Rejection of Containment Policy in the Management of COVID-19 in Kenyan Slums: Is Social Geometry an Option?

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Abstract

This paper contests the '*massification'* policy of 'containment' in the management of pandemics (COVID-19) in Kenya's densely populated areas. The paper proposes a typological construct of social geometry for analyzing and designing public health intervention (PHI) in areas with such unique geographies. We contrast this approach with the two most widespread forms of social control: social distancing and spatial distancing. Our central claim is that the policy of 'containment' fails to recognize the socio-cultural, economic and political complexities of the urban slum residents. This unmitigated policy predisposes the residents to risks of heightened transmission of the pandemic. Social geometry model, however, has the potential of informing the redesign of an alternative PHI that is compatible with the unique pattern of livelihood in the informal settlement. Based on the residents' pattern of livelihood (which exhibits a *pendulum-like* swings), and their geometry of life, we coin a thinking framework; '*social pendulum.*' Our conclusion revisits the reliability and validity criteria for the new framework, and offers some direction for future research.

Introduction

As the world over institutes restrictive policies such as 'containment' in preventing transmission of pandemics (COVID-19), we must ask, what does the 'containment' mean for the vulnerable population in the informal settlements? In Kenya, the government operationalized social distancing through what was popularly known as 'containment.' The policy was enforced through a number of restrictive measures; curfew (dusk to dawn), workplace closure, isolation, cancellation of mass gatherings, workplace distancing and school closure. As a result, containment policy was presented as a 'new normal.' However, the challenge with the 'new normal' policy of 'containment' is that it obfuscates and denies the inequalities of 'normal.' How 'normal' is 'normal', anyway? This is the crux of the cliché; one person's normal is another's 'abnormal.' Hence, it is extremely difficult to label certain conditions as 'normal' as opposed to other dissimilar conditions. Normal, in the context of containment policy generally infers a blanket policy or rule. From a political economy point of view, the so called 'new normal' also includes policies that have marginalized the slum residents in years. This structural disruption in urban settlement has wide and deep implications on the social geometries of life. Black (1976), defines social geometry as the social structure of behavior among individuals or collective. For instance, the day to day behavior of micro-migratory communities living in informal settlement rely on their social networks to provide for their families and seek social protection through collective actions. If this lifestyle is suddenly disrupted by restrictive policies, this community would find it difficult to survive as they do not have regular source of income. Moreover, restricting out-movement of residents in such a densely populated area leads to indoor overcrowding; an environmental factor classified by epidemiological researchers as deadly for the spread of respiratory infectious diseases in sub-Saharan Africa (Boyce et al., 2019). This is more so because the coronaviruses can lead to severe lower respiratory tract infections and acute respiratory distress syndrome (ARDS).

In light of this understanding, it is reasonable to observe that the 'containment' policy could potentially disrupt the social geometry of slum residents. Disrupting people's livelihood increases the likelihood that they become vulnerable to communicable diseases. Invariably, containment, as a public health intervention (PHI) lacks the diversity, promotes massification and constraints access to the already overburdened sanitary facilities. Although WHO (World Health Organization) (cited in Lewnard and Lo 2020), applauded social distancing as being scientifically robust with significant reduction in transmission of COVID-19 in countries such as China, the socio-economic injustices perpetuated through this policy might be overstraining to vulnerable population. In other words, the effectiveness and impact of social control will depend on the efficacy of PHI, pre-existing politico-economic dynamics, behavioral orientation of the slum residents as well as the institutional arrangement (Prem et al. 2020). To this end, researchers have recommended the evidence-based interventions as the only way public policy makers can ensure publics' trust (Lewnard and Lo 2020). Despite this budding body of knowledge on the epidemiology and politics of infectious viral diseases, the meaning of containment policy in the management of pandemics for the vulnerable population in the informal settlements is unclear.

We argue that the policy of 'containment' within the broader framework of 'social distancing' in preventing the spread of pandemics (COVID-19) has become increasingly discordant with challenges faced by the most vulnerable population in informal settlement, and impedes efforts at institutionalizing a more effective approach to its management. At the same time, the potential presented by frameworks such as the 'social geometry' goes well beyond social distancing and other social control models. Social geometry, as a model defining human interaction, could provide an important foundation for promoting an effective PHI for addressing the various socio-economic and spatial inequalities when managing pandemics. This framework aligns well with the epidemiological characteristics of the novel viral contagion, which often is asymptomatic at the time of transmission leading to difficulty in its initial detection and propensity to posing a challenge to regular surveillance in areas with weak health systems. To identify a balanced PHI strategy that embodies dimensions of social geometry remains a challenge for public health actors, policy makers and scholars concerned with the promotion of equal access to health care. Based on the outlined *social-theoretical* foundations of social geometry, the various interactions between political economy and vulnerabilities of slum residents to a pandemic are discussed.

The introduction is proceeded with an overview of the unfolding epidemiological situation and its relationship with the living conditions of the urban slum residents in Kenya. It then discusses the essence of social geometry of life. In this section, we take an interdisciplinary approach to addressing the research question by undertaking a conceptual clarification, at the same time discussing how the concept of social geometry can assist in predicting the behavior of individuals or groups affected by a PHI. We outline the methodological considerations before proceeding to discuss and conclude on the conditions of slum residents in three levels: first, we examine the vulnerabilities of communities in densely populated areas. Secondly, based on the above spatial vulnerabilities, we draw various decision scenarios using the pairwise ranking technique. Finally, we identify elements within the typologies of social geometry that would constitute an effective analytical framework for informing a PHI in the management of future

pandemics. In light of this, we are mindful that the alternative framework should reflect the realities of densely populated geographies, and that such an intervention should be inclusive, innovative and based on the socio-geometric realisms of life.

Situational Analysis And Gaps In The Literature

On 7th January 2020, the World Health Organization (WHO) announced the epidemic disease caused by a novel coronavirus identified from the throat swab of a patient by the Chinese Center for Disease Control and Prevention (CDC). This virus was named SARS-CoV-2 due to severe acute respiratory syndrome it caused. The disease caused by this virus was named coronavirus disease 2019 (COVID-19). This disease was later declared a public health emergency of international concern (PHEIC) on 30th January, 2020 by the WHO (1). This is the 3rd of the outbreaks caused by the viruses from the *Coronaviridae* family, the foregoing two having been the severe acute respiratory syndrome coronavirus (SARS-CoV) in 2002, Guangdong, China and the Middle East respiratory syndrome coronavirus (MERS-CoV), detected in Saudi Arabia in 2012 (2). The Coronaviruses are large, enveloped, single stranded RNA viruses infecting mammals and birds. These viruses can lead to severe lower respiratory tract infections and acute respiratory distress syndrome (ARDS). Governments around the world introduced suppression and mitigation measures to contain the spread of the pandemic.

An acquaintance with the epidemiological situation and settlement pattern among the urban slum residents enables one to fully comprehend the dynamics and impact of the ‘containment’ policy that was instituted from the time the first case of the disease was reported on March 12, 2020. However, it is important to note that the situation in informal settlement dates far back beyond the time of COVID-19 in Kenya. In Kenya, the first COVID-19 case was detected on an individual who had travelled from the US through the United Kingdom. As of 1st June, 2020, SARS-CoV-2 has been responsible for 6.2 million confirmed cases and 372000 (6%) deaths around the world, 1962 confirmed cases and 64 (3.3%) deaths in Kenya alone. These cases and deaths occurred as a result of rapid local transmissions through local travels, gatherings and human behavior. Although there exist no antiviral treatment or vaccine for the disease at the time of writing this paper, there are several behavioural methods of preventing and combating the disease; cleaning of hands with alcohol based sanitizers, avoiding touching one’s face, practicing respiratory hygiene, self-isolation, quarantine, restricting travel, and social distancing (Nyabadza et al. 2020). As earlier indicated the Kenyan government instituted the policy of ‘containment’ as the national strategy in the fight against transmission of COVID-19. However, this policy intervention poses a socio-economic distress to the people, especially residents residing in densely populated urban slums.

Contrary to the speculations which posits that social distancing would eliminate transmission, the cases in Kenya continued to rise (see Figure 1 derived from Annex 1), albeit less, compared to other African countries such as South Africa. The fact that the transmission of the disease continued and the COVID-19 was not eliminated deserves a reflection. This reflection illuminates the social geometry as a theoretical framework potential of predicting the behavior of slum residents under the policy of

‘containment.’ In this study, ‘containment’ refers to the measures that were put in place by the Kenyan government to restrict movement and human interaction.

On 27 March, 2020, the Kenyan government introduced the containment policy restricting movement aimed at curbing the transmission of COVID-19 pandemic. However, from Figure 2, it is clear that the infection cases continued to rise, despite the policy.

We utilized information from *Google Mobility Reports* to gauge the general pattern of movement among Kenyans before and after the policy (Google Reports as at April 26, 2020). The report shows how visits and length of stay at different places changed. In our study, this trend is interpreted as social distancing. The overall mobility trend in Kenya has decreased after the containment policy was instituted on March 26, 2020. It is evident from Annex 2, that visits to retail and recreation decreased significantly (-50%), followed by transits stations (-47%). The report shows that people visiting grocery and pharmacy decreased (-39%) as soon as the containment policy was enforced. However, in both cases there were still movements due to essential workers providing essential services. But the opposite trend was observed between work places (-19) and residential (+20) (see Annex 2) understandably because during the containment period there were companies providing essential services still operating and movement within residential spaces was inevitable.

It is not clear whether containment had any impact on the prevention of transmission of COVID-19, as seen from Figure 2, the number of new infections continued to increase with spikes being experienced from March 28 to May 25. From the county reports we can also observe that although Nairobi (-58%) experienced the most significant decrease (except for Wajir with -100%) in mobility, it continued to record spikes in the new cases of infection. This trend points to the importance of *intervening factors* influencing the adoptability of the different categories of Nairobi residents to the policy of containment. For instance, it is estimated that in the city 60-70 % of the population occupy only 5% of the city space. This has implications on access to important services including housing, sanitation and hygiene. Even though Figures 1 and 2 show relatively lower numbers of people infected by COVID-19, compared to the western world, the slum residents carry the largest risk of transmission due to the deleterious macro-environmental factors, including, poor household air condition and overcrowded housing facilities (Dianati et al. 2019). The divide between the rich and poor in urban setting is deep and wide. A recent study shows that workers earning more than US $70,000 per annum can carry on 60% of their work at home, compared to only 40% for those earning US $ 40,000 per annum (cited in *The Economist* April 2020). This trend is more dire for Nairobi slum residents. The health and demographic surveillance studies have shown that only 6% of population in informal settlement have access to piped water and 51% shared toilets and other sanitation facilities (Khagayi et al. 2011). All these forms of deprivation point to the inability of slum residents to deal with infectious diseases.

In order to gauge the movement (swing) of people in and outside the nuclei of the informal settlement, we simulated the swing as illustrated in Figure 3A and 3B. Figure 3A shows the behaviour of slum residents before the policy of containment is enforced. As earlier indicated the livelihood of people in the informal

settlement is erratic; the most viable mode of survival is 'moving away' from the *community nuclei (*land area occupied by slum residents*)*. The erratic movement serves several societal functions; residents move in order to secure food, water and safety. Also, this irregular movement of the residents is a form of coping mechanisms in their efforts to deal with the burden of providing for the family ("*family responsibility escape routes*"). To the contrary, when the residents' movement is restricted, as is, the case for the policy of containment, diffusion of people towards the community nuclei (Figure 3B) suddenly increases the pressure on available spatial space and resources. The community nuclei become overcrowded and the spatial space get shrunk. Consequently, the spatial shrinking disrupts the resident's social geometry, activating structural inequalities that eventually leads to unbalanced cost of living and access to services is truncated. This socio-economic disequilibrium increases the incidence of intra-community transmission of a pandemic.

From Figure 3B above, it is plausible to argue that the movement of people towards the nuclei of the community as triggered by the policy of containment which would eventually increase the risks of slum residents to numerous health-related threats. The government's effort to improve living conditions in the informal settlement is often thwarted by neopatrimonial power politics, hence leaving the residents to endure socio-economic destitution. From the foregoing discussion, it is evident the socio-economic interdependence among slum residents increases their *social closeness*.

This paper questions the policy of 'containment' as instituted by the Kenyan government in preventing the spread of the COVID-19. The current social distancing policy tends to assume that any attempt to prevent further spread of the virus is viable only if it is compatible with the policy of 'containment', regardless of the spatial conditions of slum residents. The social distancing, a widespread form of preventing transmission, which here in metaphoric sense implies 'spatial distancing', either endorses containment or lock down. Indeed, public health scientists have recently called for 'spatial distancing' as opposed to 'social distancing', because the former is grounded in biological and epidemiological stance (Abel and McQueen 2020). Even though social distancing has been instituted as a preventive measure, fact checks and modelling on the effectiveness of this intervention indicate albeit at a lower rate, the infection cases have continued to rise in the lock down period (Nyabadza et al. 2020). The goal of this paper is to explore alternative analytical framework for informing the design of a PHI for managing future pandemics in densely populated settlements as modelled on the Black's (1976) sociological paradigm of social geometry. Much recent studies of social geometry have been concerned with the social distancing in the management of transmission of pandemics. While some have described social distancing as a 'standard' intervention (Koo et al. 2020), others have viewed it as an 'unscientific' and 'unethical' intervention' (Lewnard and Lo 2020). Normatively, especially in studies that follow epidemiological scientism (Koo et al. 2020; Lewnard and Lo 2020; Nyabadza et al. 2020), social distancing has been considered the only non-pharmaceutical intervention available in containing infectious diseases that do not have cure or vaccine.

Hitherto, for other scholars, social distancing is a triadic doctrine that rests on the distinction between social groups of people; 'low class' and the 'upper class', where the design of the PHI should embody not

only the epidemiological characteristics of the epidemic, but also the behavioral, cultural, and political economy of the population (Abel and McQueen 2020; Campbell and Manning 2019; Zeleza 2020; Nicola et al. 2020). Those who subscribe to Donald Black's theory of *pure sociology* tend to present social geometry as an important tool for analyzing inter-group conflicts (Campbell and Manning 2019; Norris et al. 2006). Yet in other disciplines, scholars have assumed that the pattern of settlement in a given country is homogenous (Abel and McQueen 2020; Koo et al. 2020). However, for developing countries, the social stratification predominant in cities such as Nairobi implicates the effectiveness of health care system. Whereas, these studies and others that have examined informal settlement's social geometries and public health challenges therein (Beguy et al. 2015; Kyobutungi et al. 2008; Dianati et al. 2019), are key in highlighting relationship between social spaces and potential impact of pandemics, the dilemma of how restrictive public health policies affects the survival of slum residents is yet to be unraveled. Therefore, restriction of movement may increase risks of intrahousehold transmission from index to contacts (Koo et al. 2020), especially in the informal settlement where most of the facilities are shared. It is therefore imperative that the alternative framework of intervention embodies the various dimensions of social geometry-equity, social cost as well as micro-migratory behaviour of the residents.

The next section examines the dimensions of social geometry (theoretical foundations, conceptual clarity, and criticism), as espoused by pioneers of this model led by Donald Black (1976).

Essence Of Social Geometry And The Pandemic (Covid-19)

Social geometry can be a predictor of behavior in individual or collective in interdependent situation. Before delving into its predictive capability, some ontological explanation is needed. Scientific inquiries, whether, social, natural, or applied, postulate an ontology or breed system of ideas about relationships, interactions and the nature of existence in the universe. However, each one of these scientific inquiries differ, depending on their epistemological and axiological foundations. Inherent to positivism is the physicalist ontology (commonly known as Newtonian ontology), in which materials and events, located in space and time, are the focus of inquiry. In some cases, the physicalists (Smart 1959; Feigl 1958), have no regard for metaphysics. Although both set of science apply logic in arriving at conclusions in their investigations, positivists believe that metaphysics cannot be the basis of scientific reasoning, because it is imperfect mode of knowledge production. This ontological tension has given rise to confusion in framing public policies. A case in point was the management of COVID-19 pandemic: what most governments globally referred to as 'social distancing' was in fact, practically 'spatial' distancing (Abel and MacQueen, 2020). Despite this confusion, there is a growing body of knowledge that has found ways of accommodating the social space within the spatial space. As a result, although most social scientists studying social geometry, for example, accept the ontology of natural science, many contests the simplistic equation of physicalism to social distancing (Black 1976; 1998; Phillips and Lapuck 2015).

It is important to note that the foundations of social geometry are grounded in social structure of human behavior (Black 1976). Put it differently, as individuals interact, they constitute group actions or collectivities. For instance, slum residents might decide to regroup and resist government policy requiring

them to remain under curfew, because they share social space and similar socio-economic characteristics. In this sense, social geometry is a system of relationship defining cultural distance and closeness. That does not mean, social geometry is completely outside the realm of spatial space. Indeed, most of the variables studied by behavioural scientists when investigating direction (vertical or horizontal) of relationship tend to measure positivistic variables-forms, styles and quantities (Black 1995; 2002). Quantity is particularly important in determining *cultural closeness* in intergroup relationships. For instance, the more the public health officials are culturally distance from the slum residents, the higher the chances of aggression when the former decides to enforce a public health policy during a pandemic. In this conception, it does not matter how close spatially the individuals are to each other. This implies that when investigating human interactive space, location, direction, and distance are key. These three elements are often referred to as the social geometry's *building blocks* (see Figure 4). But, how do you reconcile the physicalism ontology with those of metaphysics?

One way of reconciling this philosophical divide is to view the mind phenomenon as the link between the physical space and the social being. Based on this mental functionalism, social geometry needs to be looked at as a behavioral concept as opposed to the narrow perspective of distance or merely social space. In this paper, we are developing the concept of social geometry, both as a protest against the blanket policy of 'containment' in the management of pandemics (COVID-19), and as an enrichment of the behaviorist stance in PHI and analysis. In protest terms, we sought utilize social geometry model to develop alternative approach to public health analysis, sharpen its tenets, and introduce new methods of intervention. In this regard the goal of applying social geometry in this paper is to aid is analyzing the implications of 'containment' policy in the management of future pandemics in densely populated urban spaces in Kenya, and, if possible, predict public health phenomenon in areas with similar context. For instance, if settlement pattern and population density in urban spaces of less developed countries were similar, then, the impact of 'containment' policy would be unison across the population. As the data demonstrate in this paper, this was not the case.

In this paper, we deploy, an intensive micro-analysis to illuminate this policy concern in the management of pandemics (COVID-19) in densely populated urban settlement in Kenya. This public health concern brings to the fore two common fallacies in public policy engagements: First, the ontological fallacy-the government of Kenya made the public to believe (….) that 'containment' is the absolute 'solution' to the COVID-19 crisis. As a result, which is the second fallacy of representation, a cloud of assumption was created among Kenyans of an independent reality about the policy of 'containment'. In other words, there was no context-specific intervention and given the nature of this pandemic that had not been experienced anyway else, there was no standard social control measure somewhere, with which the public health officials could use as a template to compare and contrast in order to develop accurate models. In several ways, this axiomatic tension led to speculations and hasty generalization on the impact of 'containment' on the Kenyan population. Yet, the unique challenges faced by the Nairobi's slum residents, such as the lack of access to public services and congestion, have negative implications on health outcomes (Kyobutungi et al. 2008). Indeed, implementing the policy of 'containment' in the informal settlement can be challenging when such areas lack sufficient provision of affordable housing and other social

amenities (Dianati et al. 2019). This means that a combination of social distancing strategies that does not factor-in the complexities of informal settlement cannot be part of the solution to a pandemic. This is because, if 'containment' implies restricting movements, then the slum health condition will be worsened by putting pressure on existing sanitary facilities and congestion. Consequently, if, COVID-19 disease thrives in highly congested population, then the policy of containment would exacerbate the rate of transmission among the residents of informal settlements.

However, the challenge here is not only limited to the public policy choices and the judgement of public health actors, it is also conceptual ambiguities. Social geometry, as a concept, means different things to different people. Its conceptual ambiguity and relationship with other concepts (social distancing, social control and spatial distancing), requires attention, because, they can pose a challenge when applied to the analysis of public policy decision making.

Conceptual Clarity

Although Donald Black (1976; 1995; 1998), is considered the 'father' of social geometry, the concept has attracted scholarly debates among sociologists, geographers and more recently epidemiologists. The scope of this paper does not allow us to exhaust the various conceptions of social geometry. A detailed overview of the various dimensions can be found in the Donald Black's, "*The Epistemology of Pure Sociology, 1995:829-870*." In this analysis, there are three main ways in which social geometry is constructed: in terms of location-as social space in relation to others; in a wider purposive sense to refer to social behavior resulting from interactive relationships-upward or downward depending on the status of the actors; and as an organizational sense to refer to governmental social control established to achieve specific planned PHI. In essence, the three conceptions refer to the predictability of social geometry, thus:

Location in social space; a social setting can be defined by five dimensions: stratification, morphology, culture, organization, and social control (Black 1976: 1-2). This implies that every individual in social space function in relation to the others. In the case of managing pandemics (COVID-19), the impact of any PHI will depend on individuals' relative position and status in the society.

Direction; location and direction are interrelated concepts in both social and spatial spaces. But in social space, which is the focus of this paper, human relation interacts in two main directions-upward or downward. Any PHI may trigger directional imbalances-giving rise to various forms of inequalities. One source of inequality is the uneven distribution of wealth, and how much spatial space people occupy in relation to others. In this regard, wealthy people are described as having a high status and poor people as having a low status. For instance, restrictive policies that confine individuals to work from their houses are likely to disadvantage the lower-class people because they compete for the same social space and opportunities.

Distances; without necessarily getting into the controversies of social physics, there is something particularly satisfying about being able to hypothesize, for example, that containment is directly

proportional to the rate of transmission of COVID-19 and so on and so forth. That means upward transmissions of the disease varies directly proportional with the distance between two individuals. But, in less individualised societies (such as slums), the term “social distancing” may limit the culture of ‘burden sharing’, especially in crisis situations. As earlier discussed, the densely populated settlements are often prone to be harder struck by an infectious pandemic because of poor conditions based on weak economies, and poor infrastructural connectivity. Even in situations where ‘spatial distancing’ (a term grounded in biological and epidemiological scientism, to mean physical extent), would be considered as preventive measure against transmission of a pandemic, lack of enough spatial space still presents a challenge to the slum residents. Shared responsibilities are closely knit in urban communities’ social and cultural contexts. Owing to this contextual and behavioral homogeneity, an effective PHI in the foreseeable future should be evaluated against notions such as *social closeness, migratory behavior, social safety nets* and *equity*. All these operate within the three building blocks of social geometry (Figure 4).

From the foregoing analysis, it is clear that the construct, social geometry, can play a key role in the design of PHI, therefore its appropriate application should be directly linked to the pattern of lifestyle of slum residents. In this paper, therefore, the application of social geometry model in the management of pandemics is defined as the “process of designing a PHI that is buttressed on locational human behavior, social class of people, population density, migratory behavior, shared values and social relationships across social spheres of life.” But management of pandemics can be a complicated process, involving diverse issues and actors beyond the epidemiological characteristics. Within the public policy realm, interventions take place within a national setting in which governments’ socio-economic policies and their implementation either improves or cause further deterioration of health care system.

Usually, government policies are implemented by the relevant ministries and in collaboration with other institutions. In the case of a pandemic (COVID-19), the Ministry of Health in collaboration with other institutions (universities and research) are usually coordinated to provide the technical support to the intervention ecosystem. Therefore, in analyzing the effectiveness of an intervention, the application of social geometry needs to be evaluated in two levels: First, point of intervention among the slum residents; Secondly, the socio-economic status of the residents and the relationship between the source of the public health policy and the residence will determine whether an intervention succeeds or not. This is in line with Black’s argument that ideas travelling downward in social space (from a higher status source to a lower status audience), are likely to succeed. The other consideration is case management. Although, proper use of ‘social distancing’ has been found to reduce the number of transmitted cases and death, however, in situation where the transmission of the disease is ‘asymptomatic’, social controls cannot be solely dependent on ‘containment.’ Therefore, the alternative intervention should be anchored on the contextual and behavioral dynamics of the target population. This can significantly reduce the burden of health care system, thereby promoting effective case management and treatment.

In this paper, we interrogate concepts such as, *health politics*, *vulnerabilities* etc, because they have a role to play in *reimagining* an alternative PHI framework. But as earlier stated, the notion social geometry

cannot be without criticism.

Criticism of Social Geometry

As pointed out above, some of the underlying ideas of social geometry match very closely the basic characteristics of natural sciences. However, when viewed as a body of knowledge, the concept has not gone unchallenged. Some have argued that the concept of social geometry might just be another jargon with sophisticated methods of inquiry but lacks systematic and orderly thinking and analysis (Michalski 2008). Thus, although the geometry of social relations can be a good predator and explainer of social behavior (Black 1995), most studies have merely used Black's ideas as a buttress for the interpretation of specific empirical findings (Norris et al. 2006), rather than as a framework for evaluating the efficacy of an intervention, and especially one that concerns a public health system. Ever since the time of Donald Black, attempts have been made to sustain the debate on the three main tenets (location, direction and distance), however, subjecting these tenets to purely metaphysical analysis without diverging to spatial space and actions has proved challenging. For example, Norris et al. (2006) found out that social geometry, as espoused by Black has little predictive value when applied to a specific instance of the behavior of law such as use of force by the police among the lower and upper social class of people. In this regard, Donald Black's (2000) work on social geometry, especially the relativistic nature of social space and the differences between social and spatial spaces gives insights on the difference between nature and social being, however, in this paper, we conceptualize the notion of social geometry beyond perceptual spheres of life. Thus, in order to develop an effective PHI for managing future pandemics, we may require new theorization beyond the location, distance and direction.

The critics of social geometry have pointed out that the sociologists who often apply the concept to their studies of metaphysicalism, have failed to prioritize ideas, and many a times their sophisticated social science methods and language have been efforts to debunk the doubts cast by positivists on their methodologies and techniques of analysis. As a result of this ontological tension, social scientists applying social geometry end up revolving around semantics and the obvious. Similarly, critics have cast fears that efforts by social scientists to apply social geometry in 'hard' sciences such as epidemiology is in futility, since it is not possible to apply the natural science methods of study to human behavior, culture, politics, urbanism and relationships. Recent studies by Abel and his colleague have observed that public health consequences of limiting human connections are wide and deep, leading to anxiety and domestic violence (Abel and McQueen 2020). This sociological phenomenon and other multidimensional geometric models can be further developed to explain social determinants of health care system. However, if such an interdisciplinary approach is to succeed, both social and natural scientists must endeavor to undertake not only the systematic hypothesis testing, but also be willing to bludgeon a metaphysical scrutiny of human existence.

Social geometry poses a methodological dilemma. On one hand, variables such as distance, direction and location are well studied through experiments and physical measurements. However, controlled experiments are of limited value in social science analysis. Besides, the objects of study (human beings),

are not passive, nor are they fully understandable through the study of apparent and observable behavior. Unlike the positivist, social scientists cannot be detached in the study of their objects. Although not synonymous with social geometry, cultural distance (the difference between the cultures of the home and host countries) is a concept closely related to the social geometry of life. The attempt to use the notion of cultural distance interchangeably with geographical distance in Beckerman's (1956) work (cited in Beugelsdijk 2018), lays even more ground for seeking clarity with social geometry. The point of convergence between social geometry and cultural distance lies in the why and how countries and individuals' characteristics affect the formation of perception of *closeness* or *farness*. Other associated terminologies include, "foreignness" and "psychic distance" (Ambos et al., 2019). Implicit here is the idea that cultural distance can be a barrier to human interaction due to lack of local knowledge. When seen in the public health perspective, cultural distance can have implications on the processes of designing and implementing interventions. This is particularly crucial when the public health officials and government have to make important decisions how such a structure should be designed in order to serve the densely populated residents, how much to invest, and what entry points to engage. Considerations for cultural distance will vary with stage and process, the complexity and cost of designing such an intervention, fully integrated with the knowledge of cultural distance must have some purpose.

When applying the knowledge of cultural distance to PHI *on* design, we however need some cautions; while the concept's mental utility is social space, most of the studies of cultural distance have adopted 'distance' as physical space that requires quantification (Kirkman et al. 2017). But, the 'distance' here does not necessarily have to be the distance between point "A" and point "B." In Nairobi, for example, it is not hard to find different social clusters of settlement in the neighborhood. It is the onus of stakeholders to design a PHI that is appropriate-based on these geographical and social class dynamics. The 'containment' policy by the Kenyan government during the COVID-19 pandemic was unfortunately blind to this reality, leading to unbalanced impact on the slum residents. A well thought out *intervention* would concur with what Michalski (2017) coin as 'vectors of cultural distance'. In Michalski's scheme, any urban policy intervention should consider non-architectural factors, including nationality, location, religion, communities' diversity, ethnicities and sometimes intellectual orientation. It is against this reasoning you wouldn't be surprised to find certain residential zones in cities such as Nairobi predominantly occupied by university academic staff; sometimes from same university. This view has however been contested by Black's works of latter years, in which he argues that people's occupation of spatial space is guided purely by logic-objectivity and value neutrality (Black 2013). Going back to the earlier classification of geometry of life-high vs low, downwards vs upwards, we are making assumption that, all these categories of people will respond differently to an epidemic, and subsequently to an intervention. This is what Donald Black coins as 'social differentiation in mind.'

In light of this, Black (1976) proposes four main socio-geometric analytical techniques that can be utilized to evaluate a PHI: 1) form; 2) style; 3) quantity; and 4) multidimensional. latter on in this paper, each one of these techniques will be elaborated to illustrate how the proposed alternative analytical framework could work to mitigate the impacts of future pandemics. Meanwhile the following section outlines the approach and methodological considerations in the paper.

Methods

This is an exploratory study designed to help in identifying linkages and dissonances between the socio-economic vulnerabilities of residents in densely populated Nairobi's informal settlement and the prevalence of the pandemic (COVID-19). Given the fact that it was the first time the disease (COVID-19) was being experienced among the human population, exploratory approach was ideal to gauge the '*fittability'* of the new PHI (containment) among the slum residents. To understand how the targeted residents were adapting to containment policy inform of mobility, we reviewed the *Google Data Reports* (as at April 26 2020). This report, together with other national data bases such as the *Kenya Demographic and Health Survey* (2014), *The Economic Survey of 2020* (Republic of Kenya, 2020), and the *Kenya Population and Housing Census* (2019), provided the researchers with insights on important variables including population mobility (before and during the containment period), population density, health facilities across the city as well as information on livelihoods of slum residents.

To put the study into perspective and the understanding of social space, we reviewed and developed a theoretical typology of social geometry. The geometry of life typology was based on Donald Black's (1976) model of *pure sociology*. The analysis of the social geometry typologies was limited to the documented profile of slum residents in Nairobi. The choice of Nairobi was guided by the fact that the most densely populated settlements in the country are located in the city, thus: Mathare (68,940 persons per square kilometer); Kamukunji (25,455); Makadara (16,150); Kibra (15,311); Dagoretti (14,908) (see Annex 3: Republic of Kenya, 2019). The documentary review and content analysis methods were complimented by Pairwise Ranking technique, commonly known as Perron-Rank. Pairwise ranking was preferred because it supports our scenario development in search of the most suitable option to PHI in informal settlement. The technique has been hailed by social scientists in developing arbitrarily different rank order and prioritization of projects, issues affecting the community or policy choices (Tran, 2013). The method was ideal for this study as it helps to reveal the implications of the ranking result in gauging the risk levels projected by the three PHI policy options-containment, lockdown and the new framework-social pendulum.

The above set of data and methods are useful in understanding how the socio-economic and political determinants of health influence the susceptibility of slum residents to risks of a pandemic. We deployed social geometry model to inductively develop concepts, properties and interrelationships and tested it against the existing literature on social space, urbanism and the epidemiological characteristics of COVID-19. We then utilized the concepts *constructively* as a way of theoretically developing an alternative analytical framework (see Figure 5) for scholars and public health interventionists interested in managing future pandemics among densely populated communities.

Discussion And Conclusions

In this section, we continue to build the analytical framework (*social pendulum)* based on socio-geometric constructs developed in the previous sections. The construct is then designated as the *model*,

which helps us develop projections of the situation under the ‘old normal’ (without the policy of containment) and the ‘new normal’ (under the policy of containment) in the context of COVID-19, and probable future pandemics. While taking this trajectory, we explore different ways the social geometry model could offer insights for analysis and design of an effective PHI in the management of future pandemics in densely populated informal settlements.

Rejection Factors: Vulnerabilities of Slum Residents

Within the realm of the model, we will therefore explore five policy scenarios (*what-if*) that are likely to have implications on the susceptibility of the residents of informal settlement to the future pandemics; epidemiological characteristics of the COVID-19, quality of housing, household air pollution, migratory behavior of residents, and social safety nets.

The epidemiological characteristics (transmission and infectivity profile) of COVID-19 remains uncertain. Indeed, SARS-CoV-2 has been found to exhibit high transmissibility potential- estimated to be between 2.2 – 3.11, significantly larger than 1 (Zhao et al. 2020; Fis Majumder et al. 2014; Read et al. 2020). COVID 19 generally carries the course of mild to no clinical symptoms during the incubation period that may last up to 3 weeks, making these people capable of continuing with their daily routines and spreading the infection unperturbed to the unsuspecting population. Other studies have reported that oro-fecal transmission may also be possible (Danchin et al. 2020). Therefore, as projected by our model, suppressive policies such as staying at home, and banning non-essential travels can significantly reduce the reproduction rate of the virus. However, although these measures can play crucial role in controlling transmission, the predisposition of slum residents to risk factors such as lack of sanitary facilities and overcrowding are likely to increase their vulnerabilities to an outbreak or even high number of comorbidities. Even to the larger population, these suppressive measures Kenya has adopted caries a risk of a second wave of the disease outbreak. This implies that for any PHI to have long-term impact on the population, the framework must be implemented in tandem with other socio-economic measures. In efforts to address the limitations of mitigation and suppression measures, various predictive mathematical models for epidemics have been proposed. They include SIR (Susceptible, Infection, Recovered) and SERS (Susceptible, Infection, Recovered, Susceptible) models, which describe individuals through three mutually exclusive stages of infection: susceptible, infected and recovered, SEIR (susceptible, exposed, infectious, and recovered) model that considers post-infection incubation period in which an exposed individual is not infectious, mass-action SIR model, and Edge-based compartmental model (Giordano et al. 2020). It is however, important to note that these models only represent the epidemiological profiling of pandemics, future PHI must stress the need to create a wholistic approach in the management of infectious diseases.

In the event that the policy of containment is enforced in the foreseeable future pandemics, our analysis suggests that outbreak prevention in informal settlement will do relatively little to prevent transmission of the pandemic, provided that 65% of the 4 million people living in Nairobi continues to reside in the informal settlement. This observation has been reinforced by previous studies on why any public policy in

informal settlement cannot succeed, unless the issue of population density is adequately addressed (UN HABITAT 2019). It is a combination of factors, however, central to this is the *quality of housing* in the informal settlement. Challenges facing slum residents in Nairobi are numerous, ranging from small dwelling, high population density, pollution, shared facilities, multi-generational households and lack of clean water. This observation is consistent with recent studies that found out that within the informal settlement there are higher levels of intra and inter social mixing, poor environmental conditions, transient residence, and less regard to human well-beings that makes slum residents highly vulnerable to infectious diseases (Emina et al. 2011). The implementation of containment policy, however, is likely to have an acute negative effect on slum residents who live in *makeshift* single-roomed units made from corrugated iron or mad and often serve as the kitchen, bedroom and sitting room for a multi-generational family. The double tragedy for the residents is that, not only are they vulnerable to various forms of transmitted diseases given the quality of housing they live in; but it is also very difficult for them to implement government policies especially those that require adherence to spatial distancing. Thus, future implementation of the policy of containment becomes a function of risk as to whether such policies will prevent transmission of a pandemic or will in fact accelerate intra-house transmissions. Our analysis is consistent with Gibson et al. (2019), who argue that lack of access to public housing, and regular income has turned the residents into paupers who find themselves in the bustling cities. Public accountability has been compromised, thus, as projected by our model, control of local transmission might not be possible using an intervention mechanism that do not take into account the socio-economic dynamics of the residents in informal settlement.

In regard to household air pollution (HAP), our analysis show that under business-as-usual (before the policy of containment), the movement of residents away from the nuclei of the community (as illustrated in Figure 3A), would decongest households while at the same time maintaining social closeness. Hence, reducing the risk of establishing the pandemic through intra-house transmission. However, the trend changes with introduction of containment, as residents are compelled to *swing* inwardly leading to sudden drop in the quality of indoor air. This policy-induced behaviour should be taken as a warning sign that if a PHI is to reach the WHO acceptable quality of air free of indoor pollutants and other hazardous substances, government regulations and budgetary allocations should be accelerated to improve both indoor and outdoor air conditions. According to our model's projection-without addressing the social geometries of life (inequalities, abject poverty, poor physical planning and poor housing), feasibility of an effective PHI in the foreseeable future is in doubt. Even for the current COVID-19, for a downward trend in transmission to be achieved, especially for asymptomatic cases, poorly ventilated housing structures in informal settlement should be addressed. Otherwise, scenario illustrated in Figure 3B will increase the vulnerabilities of residents at the same time complicate the implementation, as containment would mean, stress on sanitary facilities, pressure on spatial space, and increased indoor pollution. However, if the preventive effect of containment and other social control policies reduces significantly due to *civil disobedience* by slum residents, the state might establish other alternative measures such as compulsory quarantine and total lock-down, which could become unattainable when the number of infected individuals exceeds the capacity of health-care facilities. In the event that suppression of the slum

residents by the state fails, and the scenario in Figure 3A remains intact, the lack of alternative means of survival compels the residents rely on air quality compromised lighting and cooking facilities (use of old rugs, and plastics). Our model, which examined hypothetical behaviour of residents under two different conditions (3A and 3B), showed that for the baseline scenario (without policy of containment), voluntary self-isolation would be effective, especially where access to sanitary facilities is limited. However, the caveat here is that, the PHI should be one that has the capability to mitigate intrahousehold transmission from index cases to contacts.

The continually spiking percentage of transmission of COVID-19 infections in the country despite instituting the policy of containment suggests that there are other *intervening factors*, whereby the "unknown" factors contributing to transmission averts the effectiveness of the social control measures. The effect of school closure, work-from-home and other mobility restrictions were comparatively promising. The assumptions by the Kenyan Ministry of Health was that by "containing" people in their homes, they would then redirect investment towards quarantining those infected as an ultimate measure of controlling further transmission. However, asymptomatic cases that accounted for 80% of the infected population, unfortunately turn out to be a significant contributor to the transmission. The challenge, however, was the identification of such individuals, and especially in informal settlement where residents exhibit *irregular migratory behaviour*. This lifestyle is unique feature of slum residents, who exhibit *pendulum-like* swings in search of food, job opportunities, new networks, escaping the scourge of hunger and domestic quarrels. The swing is also a sign of personal safety and security. Our model point to the potentially high transmissibility given the *irregular migratory behaviour* of slum residents. Factors contributing to this susceptibility are many: the mode of transport is a concern since many slum residents in Nairobi rely on public means of transport that are characterized by crammed mini-busses and vans (*matatus*) often for long distances making this form of mobility a perfect vector for the spread of respiratory diseases. But even after the government announced countermeasures to curb the spread of the disease, still slum residents are inadvertently affected.

Most of the slum residents are daily wage earners either from low paying jobs or from petty businesses. Most of them, unlike other well-earning city residents, can hardly save any money to cushion them in time of disasters. This means, the containment policy would either leave them to starve to death or some would be forced to break the lockdown rules in search of income. The government cash -transfer for the poor and food portions have not been effective especially, due to clandestine networks that operate in informal settlements. This is in line with our model's projection that inequalities give rise to differences and conflict in status and sometimes influences important decisions such as resources allocation and distribution. An effective PHI should therefore make use of existing inter and intra relationships; how often people in a locality interact, scope of their interaction, and the length of their relationship (Black 1976: 40-41), determines whether such policies succeed or rejected.

To achieve this, our study suggests, rather than curtailing people from *livelihood swings* (movement), an effective PHI should aim at; 1) closing the *swing loop* (in other words, provide the needed basic requirements to the residents, including watering point, movement corridors, sanitizers, and indoor

ventilation facilities); and 2) intervene *just-in-time and space* (JITS). JITS, aims at minimising overcrowding by ensuring that the PHI is provided wherever the immigrants are found along the swing path-way. However, the PHI should recognize that intervening on the basis of JITS may not necessarily be the panacea for preventing the transmission of a pandemic, because this is a logistic intensive process that depends on the efficiency of the existing public health infrastructure and other collaborating institutions. In the world of public policy, the delays in decision and lack of provision of supportive facilities to migratory population may actually lead to spikes in transmission of an infectious disease, leading to a potential humanitarian disaster. Previous studies that have examined other control measure beyond the draconian ones (containment and lockdown), recommend effective monitoring and surveillance capabilities (Ng et al. 2020). This mitigation strategy was deployed in Macau, China and Taiwan. In the foreseeable future where the policy of containment fails, this would enable government agencies to trace contact as well as regulate the movement of potentially infected individuals, will assist in early detection, treatment, and efficient data collection. In line with our model's projection-informal settlements lack designated entry and exit points, with 'containment', it becomes extremely difficult for individuals to know who resides in which house and general suspicion of government activities and a sense of solidarity affects information gathering.

Finally, our analysis establishes that *social safety nets,* when used in combination with changes in the above policies, have the potential of mitigating transmission of future pandemics. As per our model projection- lack of social security measures such as health insurance coverage can be exacerbated through societal inequalities, job insecurities given that most of the residents rely on daily livelihoods without pension. Social control measures instituted under the policy of containment included casual workers from informal settlement being subjected to compulsory leave days, yet there is no guarantee that one would be recalled back after the pandemic is over. For those who are into the private sector, the majority are absorbed into low-earning, high-risk jobs like waste recycling, street vending, and artisanship. The state brutality executed through police force, meant that the slum residents violates social control measures in order to earn a living. However, in this study, we observe that for future pandemics, if the preventive validity of social safety nets is to be enhanced, the PHI framework should be integrated with these patterns of livelihoods. But also, the PHI framework should embody a *social sensitivity* (gender, age and socio-economic status). These social sensitivities should be an integral part of the future response strategy to pandemics. Our observation concurs with JP Morgan's (cited in Mail online 2020) findings that the falling infection rates after countries lifted lockdowns suggest that the COVID-19 has its own dynamics, which are unrelated to often inconsistent lockdown measures. Related to this is the question of social injustice. The declaration by the Ministry of Education for all schools to shift to online learning as part of the containment policy, was yet another burden to the slum residents. Previous studies have clearly shown how the Kenyan education system perpetrate inequalities across the entire ecosystem- staff, facilities and equipment (Alwy and Schech 2007). Although previous studies show that school and workplace closures could moderately reduce the transmission of influenza and delay the peak of an epidemic (Koo et al. 2020), our model projection shows that enforcement of such draconian policies could trigger structural inequalities, hence, magnifying the already existing societal imbalances; a factor

that account for the high economic hardship and social distress during and post-COVID-19 era. Thus, what constitutes the most suitable PHI framework for informal settlement?

Decision Matrix: How to Select the Most Suitable PHI

In this paper, we also wanted to understand how the variables (henceforth referred to as “risk factors”) in Figure 3 would be affected by various PHI policies (containment, lockdown and social pendulum) on pair wise ranking technique. The severity of the “risk factors” is based on the discourse analysis (literature review) of the same factors in the preceding section. The ranking would then facilitate decision making in selecting the most effective policy in managing future pandemics. On this technique, the most effective policy is one with the highest frequency of the “Green” label, while the “Red” would symbolize inappropriate or potentially harmful policy intervention. To be precise, for the three policy options, the 16 items were compared in the decision matrix (Table 1) such that the rankings generated the prescribed policy option.

Table 1: Decision Matrix

RISK FACTORS / POLICY OPTIONS	Indoor Pollution	Social Networks	Asymptomatic	Outdoor Pollution	Sanitary Facilities	Infrastructure	Closeness	Collectivity	Social Distancing	Domestic Violence	Water Stress	Ventilation	Inequalities	Value System	Livelihood Disruption	Irregular Migration
Containment	Medium Risk	Medium Risk	High Risk	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Medium Risk
Lockdown	High Risk	High Risk	High Risk	Low Risk	High Risk	Low Risk	High Risk	Low Risk	High Risk	High Risk	High Risk	High Risk	High Risk	High Risk	High Risk	High Risk
Social Pendulum	Low Risk	Low Risk	Medium Risk	High Risk	Low Risk	High Risk	Low Risk	High Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk

KEY

- High Risk
- Medium Risk
- Low Risk

Source: Authors’ Construct

The number of times a “risk factor” had been found to be most affected by a particular “reagent” (policy option) was determined by counting the number of times a distinct color appeared in the decision matrix (“Red”, “Yellow” or “Green”). Each one of the “reagents” were mutually exclusive. The assumption here is that the “reagents” (policy options) would be introduced at different times to the same group of people. Residents’ reaction would vary according to the reagent’s effect. The outcome of the decision matrix facilitated the construction of Table 2, with each “risk factor” being compared against the three policy

options. Thus “Containment” was compared first with “Lockdown.” We deduced that “containment” induced the least (1 out of the possible 16), “High risk factor” compared to “Lock down”, which generated the highest (13 out of possible 16) “High risk” factors followed by “social pendulum” with three “High risk” factors. In line with our model projection, if movement restrictive policies, such as containment and lockdown, are instituted, most of the items would indicate “High risk” and “Medium risk.” However, infrastructure, and collectivism seem not trigger “High risk” on the same policy. Interestingly, ‘infrastructure’, ‘collectivism’ and ‘asymptomatic’ factors would actually change to “High risk” if the *social pendulum* was to be adopted as the policy option for managing a pandemic. The policy option recording the highest number of risk factors, is considered to be the least preferred option. In this case, “Lock down”, appear to record the highest (13) in the matrix than any other policy option (Table 2). Hence, the public health officials and government authorities would be advised to be cautious of a “Lockdown” as a PHI.

Table 2: Ranking the Policy Options

Policy Option	High Risk	Medium Risk	Low Risk	Score	Rank
Containment	1	15	0	1	3
Lockdown	13	0	3	13	1
Social Pendulum	3	1	12	3	2

Source: Authors’ Construct. Table 2 is a derivative of Table 1, the former ‘matrixed’ the reaction of the three policy interventions against the 16 items (“factors”) considered risk in the informal settlement

In line with our model projection, “Lock down” policy option was considered to be the most ‘problematic.’ From Table 2, it is emerging that, although the *social pendulum* option generated the highest number (12 out of 16) of “Low risk” factors, its adoption would have to consider two structural factors: First, if it is adopted as a *solitary* PHI, it is likely to put pressure on existing outdoor infrastructure (watering points, roads, and other public amenities) and contribute to outdoor pollution. Secondly, the epidemiological management of the asymptomatic condition among the residents will be crucial. As illustrated in the decision matrix (Table 1), this “risk factor” is likely to be highest for both “Containment” and “Lock down” policies. Although, it would indicate “Medium risk” for *social pendulum,* this shows how complicated it can be to control the spread of the disease when residents are asymptomatic.

In the event all the three policy options fail to curb community transmission through asymptomatic individuals, a combination of interventions should be integrated in the PHI, including surveillance, school closure, work place spatial distancing. In a recent study, Qun and his colleagues recommended that in situation of a persistent asymptomatic conditions, potential secondary control response strategies should be part of the intervention (Qun et al. 2020). In line with our model projection, prevalence of future pandemics will be mainly driven by the resident’s access or lack of access to sanitary facilities, social safety nets and appropriate urban planning that accommodates the unique behaviour of people living in informal settlement.

Given the conditions under which slum residents live, it is important at this juncture to try and address the central concern of this paper, what does the 'containment' mean for the vulnerable population in the informal settlements? What would therefore be the most suitable PHI framework for managing future pandemics? The idea of "*social pendulum"* is based on the theoretical typologies of social geometry that considers the social, economic and political factors, as key determinants of health in the informal settlement.

Social Pendulum: An Alternative Framework?

The socio-geometric building blocks discussed in the foregoing sections indicates that such constructs can shed some light on the human behavior and what type of PHI would be ideal for informal settlement. We would like to emphasize here that effective PHI has to consider context and behavioral characteristics of the residents. The framework we propose here ('*social pendulum*') is based upon the philosophy of social science that requires search for meaning and explanations that predict human behavior and the social consequences of actions and actors. Therefore, a scientific explanation is required to explain how an effective intervention works and not necessarily cause-effect explanations. In explaining the validity of such an explanation to an intervention, it is important to consider how much the public can benefit and not how much the explanations exclude other explanations or theories that could also provide an alternative explanation of how human behavior is altered by changes in social geometry. In any case, such perspectives may provide useful explanations for explaining other social geometries of life.

The whole process of applying social geometry to PHI is one of intense interactive relationship, therefore all the dimensions involved must be structured to offer support to each other. The interaction between the dimensions is conducted through the intercourse of both technical and bureaucratic actors. This self-reinforcing mechanism between actors and the process acts within a social space framework. In other words, the pandemic has a social dimension a rising from different classes of socio-economic inequalities and social distances. The '*urbanites'* and, especially, the slum residents' (henceforth referred here as *slumites),* behavior and cultural values strongly influence whether a PHI will be accepted or rejected. For instance, *slumites* who are socially close to each other will handle the pandemic differently than those who are socially distant. The PHI may decide to follow this pattern of behavior or simply impose a generic scheme designed without considering the contextual dynamics. These social characteristics of the public health officials determines the outcome of an intervention. The actions and behaviours of both the *slumites* and the public health officials can all be conceptualized as changes in social geometry. In this light, 'containment' policy by the Kenyan government that was instituted to prevent transmission of COVID19 is viewed as a conflict that is caused by changing social geometry. In the social space parlance, such changes are labelled deviant behavior-downward-upward, because they alter the social geometry balance of power in a community. On this account, it is plausible to argue that 'containment' policy disrupted the structure of *slumites* in different directions, location and distance. As observed by Black (2011:6), the severity of this disruption is a direct function of the magnitude of the change. On the basis of this explanation, it is reasonable to observe that the containment policy gave rise to different forms of social geometries.

It is therefore necessary to analyze the importance of these socio-geometric (im)balances with the aim of *reimagining* an effective PHI in the management of future pandemics.

Geometry and form. The analysis and the design of an effective PHI should allow the stakeholders to see how the relationship fits together, and how the intervention serves the intended function of preventing transmission of the pandemic (COVID-19). As discussed earlier, *form* suggests how such a structure should be designed in order to ensure residents trust public health officials and they feel socially *close* to them.

Geometry and style. Ideally, the explanation and the design of an effective PHI should be able to account for the unintended consequences of the intervention. An important consideration is that, when containment of collective communities in the informal settlement is increases the flow of people *inwardly*, the risk levels goes high. To avert this, the PHI should trigger outward swings, which eventually increase social closeness of the *slumites*. The closer the social distance, the more likely the homogenous group will collaborate with public health officials in instituting the PHI. As earlier illustrated in Figure 3B, spatial distance has minimal influence on survival of slum communities, because they can still retain connections through social networks.

Geometry and quantity. one of the principles of ethnomethodology is that the interpretation of the intervention should be bestowed upon the affected population. Since cultural distance can be a hindrance to public health officials, this can be checked by examining how the *slumites'* treat their acquaintances vs strangers. For example, if the attitude of the host community treats the existence of strangers as an intruder, then the likelihood of harsh judgement and rejection of an intervention is high. The interventionists should then integrate tolerance factor in their design. Ideally, the design should "grow" closer relations with the host population. This observation is supported by Black's (1998) and Cooney and Phillips (2017) views that when efforts are made to 'normalize' relationship, people that would otherwise develop hostility against foreigners turn out to be 'friendly' and exercise tolerance.

Multidimensional geometry. An understanding of the urban socio-cultural structures and their functions in the community helps the interventionists to make sense of people's preferred approach to solving their problems, such as why the opinion leaders blink the eye and turns the head away, rather than saying no. In analyzing and designing PHI, caution must be made to ensure no new problems are created. For example, one of the residents does no say no to the social distancing rules being articulated by a public health official, but rather blinks the eye and turns the head back. This behavioral manifestation provides confirmation that the intervention is likely to be *rejected* or cause harm to the residents. To make sense of this intergroup dynamics, Black (2004) analytical framework provides five elements that are useful to the design of public policy frameworks: 1) interventions should ensure high intimacy and interdependence between members; 2) the intervention should not alter social geometries; groups should maintain the social closeness; 3) the intervention should be functionally independent; 4) create or sustain cultural closeness among the population; and 5) groups can be separated by an intermediate degree of relational distance.

The above criterion is key in ensuring that the group configuration is intact and that the public health interventionists build up on the existing social geometries. However, with the complex nature of informal settlement, it is not feasible to have a 'one-fit-all' approach to PHI. Interventions that tend to degrade the solidarity and perpetrate inequality among the *slumites* are more likely to be *rejected*. Worse still, such an intervention may end up exacerbating the already underlying socio-economic vulnerabilities. In the foregoing discussion, the profile of *slumites* reveals that their pattern of livelihood is *erratic* (unpredictable), and their coping mechanisms and livelihood activities are *multi-directional* (see Figure 3A & 3B). As a result, the residents can hardly follow a systematic order of events, rather they are in constant *swing.* However, the movement (swing) is not linear, but the day to day needs pushes them to swing between their *makeshift* houses and the "unknown" destinations, and back. In this paper, the *swings* represent the socio-economic needs of the residents, while the *makeshift* houses represent the fixed points in an actual pendulum. Hence, we coin the notion '*social pendulum*', figuratively to represent the PHI *structure* that is anchored on realities of the target population.

The idea of '*social pendulum'* allows *slumites* to '*swing'* freely depending on the time, available spatial space, location, distance, direction and access to livelihood opportunities. The swing also symbolizes the residents' coping strategies against economic, social, and health risks associated with high concentration of people within a limited spatial space. As earlier demonstrated (see Figure 3A), an effective intervention should then be one that allows diffusion of the population away from the '*community nuclei'* to other destinations. Essentially, our proposed model offers a canal path-way for decongesting the spatial space, at the same time sustaining *social closeness* of the *slumites* for their socio-economic survival. This '*pendulum-like'* movement (see Figure 5) of people as they seek livelihood opportunities, has the potential of creating indoor spatial space, which in turn improves ventilation of housing structures. The infrastructure should allow for adequate spatial spacing. This is crucial in lessening the ecological exigency on sanitary facilities. These socio-environmental conditions are known to prevent spread of respiratory illness (Dianati et al. 2019).

Figure 5 summarizes the concepts, properties and the path ways of the new analytical framework for informing PHI in the management of future pandemics in informal settlement.

In conclusion, it is important to note that there is no theory of social geometry- certainly not a theory in public health. There are however, theories of public policy making (Birkland 2016; Kitschelt 1986) that rely on the underlying premises of social geometry. As demonstrated in our analysis the four key areas of convergence between the social geometry and public health domain are; social groups, decision making processes, institutions and socio-economic and political impact of policy on population. These ideas find a home in public policy (Kitschelt 1986), obviously with implications on PHI. Ideas and interventions not directly addressed by this paradigm can also be addressed by social geometry. But neither the social geometry nor our newly proposed framework-*social pendulum*, is a theory. What '*social pendulum*' framework enables us to do is to shed new insight on ideas drawn from social geometry, taking into account the minimalistic nature of epidemiological theories that are not broad enough to address public health issues in population with unique settlement patterns such as slums. Therefore, the model

presented in this paper and the proposed analytical framework are not presented as the absolute model for reference by public health interventionists, rather only a perspective that could be further developed to inform both research and practice in the management of future pandemics in less developed countries.

Declarations

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Competing interests

The authors declare no competing interests.

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Figures

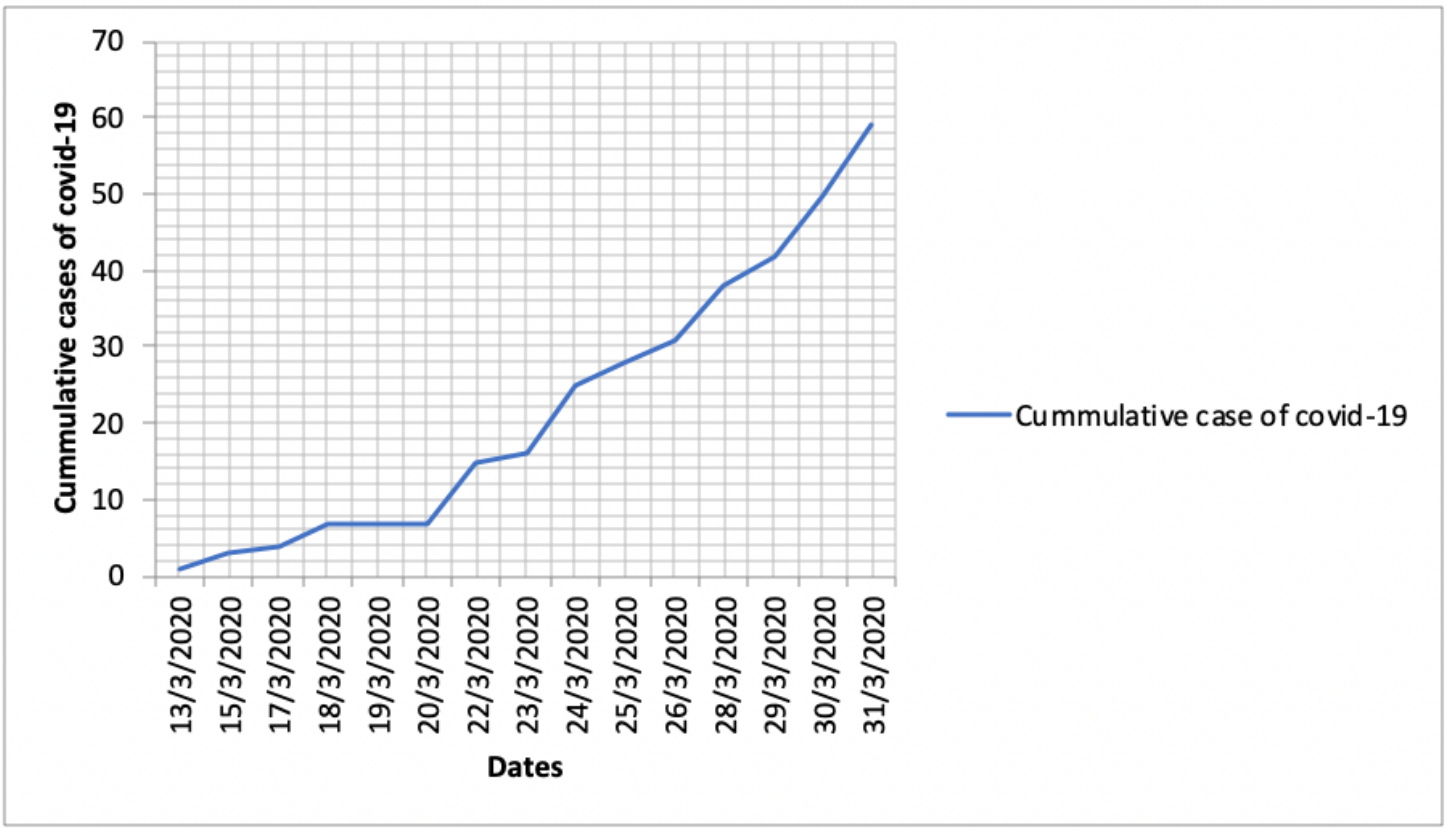

Figure 1

Daily Cases of COVID-19 Transmissions before Enforcing the Policy of Containment. Source: Author's Compilation based on the data obtained from the Republic of Kenya's Ministry of Health; Daily Transmission of COVID-19 across the 47 Counties. Analysis and plotting of the graph are based on infection cases tabulated in Annex 1.

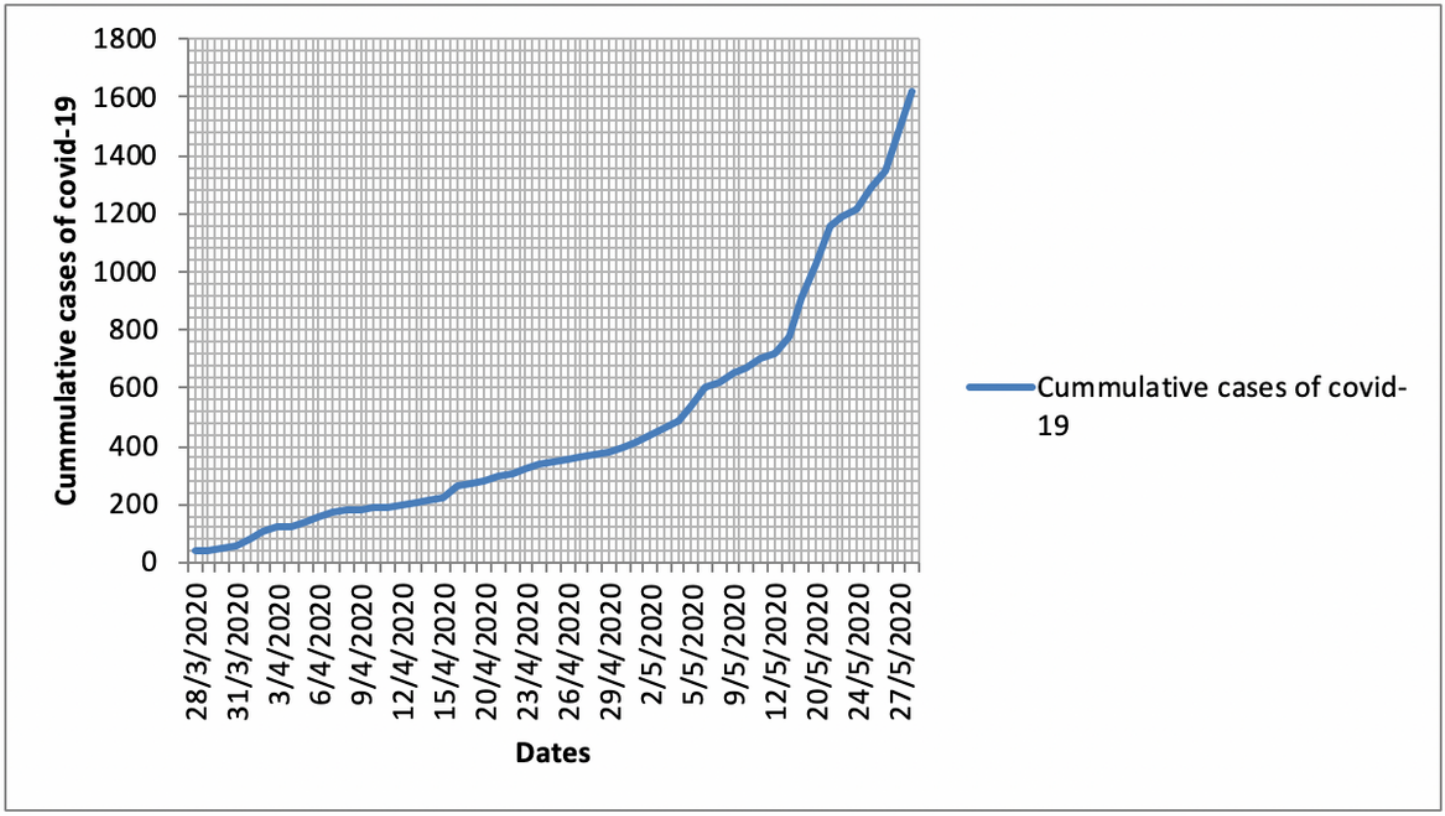

Figure 2

Daily Cases of COVID-19 Infection after Enforcing the Policy of Containment. Source: Author's Compilation based on the data obtained from the Republic of Kenya's Ministry of Health; Daily Transmission of COVID-19 across the 47 Counties. Analysis and plotting of the graph are based on infection cases tabulated in Annex 1.

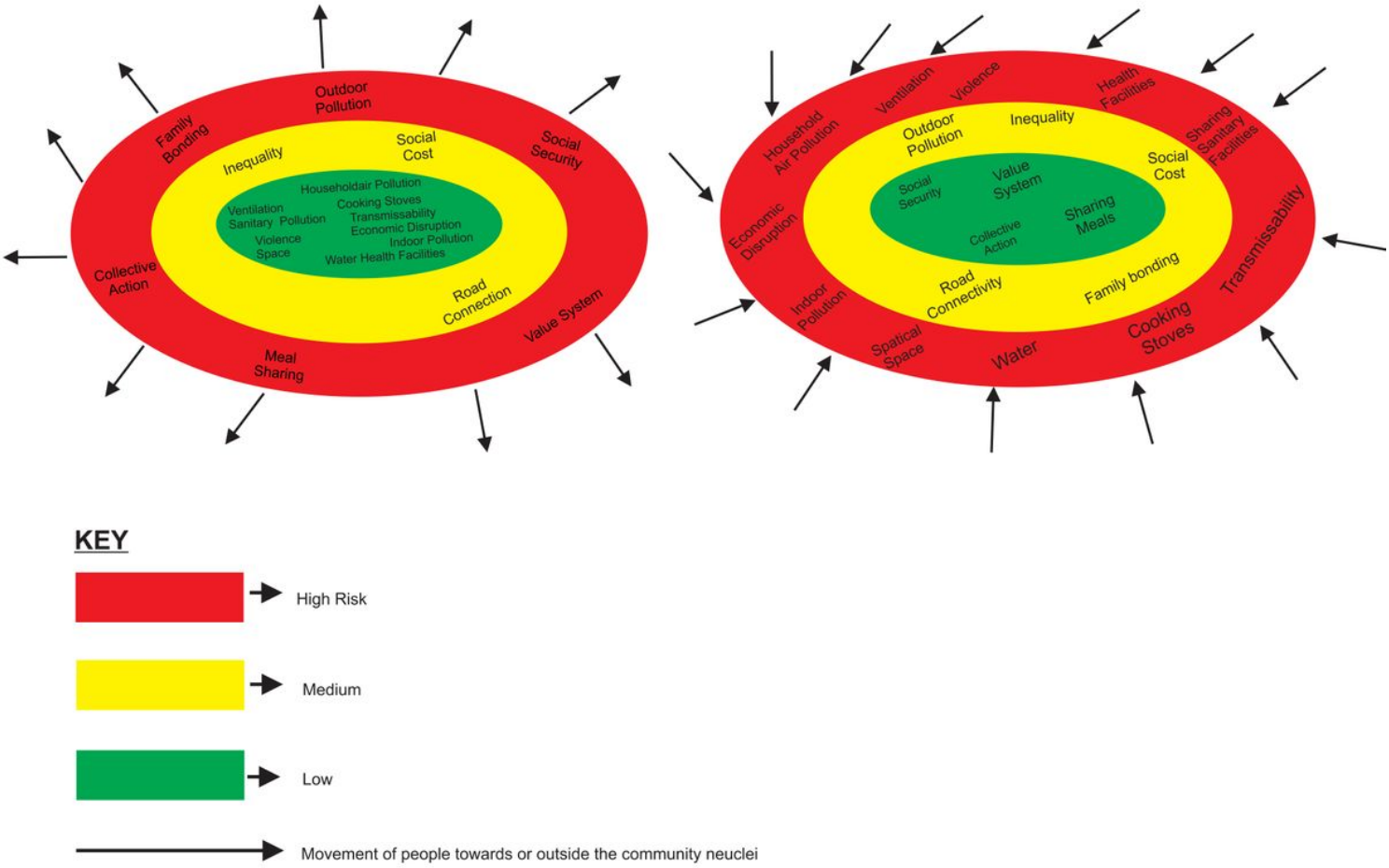

Figure 3

Simulating Behaviour of Slum Residents before (A) and after (B) the Policy of Containment. Source: Authors' Construct

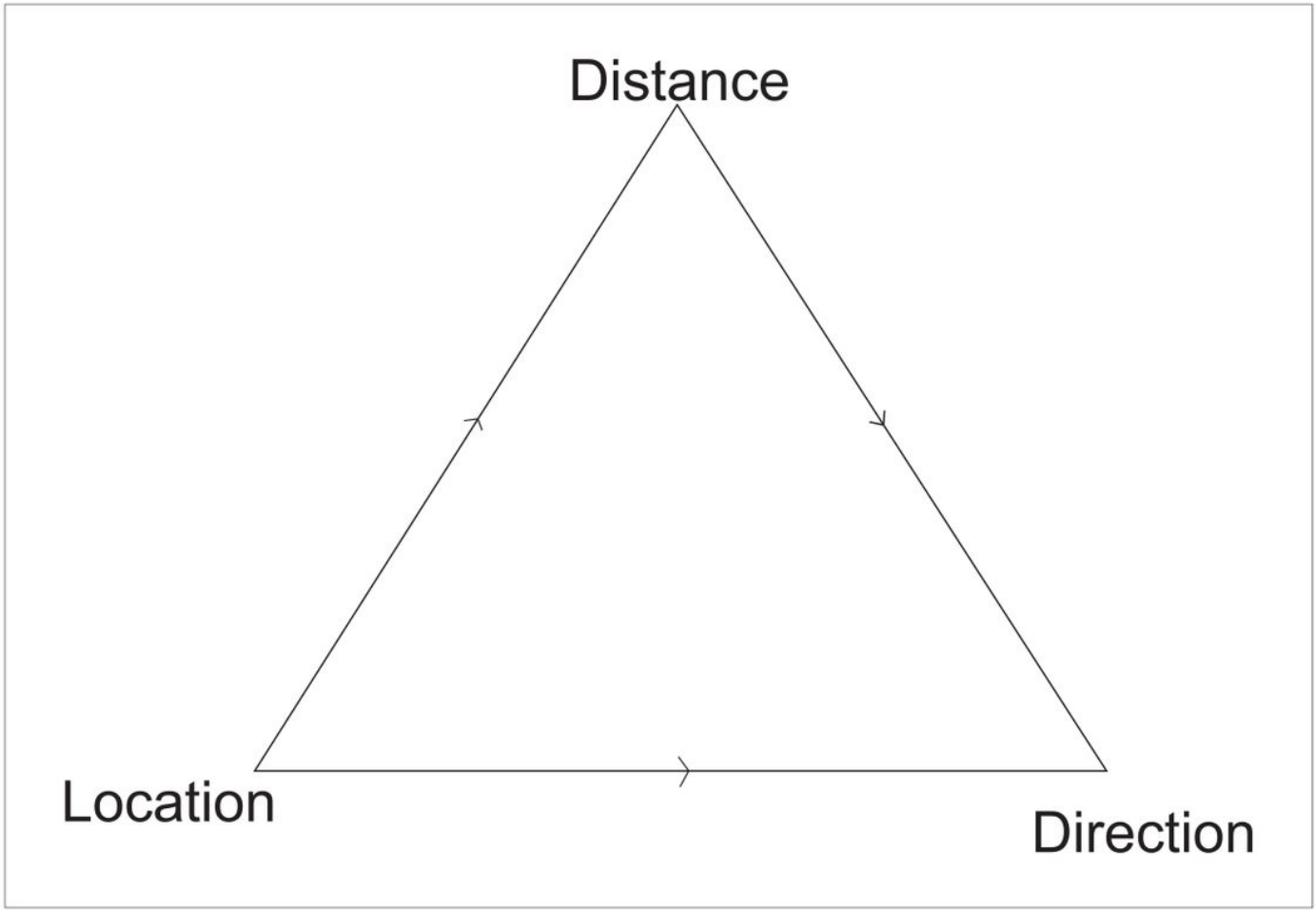

Figure 4

The Building Blocks of the Social Geometry of Life. Source: Authors' Construct

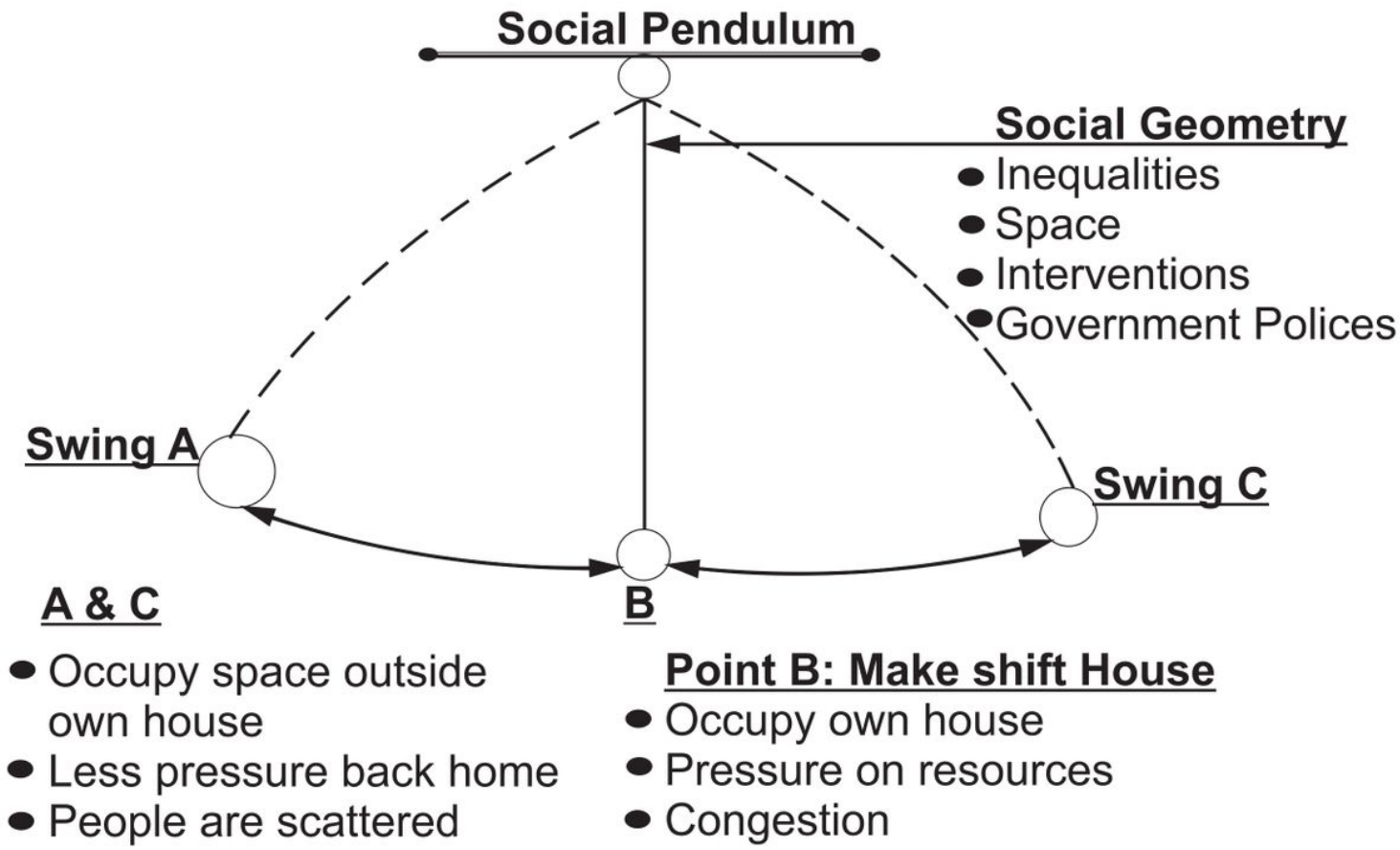

Figure 5

A New Framework (Social Pendulum) for Informing PHI in Informal Settlement. Source: Authors' Construct

Supplementary Files

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