

## Bridging Urban Vulnerabilities: A Review of Pandemic Resilience Strategies in Informal Settlements through Urban and Architecture Interventions

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**ABSTRACT:** This paper explores the intersection of informal settlements and pandemic resilience. The study emphasizes the historical context of pandemics and their correlation with urban design, highlighting the pivotal role of urban planning and architectural interventions in curtailing disease transmission. The methodology involves a systematic review of peer-reviewed literature from databases like PubMed, JSTOR, and Google Scholar, focusing on keywords related to informal settlements, urban interventions, architecture, and pandemics. The selected articles, primarily from 2020, undergo comparative analysis, leading to the development of a conceptual framework for pandemic resilience in informal settlements. Results from the literature review are presented in two sections: «Informal Settlements and Pandemics» and «Informal Settlements and COVID-19.» Findings underscore overcrowding, poor sanitation, and inadequate infrastructure as contributors to disease transmission. Case studies emphasize the significance of enhanced waste and water infrastructures, proper drainage, and improved housing design for pandemic prevention. Difficulties implementing public health guidelines, such as social distancing, in these settings are revealed. Additionally, digital connectivity disparities and multifactorial vulnerabilities of informal settlements to COVID-19 are explored. In conclusion, the study advocates for rethinking urban planning and architectural design to address vulnerabilities in informal settlements during pandemics, providing insights for post-pandemic urban remodeling, and emphasizing resilience in future health crises.

**KEYWORDS:** informal settlements, COVID-19 impact, public health guidelines, pandemic resilience, architectural interventions.

### 1 INTRODUCTION

Informal settlements are a defining aspect of major cities worldwide, especially in developing countries. A settlement is deemed informal when either the owners lack legal claims to the land parcels, or the construction of houses does not adhere to existing planning and building regulations. The current proliferation of informal settlements can be attributed to a combination of socio-political and economic factors. Given the inhabitants' lack of security of tenure for their dwellings and the associated lands, they are best described as informal renters or squatters. Urban architecture and planning ideally play a significant role in shaping a city's structure, directly influencing the scale of disease transmission.

Diseases and pandemics have been intertwined with urban settlements since their early existence. Concepts such as 'Cordon Sanitaire,' isolation, and quarantine are age-old practices employed before humanity gained an understanding of microbes, viruses, or bacteria in times when epidemics were considered acts of God [1]. The renowned John Snow map of the London cholera outbreak is likely one of the earliest instances highlighting the practical connection between disease epidemiology and urban design. This map, potentially a precursor to GIS Sciences, was created by George Snow, a London anesthesiologist, revealing the link between the epidemic surge and a communal drinking water pump [2]. While acknowledged as a practical demonstration of the reliance on the built environment for public health and a proactive measure to strengthen urban resilience against pandemics, this perspective has faced skepticism from some researchers, [3], [4]. Nevertheless, the historical context of the Influenza Pandemic of 1918 (Spanish flu), which claimed approximately 50 million lives globally, serves as a stark reminder of the devastating consequences of pandemics, standing as the most lethal pandemic of the twentieth century [5], [6].

A variety of global pandemics underscored the limitations of stand-alone frameworks used to control infectious diseases in major cities. Importantly, the literature emphasizes the need to integrate public health sector initiatives with urban planning, design management, and prevention and control measures for deadly pandemics. Urban planning and architectural design, as long-term initiatives, have demonstrated their capacity to enhance urban settlement resilience against epidemics, making them a crucial strategy for disease prevention [7]. In the face of an impending pandemic, architects can contribute by installing temporary epidemic treatment facilities and addressing transportation and infrastructural access. This transformative approach shifts the capacity of a facility from being reactive to serving as a continuous and lifelong buffer against the progression of pandemic effects in urban areas. The ongoing COVID-19 pandemic has further highlighted the pivotal role of urban planning and architectural design in addressing such challenges. It has become increasingly clear that spatial information, of which the built environment is a part, plays a major role in epidemic severity predictions and in segmenting regions that require escalated prevention measures, such as curfews. As shown, adequate urban design practices play a role in determining inhabitants' behavior, the progression of pandemics, pandemic response capacity, and urban resilience.

## **2 METHODOLOGY**

### **2.1 COLLECTION OF DATA**

The research for this paper involved a comprehensive review of peer-reviewed journals, scholarly publications, and relevant literature on the intersection of urban vulnerabilities, informal settlements, and pandemic resilience. The primary focus was on gathering information related to urban planning, architectural design, and interventions aimed at addressing challenges in informal settlements during pandemics. A systematic review of academic databases, including PubMed, JSTOR, and Google Scholar, was conducted. Keywords such as "informal settlements", "urban interventions", and "architecture" were used together with the keywords "pandemics", and "COVID-19", to identify relevant articles.

### **2.2 SELECTION CRITERIA**

Articles were selected based on their relevance to the paper's theme, publication date, and academic rigor. Priority was given to recent publications, from 2020 in peer-reviewed journals.

### **2.3 DATA SYNTHESIS AND COMPARATIVE ANALYSIS**

The gathered information was synthesized to form the basis of the paper's results, organized into two main parts: "Informal Settlements and Pandemics" and "Informal Settlements and COVID-19." Comparative analysis was employed to identify patterns, trends, and gaps in the literature, emphasizing the evolution of urban planning strategies and architectural interventions in response to pandemics.

### **2.4 FRAMEWORK DEVELOPMENT AND LIMITATIONS**

Building on the synthesized data, a conceptual framework for bridging urban vulnerabilities in informal settlements during pandemics was developed. This framework encompasses key elements derived from the literature, emphasizing the role of urban interventions, architectural design, and policy measures. It is essential to acknowledge potential limitations in the study, such as the inherent biases in the selected literature and the evolving nature of the field. Additionally, the focus on peer-reviewed sources might have excluded relevant gray literature.

### **2.5 CONCLUSION**

The methodology adopted for this paper aimed to ensure a rigorous and comprehensive exploration of the literature, providing a solid foundation for understanding the dynamics of informal settlements in the context of pandemics and the role of urban planning and architecture in fostering resilience.

## **3 RESULTS PART 1: INFORMAL SETTLEMENTS AND PANDEMICS**

The current literature on informal urban settlements highlights that the circumstances of the built environment present them as hotspots and bedrock for microbial resistance easily transmissible among families and households. Reference [8] examined antimicrobial resistance as a renowned public health issue and an increase in disease transmission in a settlement. The reflection revolves around the number of urban informal settlements factors that designate them as hotspots for microbial

resistance. Overcrowding and proximity to livestock are highlighted as the immediate causes. Overcrowding operates together with other core factors, such as increased demand for water and sanitation services, [9]. The demand for the two tends to outstrip supply. The pressure and stress on the existing distribution networks and water sources often trigger poor functionality and ultimately non-continuity, [10]. The very nature of high vulnerability to microbial contamination in the distribution network is attributable to reduced pressure coupled with a failure to maintain disinfection residual in the system, which ultimately implies another layer of vulnerability in the provision of intermittent services. Shortage of water or augmented water supply undermines coping strategies that reduce the environmental transmission of bacteria. Through the same mechanism, a dense population and poor housing increase the residents' susceptibility to diseases that often leverage person-to-person contact for their spread. Accordingly, poor planning that keeps livestock and humans near informal settlements also increases infections. Regarding the two issues, the review concludes that the transmission aided by environmental contexts can be halted by enhancing waste and water infrastructures in the city. However, to attain the desired level of spread interruption, it is essential to gauge the impacts of sanitization, [8]. The World Health Organization suggests enhanced surveillance measures on local feces-impacted surfaces for harmful bacteria prevalence. This approach offers the best approach to providing empirical evidence-based solutions, which are currently missing to guide the planning of informal urban settlements.

The existing literature provides an essential basis for the significance of surface surveillance as a key requirement in determining the vulnerability of populations to diseases. A study on the role of sewage surveillance in Maputo, Mozambique, analyzing samples drawn from households sharing common latrines, observed the presence of all harmful pathogens with the exclusion of campylobacteria, which is responsible for diarrheal diseases in humans [11]. From a city design perspective, the results imply that a faulty sewerage system and untreated surfaces in contact with fecal material present a continuing pandemic risk. Other than providing proof that fecal materials are an important predictor of pandemic risks in a community, it offers an empirical basis for establishing secure sewerage and drainage systems incapable of transmitting hazardous bacteria. The results of the empirical research by Capone et al. (2020) are indicative that proper drainage and sewerage systems are both reactive and preemptive measures in controlling the spread of pandemics. This finding is supported by the study that analyzed Mozambique's response to Cyclone Idai, the worst environmental-related natural disaster in southern Africa [12]. The review highlighted the imperative nature of multi-sectoral collaboration in ensuring optimal hygiene, sanitization, and clean water access as a sure remedy. From these studies, it is self-evident that a clean environment is a precursor to disease and pandemic-free urban and sustainable informal settlement. However, due to the very nature of the circumstances in the urban environment, much needs to be done to reimagine the planning of informal settlements to enhance the pandemic preparedness of informal settlements.

A study was conducted to explore possible solutions for fire incidences that have become common in informal settlements around Nairobi; due to this, researchers take cognizance of the daunting tasks of directing a rapid response during fire disasters due to the high density of structures and the combustibility of the materials used in constructing the houses in the settlements [13], [14]. Coupled with the lack of vibrant fire response systems, the subsequent results of fire outbreaks are more often predictably devastating. In expounding the infrastructure vulnerability to fire disasters. Reference [13] observed that the houses in the informal settlements under investigation were tightly packed in terms of typology and design and were more oriented towards an organic pattern that had little consideration for disaster preparedness. The traditional slums in Nairobi lacked sufficient access routes. Even with the recent settlements with some routes, their designs did not anticipate the need for quick responses during emergencies. Moreover, the informality of the settlements restricts even the very utilization of basic commodities and government services. The findings in this study indicate that the major cause of fire disasters in informal settlements is illegal electrification, which was rampant in at least 43% of the households in the informal settlements. Ideally, illegal electrification, which then reveals the problem of the lack of policy involvement and political willingness to participate in the development and upgrade of informal systems as a long-term strategy against preventable disasters [13]. Reference [15] in the quest to suggest a sustainable development city framework for Harare city, has advised the need to adopt city planning approaches that are sensitive to the local realities. It was observed that the planning of informal settlements is often uncoordinated and harsh, especially where city planners resort to forceful evictions and other punitive measures. Such extremism is to Reference [15], largely to blame for systemic segregation and deprivation, sometimes self-imposed, of the population living in informal settlements.

In conclusion, the literature review on urban planning offers important insights for modeling and redesigning informal settlements focusing on strengthening their resilience against future epidemics. From the literature studied, it is apparent that the built environment of slums, due to its informality, undoubtedly sets informal settlements as hotspots for breeding and the rapid transmission of resistant microbes. The development of informal settlements is more organic, largely to blame for the lack of infrastructural capacity of the sewerage and sanitization systems and other systems for the provision of intermittent services to cater to the population and support compliance with basic pandemic prevention standards. In addition to that, the

pandemic's spread pattern follows population density. Close inter-human contact, particularly when it entails proximity with domestic animals, increases pandemic vulnerability and spreads rapidly. Therefore, future planning must factor in separating the human population from domestic animals and decongesting the two. From the foregoing, the establishment of a state-of-the-art sewerage system and drainage in informal settlements provides the best option for transforming the built environment as a long-term preventive approach. In addition, reconsideration of other structural and planning aspects to ensure the population lives in standard houses and the settlements have quick access routes for a coordinated response during emergencies and other social activities offer a glimpse of a systemic upgrade of informal systems. To some extent, a policy approach could do the magic to curb continued informalities such as illegal electrical connections, water piping, and the lack of security of tenure, which is the hallmark of most informal settlements.

#### 4 RESULTS PART 1: INFORMAL SETTLEMENTS AND COVID-19

The informal settlement remains a major health concern, often characterized by the absence of basic infrastructures. This presents a dilemma in enforcing public health regulations and necessary protocols to curb the spread of diseases. Most studies during the COVID-19 pandemic have revealed challenges for the population in informal settlements to conform to simple and basic public health sector guidelines. Reference [16], conducted a study to explore COVID-19 pandemic lockdowns in Tshwane in informal settlements within South Africa. Concerning the role of urban planning and architectural development, the study made three important findings. First, social distancing was primarily impractical due to overcrowding. About 9500 citizens in informal settlements lived in 960 shacks. The implication is that about 10 people lived in a shack measuring 10 square meters, an aggregate of 6 persons per room measuring 24 square meters. Coupled with a chronic shortage of clean water, compliance with all prevention protocols requiring social distancing, stay-at-home, self-isolation, and regular washing becomes a regrettable impossibility [17]. The population is very squeezed, implying that children who must play in smaller and almost unavailable spaces are thus in great danger of contracting the virus. Secondly, there is unprecedented pressure on the incapacitated infrastructure in the informal settlement. This means that it quickly becomes overburdened. The imposition of lockdowns meant that more people had to stay at home, increasing substantial pressure on the portable toilets [18]. Over time, portable toilets have acquired the nickname "chemical toilets" due to the increasing displeasure of the population caused by the excessive use of strong chemicals. Although they have been increased, most people prefer to squat in the nearby bushes due to their discomfort. When combined with excessive hunger, poor access to education, and lack of savings, these two developments depict an exacerbated context incapable of resisting disease progression.

Across the globe, access to health resources has remained a nightmare for people living in informal settlements. As a result, the population tends to have more illnesses and a shorter life span. Part of the reason for this is the defining element of lack of basic infrastructures such as sanitation, proper sewer, and access to clean water, whose cumulative effect is to subject the inhabitant to excessive exposure to communicable diseases and other natural pandemics. Reference [19] examined the multidisciplinary nature of the vulnerabilities to COVID-19 for the people living in informal settlements in Latin American cities. Their systematic review concluded that illegal status is the main cause of the range of deprivations in informal settlements. The primary link to this deprivation is the obvious lack of recognition and the subsequent scarcity of data that could help to expose various deprivations that could otherwise inform decision-making on disease management and federal interventions. Moreover, these regions are often not captured in most geostatistics or official maps, affecting their overall consideration in developing sensitive and focused health improvement policies. A typical example is the informal settlements in Latin American cities, where domestic spaces are characterized by excessive overcrowding. In the circumstances, social distancing rules and lockdowns deepen the woes of the population, not to mention that their implementation is largely impractical. Based on several research studies, the state of sanitization in most informal settlements largely determines the population's ability to check on the progression of COVID-19 [19].

Digital connectivity is an essential component of life today, not just because it is merely a hallmark of technological advancement but also because of its enormous contribution to transforming interpersonal interactions. During the COVID-19 lockdowns, digital connectivity was anticipated to play an integral role in aligning people with the new norms. Digital connectivity in most places has helped ease physical circulation in public spaces, a necessary preventive measure against the spread of COVID-19. In addition to that, digital connectivity has been essential in coordinating national and local responses. However, Reference [19] observed that only a tiny fraction of 45.5% of urban and rural households have internet access. Only 40% have a broadband connection, and fewer than 80% of all the homes in the informal settlement have access to telemedicine, online education, and a range of vital technologically supported services. Thus, digital segregation adds an extra layer to multiple vulnerabilities of the populations in the informal settlements. This deprivation reality explains the Latin American cities as the epicenters of the COVID-19 pandemic characterized by a disproportionately high mortality rate compared to other regions. In an argument for reconsidering urban planning design interventions. Reference [20] observed that informal settlements are marked as ultra-vulnerable places despite being home to at least 25% of the global population

to high density, economic deprivation, disease burden, and infrastructure deficits. This argument portrays the very development of informal settlements as the clearest physical manifestation of poverty [18]. This explanation is consistent with the long-standing definition of informal settlements as microenvironments within urban centers characterized by substandard housing, poor access to vital services, overcrowding, and a safe and socially undesirable environment [7]. Save for that, being a physical manifestation of poverty, the findings present planners with a substantial basis to comprehend the complexity of city problems and direct various architectural planning and design interventions. Substandard housing, for example, is often constructed with non-durable and sometimes with recycled materials [21].

Reference [20] findings in characterizing the multifactorial nature of informal settlements of vulnerability to COVID-19 came up with the concept of a super-wicked problem. The concept is an attribution of the vulnerability to conceptual problems that include urban planning and experiential evidence that highlights the accessibility of media reports on the spread of the virus in a region. In response to the latter, their research observed a missing definitive understanding of pandemic threat in the informal settlements. It has no exhaustive solutions as a wicked problem, but poor urban planning forms its crust (Liu, H& Wang, 2021). As a responsive intervention, the study found architectural and planning measures to reignite the establishment of historical links between public health and urban planning, informed adoption of pandemic-responsive planning in cities to facilitate the protection of property rights and the security of tenure as an incentive to the owners to take responsibility for sewerage and sanitization processes. Furthermore, it highlighted the use of informal settlement plans tailored to support the sharing of crucial spaces and services. When supported by the systemic upgrade of slums, it could be a long-term strategy that trains the population in the informal settlements in the art of self-sufficiency [22].

In an exposition, of the rapid peaking of the COVID-19 pandemic in cities such as Wuhan, a study noted that the measures to curb the spread of COVID-19 often revolved around basic access to essential social, economic, and infrastructural provisions [23]. However, this study observed that many planning, design, and architectural issues increased transmission vulnerabilities. Density in the informal settlements, for instance, created more fronts for social mixing and personal contact, whose effect in transmitting infectious diseases is captured in a model developed to estimate the spread of influenza in Delhi. Likewise, the household and the social structures are more flexible as they support the free movement of people between homes and sharing sleeping spaces and food [18]. These spaces are often unventilated, which ideally implies confinement of the populations in places with limited air circulation.

The growth of substandard structures in slums is spontaneous as a ripple effect of the industrial revolution and extreme capitalism, which implies that the planning does not factor in enhancement for pandemic resilience [24]. These findings are consistent with other observations [25]. In this assessment of the challenges, most African cities have faced in handling and managing the spread of Covid 19. In both cases, there is an appreciation that the built environment is a key determinant of health, which then presents a valid ground for upgrading slums. In his paper, [25]. has traced the response of most African cities in the advent of epidemics. The assessment noted not the usual approach has been the demolition of slums, a classic case being in the Cape Town conduct during the bubonic plague of 1901. Such approaches are evidence of the role of cities in defining the Epidemiological characteristics of communicable diseases. From the foregoing, it is apparent that epidemics and cities are mutually influencing their character and their effect on each other.

Reference [26] has tried to examine and assess the situation of the COVID-19 pandemic in Mozambique, Tanzania, and Zambia. The researchers noted the multifactorial nature of the causes of the spread of the COVID-19 pandemic. The study concluded that the family and household structure were most implicit, especially in urban areas where individuals were forced to rent houses together and share common resources in densely packed dwellings. At least 43% of the population in the three countries lived in overcrowded environments, which made it challenging to observe common World Health Organization guidelines of self-isolation and social distancing. With at least 41% of the population in Mozambique and access to clean and safe water, most people could not conform to regular hand washing guidelines. In addition, the water systems are poorly developed, with the emasculated capacity to serve the massive urban population [27]. As expected, studies have shown that householder satisfaction is low in informal settlements presenting strong sanitary challenges. [28], [29]. These factors combined with other environmental circumstances such as poor access to social services and wealth status aggravate the devastating implications of pandemics in informal urban settlements.

## **5 CONCLUSION**

The challenges experienced during COVID-19 were a defining reality check moment, compelling urban planners to relook and reconsider the deployment of sustainable plans for informal settlements. The scale of the spread and the hallowing experience of the urban population have been a constant reminder of the vulnerability and susceptibility of the urban population to pandemics. When juxtaposed with the difficulties of the built environment to support conformity with even the

most basic pandemic control guidelines such as social distancing and regular hand washing challenges, post-pandemic remodeling the cities in contemplation of future pandemics.

Concerning this, the study presents important insights for urban planning and infrastructural development. To start with, it is imperative to reconsider the planning to consider access to health resources and other basic infrastructures such as clean water and functional sewer systems. Access could reduce the current deprivation and segregation of informal settlements. Secondly, future planning should follow findings from empirical research in developing infrastructures with a capacity to meet the population's needs. Such is important to understand the complex issues that set up informal settlements as hotspots for pandemics. Most importantly, the literature reveals that it is possible to establish plans that support sharing of crucial social services and spaces. Plans that support strategic sharing.

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