A comparative study of fire risk emergence in informal settlements in Dhaka and Cape Town

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Executive summary: Catastrophic fires are frequent in informal settlements around the world, where one billion people live. A complex adaptive systems framework is developed to untangle the emergence and manifestation of fire risk. Insights from case study analysis in Dhaka, Bangladesh and Cape Town, South Africa reveal the importance of interdisciplinarity, broad participation, and systems mapping when addressing safety of complex systems.

Tags: urban fire risk, conflagration, informal economy, housing, inequality, complex adaptive system, pressure and release framework, Bangladesh, Asia, South Africa

Section 1: Background and introduction

Fires are a frequent, everyday occurrence in informal settlements in cities around the world. Their consequences can be catastrophic and include fatalities, long term injuries and emotional trauma, destroyed homes and assets, disrupted education and livelihoods. With a quarter of the world's urban population (around one billion people) living in informal settlements, this risk is a problem that urgently needs addressing.

The study looks at fire risk in informal settlements in two cities: Dhaka, Bangladesh, and Cape Town, South Africa. In Cape Town, research focused on the settlement of Imizamo Yethu, which has suffered numerous fires since its establishment in 1991, but none as devastating as the 2017 fire that lasted thirteen hours, killing four people, destroying more than 2,000 homes, and making 9,700 people homeless. [1] Korail, Dhaka's largest informal settlement, has similarly been affected by fire – in March 2017 a fire destroyed 4,000 dwellings and displaced an estimated 20,000 people. [2]

Whilst large fires such as these make headlines, the reality is that both cities' fire problems are chronic and worsening. The City of Cape Town Fire and Rescue Service responds to informal settlement fires every day. It reported a 150% increase in the number of fires between 2003–2018, with 289 fatalities in 2018 and 2,014 in 2019. [3] These figures do not account for fires that may have been managed by residents and not reported to fire services. In Cape Town, the number of fire-related deaths is known to be underestimated: the fire services only report deaths that occur at the scene of the fire incident, and not people who die from fire injuries later in hospitals. In Bangladesh, the number of fires has tripled over the past 22 years, but there is under-reporting of data on informal settlement fires. Bangladesh Fire Service and Civil Defense (BFSCD) data suggests there were fewer than 260 informal settlement fires per annum between 2015 and 2020 [4], however comparison between South Africa and Bangladesh in terms of number of fire incidents and casualties in respective informal settlements suggests the BFSCD data grossly underestimates these values.

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In addition to a paucity of reliable data on fire incidences, there is little quantification of their consequences. There has also been a lack of attention to fire's causal factors: looking beyond how fires are ignited and spread via proximal housing conditions and energy practices, to the broader root causes and dynamic pressures that create these conditions. There is growing recognition that urban fires are not just technical and physical challenges to be managed at the site of ignition: they have complex social, political and economic dimensions. This study understands fire risk as generated by the interactions between fire hazard and the wider social, political and economic vulnerabilities experienced by those living in informal settlements.

This study explores and maps the complexities of these interactions. It asks how fire risk emerges and how fire safety is enacted in informal settlements. It provides information on systemic/root causes, impacts and how different groups of people respond to such fires. A number of key processes and interactions are highlighted that have previously not been taken into account by more traditional, engineered fire safety approaches that tend to focus on managing fire hazards rather than reducing fire risk holistically. This is valuable information that will help those working on urban fire risk reduction – such as fire safety engineering and humanitarian development practitioners, urban risk researchers, urban authorities, disaster responders and disaster management agencies – to contextualise knowledge beyond the technical and to identify key areas for future intervention.

Section 2: Analysis and insights

Fire risk in informal settlements emerges from processes of inequitable urbanisation, where fire hazards and multiple socio-economic vulnerabilities are created

and reinforce each other. There is no one single root cause, but rather a complex entanglement of environmental and physical conditions and social processes and relations that interact to heighten fire risk. Structurally constrained conditions limit people's choice of where to live, and how, leading to ignition sources and conditions that give way to fire spread.

Pre-fire

To trace the development of fire risk in informal settlements, it is necessary to understand the contexts in which people and places become vulnerable to fire. **Figure 1** shows the architecture of a complex adaptive systems framework applied to fire risk, which integrates core tenets of the Pressure and Release and Complex Adaptive Systems models. [5] [6] This approach demonstrates how root causes and dynamic pressures lead to unsafe conditions, i.e., hazards and vulnerabilities that interact to produce fire risk. The accumulation of fire risk ultimately leads to fire incidents. Post- fire disaster consequences may generate further vulnerabilities through loss of assets, injuries, insecurity, reliance on riskier energy sources. These conditions can feed back to contribute to further fire risk emergence. This adapted framework is used throughout this study to untangle the emergence and manifestation of fire risk in informal settlements, and resulting fire consequences, in Dhaka and Cape Town.

Root causes of risk are found in the political, social and economic structures within a society that affect the allocation and distribution of resources, wealth and power among different groups of people. Here, it is necessary to acknowledge and understand the structures that have led to the widespread development of informal settlements in both cities. Dynamic pressures are more immediate processes and activities

that translate the impacts of root causes, temporally and spatially, into unsafe conditions.

In South Africa, apartheid-era forced evictions and race-based town planning brought about spatial segregation. This removed individual land ownership rights for black South Africans and prevented black, mixed race, Indian and South Asian South Africans from living in centrally located urban areas. Black South Africans were forcibly displaced, and central locations reserved for white South Africans. Post- apartheid, a progressive legal and policy framework based on the right to housing, and a state-subsidised housing programme have tried to address some of these legacies. However, implementation issues, poor planning, and lack of coordination, capacity and political will have perpetuated an acute shortage of affordable housing available to low-income households.

This shortage of housing and associated municipal services has led to the ongoing growth and establishment of dense and poorly serviced informal settlements, largely on the outskirts of towns and cities, and disproportionately occupied by black South Africans. In post-apartheid South Africa, since 1996 (and especially since 2005) economic policy has shifted towards market liberalisation and economic growth at the expense of urban integration and greater equality. [7] Income inequality continues to follow racial lines, making formal housing inaccessible to large numbers of black citizens. The available peripheral locations provide fewer employment opportunities, creating poverty traps, and unsafe living conditions.

In Bangladesh, rapid urbanisation has primarily been driven by rural-urban migration. Push factors include climate change and associated risks which destroy village homes and livelihoods in disasters. Meanwhile, the country's rapid industrialisation as a ready-made garment exporter
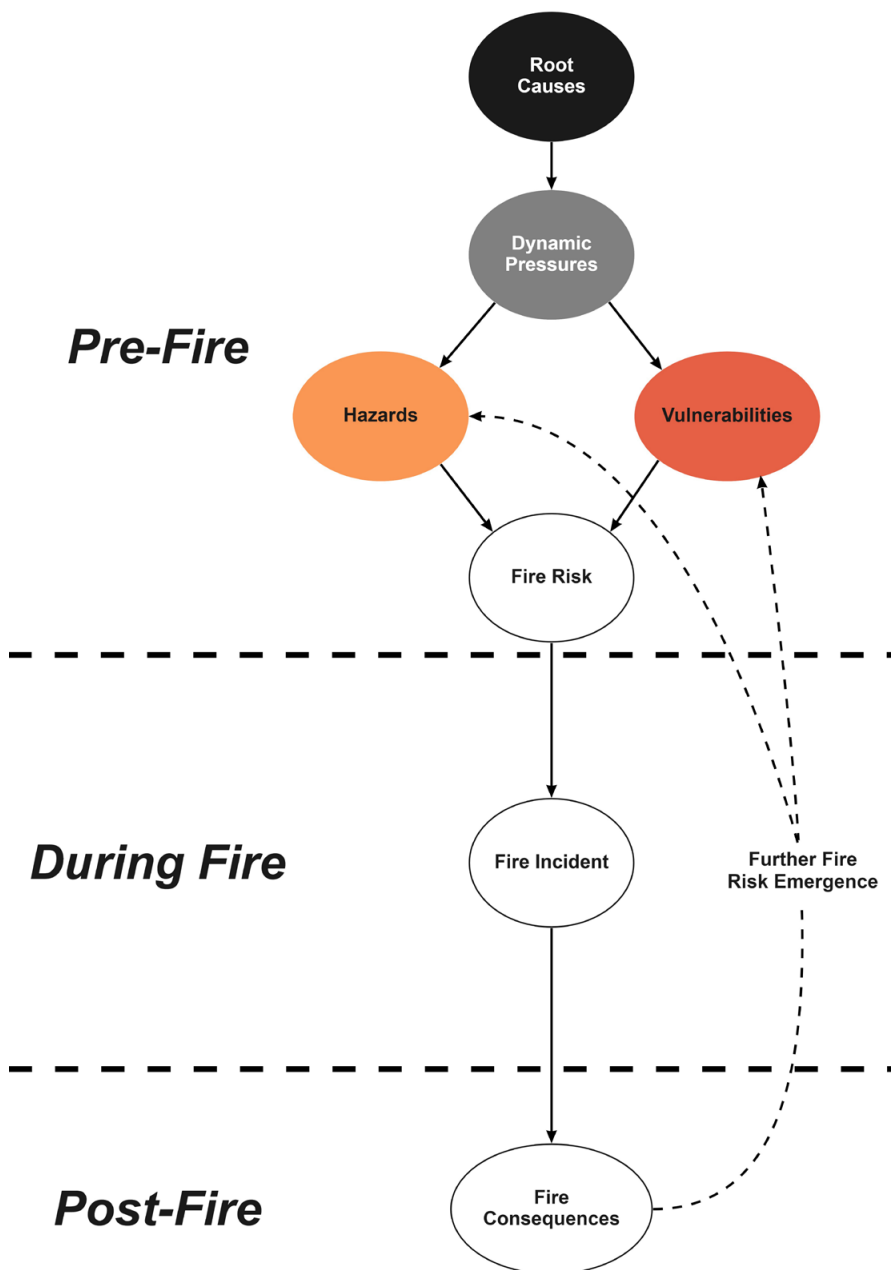
Figure 1: Fire risk complex adaptive systems framework

and associated employment opportunities has pulled people into cities. Urban densification and housing shortages have grown. Existing policies do not adequately address this rapid change, which is underpinned by weak governance, planning and urban management, inappropriate legal and regulatory frameworks, and lack of political will. Informal settlements are numerous, with their total population reaching 3.4 million in 2005. [8] Metropolitan regions have extended into formerly rural areas, resulting in dispersed and inadequate infrastructure planning and development. Urban development strategies and plans in Dhaka conceive informal settlements as illegal, contributing to ongoing marginalisation of residents in accessing adequate housing and infrastructure.

Historical legacies of urban planning, rapid urbanisation, and marketisation of urban development interact with contemporary conditions of poor governance, planning and urban management. This has led to the development of informal settlements characterised by unsafe conditions.

In general, informal settlements in both cities comprise low-quality housing with inadequate access to basic services and infrastructure. They tend to be unplanned and overcrowded, with very dense layouts. Land tenure status is often insecure, with households facing ongoing threats of eviction and demolition. Housing quality is largely dictated by affordability, resulting in the use of flammable materials. Residents may be discouraged from investing in safe materials due to tenure insecurity. Energy poverty, inadequate access to energy infrastructure and reliance on unsafe and potentially hazardous energy sources for cooking, heating, and lighting, significantly increases fire risks. Economic activities often take place within or adjacent to informal settlements, due to settlement in peripheral locations as well as socio-economic exclusion from formal employment opportunities resulting from social marginalisation. Ignition sources arise from these structurally constrained energy and livelihood options and spread via highly flammable housing materials, and dense housing layouts with small or non-existent separation distances.

In South Africa informal settlements are characterised by profound inequalities in access to basic services such as water, sanitation and electricity. Access to water is generally limited to communal water sources, with municipally supplied communal standpipes often located inconveniently at the perimeters of informal settlements. [9] Access to fire hydrants is limited. Formal electricity connections require the creation of micro grids or connection to the major grid system.

Roads may be unpaved and unnamed and houses unnumbered. Houses are constructed from affordable materials including

corrugated iron, plastics, cardboard and timber. [9] In South Africa, municipal electricity connections are not allowed on private land, and informal settlements are often at a distance from networks. Informal settlement residents in Cape Town rely on a range of energy sources to meet their needs, including electricity, paraffin, candles, gas, wood, and coal, all posing ignition risks.

In Dhaka, informal settlements are often located on government-owned land, where eviction risks exist due to land ownership disputes and the market value of surrounding areas. Population density is high; informal settlements take up only 5.1% of the city's total land but 37.4% of the total city population. [10] Settlements are found in peripheral, suburban areas but also near city centres due to access to livelihood opportunities. [8] Houses are built using low-cost materials, including mud, bamboo, corrugated iron sheets and bricks. [8] Access to adequate water and sanitation is limited. Pathways are narrow, ranging between 60–90cm in places. In Dhaka, informal settlement households cannot legally connect to the formal electrical or gas networks, so informal connections and alternative energy sources such as firewood are the primary energy sources used. Ignition risks arise via the use of naked flames indoors or in close proximity to flammable materials, or from informal, unregulated electricity connections which are often established with naked wires and are prone to overloading, causing sparks.

A range of largely unregulated informal economy activities in both cities was documented, including small-scale manufacturing, food vending, salons and fuel sales. Ignition and spread risks arise from the ways in which these activities use flammable substances, contribute to fuel loading, and use open flames, gas and informal electricity connections.

For example, a fire incident in 2016 in Korail, that destroyed 500 homes, ignited in the kitchen of a restaurant, and spread rapidly due to the fuel load of a neighbouring blanket and pillow shop. [11]

Arson is another known cause of fire ignition, allegedly used by landowners or interested parties to clear informal settlements for public or private development in Dhaka. Its incidence can be traced to market-driven urban land development and informal settlements' land tenure insecurity.

During a fire

When fires happen, residents are the first responders, and take actions such as raising the alarm, evacuating, moving possessions to safety, creating fire breaks, gathering water, and fighting fires. Inadequate firefighting equipment, training, and personal protective equipment limit the effectiveness of residents' responses, among other factors. City fire services in both cities often attend informal settlement fires but a lack of urban infrastructure such as road networks and water supplies in addition to wider issues of fire service resourcing and capacity can hinder efforts. The density of informal settlements not only contributes to fire spread but also prevents fire response vehicles and equipment from entering.

This lack of effective formal response leads to greater likelihood of fire spread and large conflagrations. In Dhaka, the average fire services response time was significantly higher in informal settlements, with an average of 68 minutes, compared to 28 minutes for the more formal residential areas in the city. [12]

Post-Fire Consequences

Property loss, fatalities and injuries are typically considered in studies of fire risk in informal settlements and tracked through fire incidence data collection systems. However, other direct and indirect consequences are rarely traced. Fire disasters can indirectly impact on livelihoods, education opportunities, and long-term mental health of residents. These shocks and stresses post-fire increase residents' socio-economic vulnerabilities in the long run, which feeds into a vicious cycle of hazard exposure and vulnerability, as well as cycles of poverty and exclusion.

Fire safety systems

Fire safety in informal settlement can be viewed as a hybrid system as opposed to a top-down command and control system. These hybrid systems comprise engineered fire safety subsystems extended from formal areas and ad hoc fire safety subsystems, which emerge and adapt to these contexts shaped by marginalisation and limited resources. There is no centralised authority – no clear stakeholder or group with designated responsibility for fire safety in informal settlements in Cape Town or Dhaka. Instead, the system constitutes self-organised actors who have various roles before, during, and after a fire, which may overlap or interact, but without much coordination. This lack of designated roles and responsibilities is reflected in the notable absence of urban fire safety from disaster risk reduction, urban resilience, and urban development discourses in both Cape Town and Dhaka. In this context, fire safety in informal settlements becomes even more of a neglected issue.

The current status of fire safety systems in Dhaka and Cape Town is characterised by a lack of oversight, governance, and communication and coordination between relevant actors, such as the fire services, disaster management agencies, urban development/planning agencies, NGOs and communities. When fire is addressed, it is through a narrow focus on physical fire hazards as opposed to a more holistic view of

fire risk emergence and underlying root causes. Communities and residents are particularly excluded from city-level conversations about developing solutions, despite the central role they have in preparing, responding to and recovering from fire, and the disproportionate risk that they bear. This lack of effective governance has knock-on effects leading to ineffective responses and contributes to fire risk emergence. Fire risks manifest into actual disasters, and disaster consequences can make residents more vulnerable, producing more feedback loops of risk. Broader conversations around service delivery, in situ incremental upgrading and the reduction of structural constraints are needed, bringing in a wider range of city actors.

Section 3: Discussion and transferable learnings

This study set out to understand fire risk as emerging from complex urban systems. This approach is underpinned by an understanding of fire risk as arising from the interactions of man-made fire hazards and social vulnerabilities, which progress temporally and spatially. The research shows interactions between system components previously considered unrelated, or not taken into consideration by more traditional engineered approaches. The nature of fire risk within a complex adaptive system means that there is not a straightforward list of interventions that can be applied. To prevent fires in informal settlements requires systemic/structural changes in urban development, tenure security, housing and energy provision for low-income urban residents. These are long-term and enduring challenges. The key message is that making safer complex systems is a process of first understanding how and why people and places are made vulnerable and exposed to hazards via social, economic and political processes. Mapping

out these risk emergence routes can help identify new knowledge and entry points for different (and new) stakeholders to understand the issues better and encourage better coordination efforts. For example, a basket of coordinated interventions is required (e.g., education, community response teams, early detection, capacitating fire departments), involving all active organisations within a community.

Recommendations for context-specific fire safety interventions (tactical and strategic) can be informed by this more realistic complex understanding of fire risk. Rather than emulating top-down command and control fire safety systems, institutionalisation of collaborative fire safety is needed that takes into account and supports the important role that all actors play [13]. This would help the whole system to bear accountability and responsibility, to counter the focus on 'responsibilisation'[1] of informal settlement residents for fire risk that emerges from across the city and not just at the point of ignition. Such an approach also takes into account the reality of informal settlement contexts for which formal command and control fire safety systems are inappropriate. The fundamental assumptions that underpin the success of formal fire safety systems do not apply in informal settlements (e.g., separation between buildings prevent fire spread, speedy response of fire services). The command-and-control approach minimises the role of the public in protecting themselves from fire (before, during and after an incident), which is not reflective of the reality, especially in informal settlements where residents are the only stakeholders able to respond quickly. [13] [14] There is, therefore, a need for more organised and supported community-based fire response.

A supporting and enabling approach recognises that

communities and residents must be worked with to inform holistic fire safety solutions that navigate local barriers and leverage resources. Improved fire safety subsystems can be adapted; for example, fire services could adapt their policies, procedures, training and equipment to address the unique fire risk experienced in informal settlements, community-driven fire safety systems could be prioritized and resourced by municipal authorities and urban fora created for ongoing communication and coordination between stakeholders with the shared goal of improving safety outcomes. Resourcing is a key issue, particularly in the context of cities in low to middle income countries, however a step change in approach is urgently needed, which aims to avoid catastrophic losses.

Whilst this research has addressed city institutional responses and perspectives it is imperative to understand fire risk and fire safety practices from the perspective of communities and residents who live with high fire risk daily. Future research is urgently needed to document and share this knowledge and related adaptive practices. Helping communities to strengthen their capacities to protect themselves from fire and fostering an enabling environment that supports and encourages the emergence of local fire safety practices may be the most achievable and scalable way to improve fire safety and fire resilience in informal settlements. [15] Engagement with diverse stakeholders (governmental and non-governmental) is critical to develop an understanding of their role and location within the system, power relations between them, and the actual roles and responsibilities that they perform whether designated or not. While there are opportunities to incrementally improve fire safety in informal settlements, through service delivery, in situ incremental upgrading, the removal/reduction of structural constraints, and where

appropriate engineering certain subsystems to be fit for purpose, it is critically important that the ad hoc nature of informal settlements is respected and that an enabling environment that promotes the emergence of fire safety is prioritized.

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Endnotes

1. "Responsibilization' refers to the process whereby subjects are rendered individually responsible for a task which previously would have been the duty of another – usually a state agency – or would not have been recognized as a responsibility at all." (Wakefield and Fleming, 2009)

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