

Looping System Theory in Land Use and Mental Health During a Pandemic Outbreak

Nur Masitah Ghazali¹, Marlyana Azyyati Marzukhi^{2*}, Oliver Ling Hoon Leh²

¹Postgraduate Studies, College of Built Environment, Universiti Teknologi MARA Selangor Branch, Puncak Alam Campus, 42300 Bandar Puncak Alam, Selangor, Malaysia

²Studies of Town and Regional Planning, School of Town Planning and Landscape Architecture, College of Built Environment, Universiti Teknologi MARA Selangor Branch, Puncak Alam Campus, 42300 Bandar Puncak Alam, Selangor, Malaysia

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ABSTRACT

Land use has a profound effect on mental health even without a pandemic. However, it worsened during the pandemic because of non-readiness in land use planning for mental health and, the mitigation and prevention process during the pandemic by changes in travel behaviour, the need for green spaces, and other effects, especially in an area with high population and density especially in the urban area. The pandemic affects mental health and the physical aspects of the cities, including land use planning. The objective of this research is to identify the theoretical framework for looping system to be used in land use planning and mental health. This paper using scoping studies by synthesis the literature and exploratory of research questions to develop a theoretical framework. This study aims to adapt the looping system to understand the relationship between land use and mental health. The result of the study is a theoretical framework consisting of the components and factors in land use and governance in mitigating the pandemic outbreak and resulting in the land use and mental health impacts that affect the population. This study underlines the importance of land use and mental health during the pandemic, and a preparedness plan for future pandemics can be constructed based on the data from previous pandemics and analysed using the looping system as the process required multiple assessment.

INTRODUCTION

In recent years, especially after the most recent pandemic, the number of people having mental health issues has been increasing, and the pandemic has become one (1) of the contributors to the increase. After the pandemic, the prevalence of the world population in the year 2023 that has mental health problems is estimated to increase to 28 per cent, which is around 1.2 billion people, compared to the year 2019, which

^{1*} Corresponding author. E-mail address: marlyana@uitm.edu.my
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is 970 million people (World Health Organization, 2022a). During the pandemic, several mental health problems are reported to affect the population, which include stress, anxiety, depression, panic attacks, sleep disorders, emotional disturbances, suicidal behaviour and many more (Fountoulakis et al., 2022; Hossain et al., 2020; Samji et al., 2022; Talevi et al., 2020). The preventive measures of the pandemic have a prolonged effect on mental health, such as depression, concerns about one's health and loved ones, uncertainty about the future, fear, anxiety and other trauma-related disorders (Fiorillo & Gorwood, 2020). During the pandemic, each person experiences a different level of psychosocial stressors and develops mental health problems (Hossain et al., 2020). Mental health problems have increased during the pandemic, especially in the lower-income group (Ma et al., 2022).

The pandemic affects mental health and the physical aspects of cities, such as the role of transport, land uses, blue and green spaces, public open spaces, facilities and services, housing and quality of life (Mouratidis, 2021). An area with limited green spaces has a stricter lockdown and more home isolation to avoid crowded residents (Mouratidis, 2021). The risk of infection is increased in an area with excessive population density, denser road density, high built density and high land use intensity (Li et al., 2020). An area with access to public and private green spaces resulted in better health and well-being (Mouratidis & Yiannakou, 2022; Poortinga et al., 2021). The critical roles of land use are to shape the environment and influence human well-being, where the changes in land use are a direct manifestation and indicator of human activity and reflect the intensity of human activities and the degree of the land use development in that area (Zeng et al., 2024). According to Abdul et al. (2024), a continuous evaluation and adaptation of policies to meet evolving needs is required where the feedback from mental health outcomes can be used for future land use decisions, which creates a feedback loop that continuously improves the mental health impact of urban environments.

The objectives of this paper are (i) to identify the theoretical framework for looping systems of land use and mental health and their integration during a pandemic outbreak and (ii) to demonstrate the integration of land use and mental health during a pandemic outbreak by building a theoretical framework. The outcome of this paper shall show the adaptation of looping systems theory to land use planning and mental health, especially for future pandemic preparedness.

LITERATURE REVIEW

Looping System Theory

A feedback loops defined as the 'transmission of a signal from a later stage to an earlier stage' (Skyttner, 2005). A looping system refers to a system where components are interconnected so that the output of one (1) component loops back as input to the same or other components, creating a feedback loop (Schlüter et al., 2019). The looping system also refers to the feedback loop, which is integral to understanding how different elements within the system interact (Hudani et al., 2024). Using looping systems in human-environment interaction refers to the human activities and environmental changes characterised by the interaction of human action impacting the environment. As a result, these environmental changes influence human societies (Gayo et al., 2024). Looping systems can also be called cause-effect relationship sequences that start and end at the same elements, leading to a specific pattern of behaviour within systems (Guzzo et al., 2024). Looping systems include the evolution of learning and adaptation within the systems by understanding how the values and behaviour evolve in response to changing environmental and social conditions (Binder et al., 2013; van Riper et al., 2018).

By understanding the looping system, people can understand how systems evolve and respond to changes (Schlüter et al., 2019). By analysing the loop, policymakers can design interventions that target specific variables to manage and improve complex systems for vulnerable populations (Hudani et al., 2024). Looping systems can also be used for problem-solving and trajectories, especially in risk-related issues (Gayo et al., 2024).

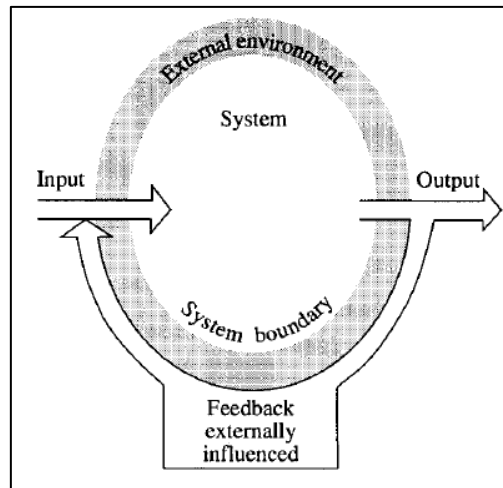


Fig. 1. The Extrinsic feedback of Theory System

Source: Skyttner (2005)

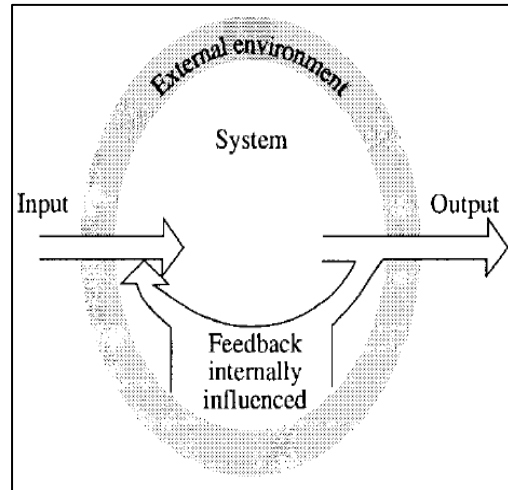


Fig. 2. The Intrinsic feedback of Theory System

Source: Skyttner (2005)

According to (Skyttner, 2005), the general theory should focus on the interconnectedness between human and the environment comprehensively and investigate the whole system rather than as individual parts which creates the feedback loop system as shown is Figure 1 and Figure 2.

Land Use

Land use is defined as the purpose for which an area of land is being used, such as residential, agricultural, commercial, industrial which also known as land cover or land utilisation (Oxford Reference, 2024). Land use planning involves identifying, assessing, and managing the resources within the built and natural environment at multilevel scales (Stevens et al., 2018). According to Metternicht, (2017), land use planning is a systematic assessment of land and water potential, alternatives for land use and economic and social conditions to put into practices and meet the needs of people while securing resources for the future. Another definition of land use planning is to protect and improves the living, production and recreation environments through the proper use and development of land (Leung, 2013). Land use planning also creates activities, and some land use zoning encourages migration of people especially to urban area which caused populations vulnerable to various stressors, such as natural and man-made disasters including disease outbreak (Sharifi & Khavarian-Garmsir, 2020). According to Yao et al. (2024) and Zeng et al. (2024), land use changes are a direct manifestation and indicator in human activity which reflect the intensity of human activities on the land and degree of land use development and can aid in optimising the land utilisation to create an efficient and sustainable environment that meet the population need and minimise the impacts to the environment. Thus, land use planning is vital in the process of shaping the locality either for urban or rural area.

Mental Health

The definition of mental health according to World Health Organization (2022b) is a state of mental well-being that enables people to cope with the stresses of life, realise their abilities, learn and work well, and able to contribute to their community which also underpins an individual and collective abilities to make decisions, build relationships and shape the world. In the absence of mental health well-being will result on mental disorders which a condition characterised by a clinically disturbance to an individual's cognition, emotional regulation, or behaviour which commonly associated with distress or impairment in important areas of function, psychosocial disabilities, risk of self-harm and other mental states associated with other significant distress (World Health Organizations, 2022). According to Fiorillo & Gorwood (2020), pandemic is considered as a novel form of stressor or trauma with unique characteristics due to the pandemic threat is omnipresent and can be carried by anyone which making it pervasive source of stress. The pandemic also can give impact land use and mental health. During the pandemic, the risk of an individuals to experience a range of psychological reactions are high including the maladaptive behaviours, emotional distress and defensive responses which consist of the symptoms of anxiety, fear, frustration, loneliness, anger, boredom, depression and stress (Talevi et al., 2020). According to O'Connor et al. (2021), the pandemic's social and economic consequences including lockdown affecting mental health as it is associated with loneliness and social isolation. Apart from that, the pandemic also has prompted how high-density areas often suffer from poor living conditions, such as lack of open spaces, noise, air pollution, overcrowded houses, and poorly ventilated which harms the mental health (Mouratidis & Yiannakou, 2022). The pandemic has highlighted the critical need for a comprehensive mental health support and intervention to the population especially during a pandemic.

Green Spaces and Mental Health in Pandemic

The most recent pandemic has had a significant impact on mental health, especially in the urban area. According to De Vos (2020) and Hadjidemetriou et al. (2020), the pandemic prompted the cities to rethink urban planning to emphasise the need for more open spaces and parks to accommodate social distancing and promote outdoor activities; it also heightened the demand for accessible green spaces. The impacts on mental health cause the feeling of isolation and anxiety due to social distancing and lockdowns (De Vos, 2020 and Hadjidemetriou et al., 2020). The other effect of the pandemic was that it underscores the role of green spaces in supporting mental health, which highlights the need for accessible public green spaces (Da Schio et al., 2021; Poortinga et al., 2021; Ugolini et al., 2020). Access to green spaces can reduce stress, anxiety, and depression and enhance the community's well-being and resilience (Ugolini et al., 2020). During the COVID-19 pandemic, an area with a high density was associated with lower life satisfaction, happiness and leisure satisfaction, negatively impacting mental health (Mouratidis, 2022). In addition, the accessibility to facilities such as health and community support for a better health and wellbeing of the populations.

The urban area can enhance resilience against future crises and promote the residents' well-being by addressing the physical and social dimensions of the urban environment in the way of good urban planning and governance (Sharifi & Khavarian-Garmsir, 2020). Urban planning also should integrate mental health considerations especially in the high-density area (Ghazali et al., 2021) addressing the factors such as overcrowding, noise, insufficient facilities. The post-pandemic has underscored the importance of thoughtful land use in promoting mental health through the diverse land use, walkability, access to green spaces, and health services that can be insight to guide urban planning and policymakers to create healthier living environments (Park et al., 2021).

RESEARCH METHODOLOGY

This research uses a scoping study to develop a theoretical framework comprising five (5) stages of the methodological framework of data extraction in the literature search (Arksey & O'Malley, 2005; Hassen, N, 2015). A scoping study is a form of knowledge synthesis emphasising exploratory research questions aimed at mapping key concepts, types of evidence, and gaps in the research. The first stage of the scoping study is identifying the research question, which for this study is 'How is land use and mental health during the pandemic interconnected?'. The second stage of the scoping study is to identify the relevant studies and research on the urban planning and mental health relationship during the pandemic by comprehensive searches through different sources using electronic databases such as SCOPUS, Web of Science, PubMed and other relevant databases. A snowballing technique is done through the references list and hand-searching of journals using the keywords 'land use AND mental health AND pandemic'. The other keywords involve in the literature review searches are 'spreading factors', 'preventive and mitigation measures', 'general system theory', 'looping system theory and the components'. The fourth stage is the study selection, which, from a total of 167 references, 81 were taken out as not capturing the scope of the research question. The sum of the total 86 references is charted based on the study's aims and essential results extracted. The final stage is collating, summarising and reporting the results by reviewing the literature, evidence and findings that answer the research questions. A theoretical framework is developed based on the scoping study of the literature search with adaptation of the looping system framework to summarise the interconnection between land use, mental health and pandemics.

DEVELOPMENT OF THEORETICAL FRAMEWORK

A theoretical framework to find the relationship between land use and mental health during a pandemic by understanding the causal and minimise the effects on the population. This theoretical framework is an adaptation of feedback loops of the systems theory by Von Bertalanffy (1972). The concept of the feedback loop is derived from an electrodynamics equation in which negative feedback is delivered back to the input, regulating the new output to a multiplier smaller than one (1), and the increase of feedback levels will decrease the production in the systems, which provides a self-correction and stabilise the systems (Von Bertalanffy, 1972).

Figure 3 shows the theoretical framework adapting the feedback loops from the general system theory integrating pandemic with land use and mental health wellbeing. For this theoretical framework adaptation, the input for this research is the spreading factors during the pandemic, which involves social activities, population density, environmental factors, human mobility, government response and other factors (Mascie Taylor & Moji, 2021; Piret & Boivin, 2021; Rasmussen, 2010). The spreading factors involves activities such as education, religious, social and the factors of density are associated with land use types and activities. Human mobility and travel, environment and ecological factors, socioeconomic conditions, population density, cultural and behavioural practices, public health infrastructure, and public health response are factors that influenced the spreading of the disease during the pandemic (Akintuyi, 2024; Abdul et al., 2024). The disease risk in the population is due to specific factors such as the mode of transmission and genetic adaptation. For the human population, factors include human behaviour patterns such as culture, density of population, susceptibility to infection, travelling behaviour, public health surveillance and responses (Mascie Taylor & Moji, 2021; Sawicka et al., 2022; Wallace et al., 2010).

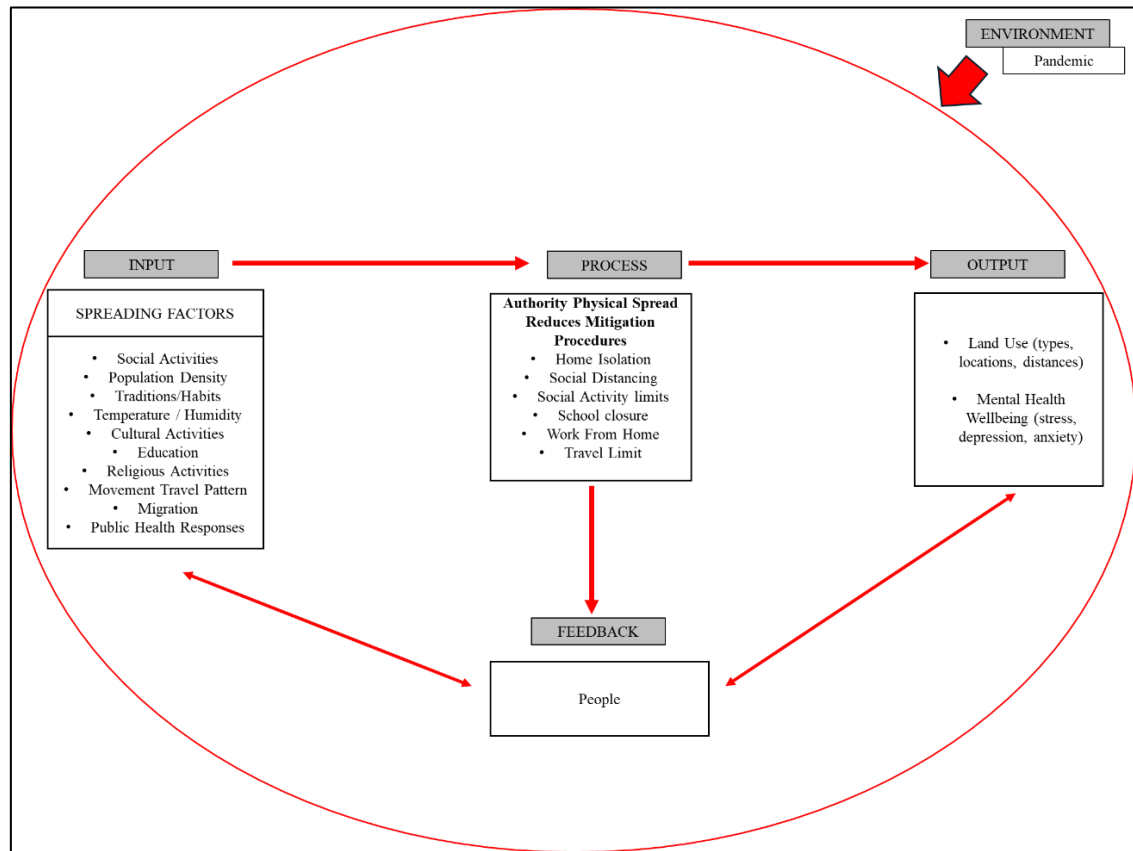


Fig. 1. A Theoretical Framework Adaptation of The Looping System

Source: Authors (2024)

Land use changes can directly and indirectly affect mental health, particularly during a pandemic, by influencing disease transmission, economic stability and services (Almeida et al., 2024). During the pandemic, an economic downturn due to the mitigation from authorities to reduce the outbreak spread has impacted housing unaffordability, worsening mental health outcomes (Arundel et al., 2024). The pandemic impacts on land use and mental health underline the interconnectedness of societal changes and individual well-being, especially in vulnerable populations (Astuti et al., 2024).

The process in the loop systems acts as the operating component. The process for this research refers to the events, behaviour or incident during the pandemic. During the pandemic, the government has taken various measures to reduce the risk of infection, directly affecting the community or individual, such as the economy, healthcare services, and essentials (Sawicka et al., 2022). The preventive measure taken worldwide is home isolation, social distancing, social activities limitations, school and institutional closure, working from home for office workers and travel limitations. Other than that, the pandemic itself has had a significant effect on the population, especially on mental health, social restrictions, social distancing and home isolation, which led to stress and anxiety (Taylor, 2022). It is supported by (Sampath et al., 2021) that the action taken by the authorities to mitigate the outbreak affects multifaceted challenges to global and community, impact on health, which puts pressure on the health systems, economic issues including job losses, a decline in economic productivity, and social aversion which causes individual reduced

interaction with others, impacting to the business that relies on close contact, and educational impacts due to remote learning.

The output of the research in the looping systems is the future or the results from the process. The output can be either negative or positive. Land use and mental health well-being determine this research's output. The input will go through the process of mitigation, and the result of the process is output. The feedback refers to the population that will experience the results from the process, which is the output. The feedback from the output will then come to the looping process, which will be processed again to get a positive input and be highly effective for the population.

As the pandemic is unpredictable, comprehensive preparedness plans to reduce its impacts are necessary. A proper understanding based on previous pandemics is essential in ensuring good land use planning that caters to a risk pandemic's needs and ensures that mental health and well-being are protected during the pandemic.

DISCUSSION

The results from the previous pandemic have shown multiple effects from the mitigation process. This output from this process shown both negative and positive feedback. The second stage of scoping review shows a significant finding from the other countries. During the pandemic in Shanghai, the usage of public transport is decrease and increase in walking and cycling which highlighted the importance of walkability and accessibility, it also underscores the importance of public spaces as people sought outdoor areas for exercise and social interaction and has exacerbated existing inequalities in access to resources such as to green spaces especially to the vulnerable communities (Lyu, 2024). As in Nigeria during the pandemic and effect from the lockdown measures has affected on several aspects such as on the livelihoods, food security, health, education and the overall social fabric of the community (Awosanmi et al., 2024). According to Li et al. (2020), the study in Wuhan City also shown that land use patterns and traffic exposure is significant in the increased risk of virus spread. The pandemic mitigation process especially on the mobility reduction has fundamentally altered the travel behaviour and to the potential of long-term implications on the individual social engagements in daily activities and public transportation (De Vos, 2020; Hadjidemetriou et al., 2020). According to Poortinga et al. (2021), the impact of previous pandemic to the population in United Kingdom have shown an increase of mental health issues, highlighted importance of having perceived access to both public and private green spaces to cope with the challenges posed by global pandemic. Most common impacts of the pandemic are to the health, mobility and accessibility, and to social factors, this is proved by Mouratidis & Yiannakou (2022) which in their research shown the decline of health and well-being, poorer living conditions especially in the older and high-density area and importance of access to local facilities and green spaces. It is supported by Robinson et al. (2021) which the pandemic mitigation process led to changes in the human lifestyle including to the mobility and social interaction, and changes of population behaviour in increased usage of green spaces and highlighted the importance of accessibility to green spaces. The pandemic impacts to the population due to mitigation process or the outbreak itself in most of the countries are relatively similar. This is due to the similar process of mitigation which is recommend by the World Health Organisations (WHO). Based on the previous literature studies, the pandemic shown a significant impact especially to health and wellbeing whether to the physical and mental health, the pandemic also has highlighted the importance of green spaces and other facilities which includes the accessibility to these facilities. The mitigation process is a part of the process conducted through the multiple assessment of the effects from the pandemic. This process will change in accordance with the results of the effects which could be in increase or decrease of outbreak cases.

CONCLUSION

This study has explored and understood the relationship between land use and mental health during a pandemic. This study also underlines the importance of land use and mental health during the pandemic, and a preparedness plan for future pandemics can be constructed based on the data from previous pandemics and analysed using the looping system as the process required multiple assessment. To ensure the population's mental health well-being, primarily when an outbreak occurs, a preparedness plan, especially on land use planning, is vital to ensure the risk of infection can be reduced, and the mental health well-being will not be jeopardised. The data on the input, process, and output in the looping system for this research need to be taken into precise and accurate data to get a better insight into the population's feedback and ensure that future planning includes and tackles all relevant issues. As there is vast evidence on the relationship between land use and mental health during the pandemic, thus this research can be expanded into details to capture all the relevant data and issues.

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CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

AUTHORS' CONTRIBUTIONS

Nur Masyitah Ghazali carried out the research, wrote and revised the article. Marlyana Azyyati Marzukhi anchored the review, revisions, supervised research progress and approved the article submission. All other authors participated in revising the article, conceptualising the central research idea and reviewing the article for submission.

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