human resources, workplaces, processes, and technologies. Space management is one aspect of facility management. In addition, the management of space is both an art and a science that aims to maximize the use of existing space while minimizing the requirement for additional space (Pheng et al., 2019). The management of available space ought to rank among the facility's highest priorities in terms of its constituent parts. One of the most difficult challenges facing industrial and architectural designers today is coming up with space-saving furniture that can either be folded up or transformed into different configurations (Vandoros, 2017).

"Man, who is in and of himself a malleable being, both physically and psychologically, requires and desires malleable instruments" (Lauwaert, 2008).

In the context of this project, the primary objective is to incorporate as many pieces of furniture into a single module as is technically feasible through design intervention. When carrying the system from one location to another on a two-wheeler, combining will assist save space and make the process easier. There is a significant shortage of space in the patient rooms of many hospitals. More space would make it simple to move obstructions like furniture out of the way and would make it possible for patients and family members to temporarily exit the area around the bed, which is where most patient care activities take place. This would solve several issues (Lavender et al., 2002). While though light, color, nature, and the opportunity to control one's environment all have a healing effect, patient rooms with big spaces help in nursing ease and efficiency, which in turn helps patients feel less stressed. He goes on

to say that larger room spaces make it easier to do more diagnostic and therapeutic treatments, and he also says that more space means there is room for more equipment and supplies. Large areas will be able to satisfy these needs and will provide medical personnel the flexibility they require to respond to technological developments (Murphy, 2000).

On the other hand, the most significant barrier that the mobile Primary Healthcare Center (mPHC) faces is the lack of available space. It is necessary for the system to have a design that allows it to take up the least amount of space when it is collapsed, which indicates that it should supply the least amount of space while it is in the deployed condition. A collapsible design makes it difficult and beyond the scope of this project to provide the greatest amount of room. The most one can hope to accomplish through design is to create an environment in which the desired activity may be carried out in the most efficient manner possible once it has been implemented.

Alternative site that are not connected to the traditional medical infrastructure should be approached with caution. This points to the possibility of deploying temporary structures, such as mobile hospitals, in addition to base hospitals in times of war. The other part is to come up with ground-level solutions in terms of basic infrastructure that are both cost-effective and relevant to the situation. Experimenting with collapsible and foldable solutions for healthcare infrastructure is one of the ideas found as a part of this study. The simplicity and speed with which these systems can be deployed are their primary benefits. These systems must be developed, ranging from space-saving to easy-to-carry with less weight (Pentecost, 2022). Folding and cutting-packing are two well-known geometry issues associated with small-space designs (Lodi et al., 2002; Bennell and Oliveira, 2008). The stackabilization problem, which looks for minimal alterations to a 3D object so that it can be compactly stacked together (Li et al., 2012). This article examines some of the most popular foldable and collapsible designs on the market. The study's main goal is to examine and forecast potential healthcare infrastructure innovations.

MATERIALS AND METHODS

The main question which is addressed in this study is: How design of healthcare facility can be made adaptable and flexible for times of natural catastrophe? What are some feasible innovations for post pandemic healthcare facility design? To answer the above questions of urgency, this study explores possible design ideas of future healthcare facility design. Google search was used to conduct a keyword search for "collapsible mechanisms." We gathered design examples of both conceptual and real-world items. Only five concepts were chosen for analysis out of 80 collapsible mechanisms. The designs were predicted using Futures Thinking Technique to be used as part of a prospective healthcare infrastructure. We used Futures Thinking technique developed by Jane McGonigal, a research director at the Institute of Futures, Palo Alto, California, USA. Ideas were brainstormed with focus groups of health professionals around the premise of bringing innovation at all levels of healthcare services. Ideas were analyzed on some defined parameters for its feasibility. Thus, a set of ideas were proposed for future healthcare facility design.

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RESULTS AND DISCUSSION

Corrugated cardboard sheets are the most basic material that can be used to create a design. The main benefit of these sheets is that they are readily available and are simple to use. The inexpensive and biodegradable design (Fig. 1) comes with 3 foldable drawers, a strap, a moving/storing box, and a laminated white surface top, all designed with portability and limited space in mind. All the components are easily interchangeable. The table has been used as a cutting table, conference table, supper table, baby changing table, RPG table, and a bed, according to the designers. With a weight of 12 kg, the table has a dimension of 1500mm x 1200mm x 930mm. Scoring is a technique for handling corrugated sheets. Scoring the pattern with a sharp object or a knife, then folding to the desired and intended position for use. These sheets can be used to customize OPD seats and benches to meet specific needs. For rapid service, a readily available scoring design module could be available at the deployment site. Staff training will be required for the deployment procedure.

Collapsible Mechanism 1: Portable cardboard table

Fig. 1. Portable cardboard table (Rebecca, 2008).

Industrial designer Jos Blom's brilliant idea is the Jig Seat chair (Fig. 2). This small and collapsible seater is inspired by everyone's favorite childhood toy, the Jigsaw puzzle. It is made up of six wooden sections that are joined together to make the three-dimensional furniture piece. The chair is delivered flat-packed and includes an easy-to-assemble and dismantle design. This folding seater, made from a succession of CNC-milled wood sections, takes about two minutes to assemble and requires no additional screw, nail, or glue joinery fasteners. Not only for mobile hospitals or mobile medical units, but also for base hospitals, these principles can be scaled up for a vast healthcare infrastructure. This concept could be used as a common design solution in traditional hospitals to conserve space. The collapsible construction of this furniture will save enough room and will be erected as needed in a short duration. This technique should be used in the design of all furnishings in the lab, pharmacy, OT, and OPD. In addition, there should be a graphical guidebook with self-explanatory images that shows the methods to be followed to erect the design.

According to the inventor, the bed is made up of fiberglass reinforced plastic tubes (Fig. 3) that can be telescoped to fit various mattress sizes. All tubes and the remainder of the wooden frames can be held together by the angled frames, which can be arranged as a space-saving diamond. Even better, the assembly does not necessitate

the use of any tools. These designs could be used in both mobile and traditional hospitals to accommodate heavy equipment.

Collapsible Mechanism 2: The Jig Seat inspired by Childhood Building Toy

Fig. 2. The jig seat (Blom, 2013).

Collapsible Mechanism 3: The Delta Bed

Fig. 3. The delta bed (Yamada, 2008).

The PLoP! is a Joyce Hong-designed storage shelving system (Fig. 4) that is both flexible and portable. With a weight of 1.8kg, it is easy to move on public transit. The PLoP! is made of eco-friendly corrugated cardboard and is extensible, allowing to expand the basic 4-section unit to 6, 8, 10, and so on. The coolest feature is that PLoP! remains collapsible even after being extended. These could be the best options for a collapsible mobile hospital system.

Collapsible Mechanism 4: The PLoP by Yankodesign

Fig. 4. The foldable storage (Tran, 2008).

The Kenchikukagu mobile furniture set (Fig. 5) is a unique collection of furniture designed by Atelier OPA in Japan. A movable desk, a mobile bed, and a mobile kitchen are all included. When folded, the mobile bed has a tiny

working space and lighting fixture, and it can be stored in a case. With the world becoming increasingly flooded with mass-produced goods, customers are flocking to objects that give them the feeling of being a part of something special. These could be best solutions as a mobile bed, mobile workstation, and a mobile kitchen for a mobile hospital, or mobile medial unit.

Collapsible Mechanism 5: Kenchikukagu Mobile Furniture

Fig. 5. Mobile Furniture (Foiret, 2008).

It is therefore concluded that, Futures Thinking technique is an effective way to forecast future of healthcare design. The forecasted ideas proposed paved ways to think ahead in the domain of future healthcare facility design with the focus on functionality, livability, and sustainability.

As conclusion, the above study discusses a wide range of issues pertaining to healthcare facility design during any catastrophe and possible quick solutions with their potential constraints. The paper focuses to propose solutions at a basic level of furniture type infrastructure which is collapsible, foldable, and easy to carry for quick deployment, service, and recovery. This opens a discussion to envision complex infrastructure keeping this as a foundational concept. The designs studied were commercial products created by well-known designers from all around the world. Most of the designs were made to be space-saving, mobile, modular, light in weight, and rapid to deploy. As a result, it is up to the designers to take inspiration from these ideas and come up with creative solutions to make the healthcare infrastructure more adaptable. From the preceding research, we can draw the following conclusions:

a) Finding alternative adaptable methods to accommodate future healthcare burdens is urgently needed.

b) Temporary constructions that can be deployed in an emergency are one of the quick options.

c) The best technique to build temporary structures is to make them collapsible and foldable to small sizes, allowing them to be carried, assembled, deployed, and collapsed with ease.

d) For these future forecasted ideas to become key elements or an auxiliary to India's current healthcare system, it will require input from designers, healthcare professionals, and policymakers.

e) These are simple design systems from which others in developing nations might take inspiration and adopt in their own contexts.

f) While using the different collapsible mechanisms studied in the context of healthcare system, the specific use case scenario depending upon the constraints and opportunities must be followed. We need to check the healthcare standards and adherence for using a particular material.

We have seen that COVID-19 care is the contrary of the desired form of personal, humanistic, and highly tailored care that most of us expect. The COVID-19 response, if not an entirely new design paradigm, necessitates something completely different from what most of designers and architects have been designing in recent years. Thus, it is the need of the hour to think beyond, envision and embark on a completely new journey of thinking out of the box for a better healthcare facility design.

“Future is already here; it’s just not deeply imagined of” - Author

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