Getting To Know The Built Environment As A Complex System

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Seeking Higher Ground: PART ONE

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Introduction

Seeking Higher Ground Towards Healthier City-Building

> *"With the majority of the population living in cities, it is sensible to look at how urban environments have changed, influenced lifestyles, and contributed to the increase in overweight and obesity."* [1]

Gradual changes in our physical environments, including the dominance of low-density, car-oriented sprawling suburban neighbourhoods in North America, have facilitated more sedentary lifestyles and contributed to a significant rise in chronic illnesses like heart disease, stroke, cancer, diabetes, and obesity.[1, 2] Municipal governments, local community agencies, and non-governmental organizations are increasingly working to better understand the built environment's role in determining people's health attitudes, choices, behaviours and outcomes. Understanding how health-enhancing neighbourhood amenities, like walkable streets, proximity to healthy food, affordable housing, safe community space and opportunities for physical activity, are geographically and spatially distributed moves us closer to more equitable neighbourhood and regional planning.[1] Understanding how our landscapes (whether urban or suburban) might perpetuate or mitigate social exclusion and socio-economic inequities, especially for segments of the population who are vulnerable or disadvantaged, can help us chart a path to investing in population health through the built environment.

Seeking Higher Ground, Part One and Part Two, takes a closer look at issues related to the built environment, offering discussion and commentary on the following topics:

1. Understanding The Built Environment As A Complex System

> Local patterns of health and health inequities in cities and neighbourhoods are shaped by a wide range of constantly changing factors: global and national economic trends, the structure and dynamics of the local labour market, the demographic and cultural make-up of local populations, the state of housing and infrastructure, availability and accessibility of health and social services, neighbourhood safety and resources, and how well communities are connected and how resilient they are. Making these community foundations healthier and more equitable involves concerted action by multiple governments across many policy spheres and collaboration of many stakeholders across the public, community and private sectors. And, of course, fundamental change on deep-seated inequalities will take years to have an impact. How can we make sense of all this and develop effective strategies to build healthier and more equitable communities? How is complexity thinking useful as a framework for exploring the built environment and improving population health? What does a systems lens offer urban planners and public health professionals? What are some important connections in the built environment-health relationship?
>
> By studying the delicate and intricate structure of the built environment, we can get a better sense of how its components interact to influence our health. Conceptualizing the

built environment as a complex adaptive system also provides some insight as to how and where planners, public health experts and policy-makers can direct interventions to secure long-lasting, positive health outcomes for all residents.

2. Building Population Health Into Municipal Planning: The Use Of Health Impact Assessments

Many crucial areas of municipal policy and services – from availability of child care to bus routes and safe parks and recreational opportunities – have a direct impact on health. But health is not usually considered in municipal deliberations around budgets, transportation and infrastructure investments, neighbourhood planning and other areas of policy that affect health. How can we ensure that the impacts of broad areas of local policy on health and health inequities are properly considered? How can we address the local drivers and determinants of health more effectively on municipal and regional policy development?

This paper sets out systematic approaches that could embed population health into municipal planning and priority setting. It explores how tools such as health impact assessment and health equity impact assessment have been used in jurisdictions across the world. What are the institutional and technical barriers to the use of HIA/HEIAs? Are there lessons to be learned from other jurisdictions?

These commentaries are meant to inform and broaden the parameters of the healthy city-building discussion by reflecting on how we define health in contemporary planning theory, research and practice in addition to facilitating knowledge transfer on the above topics. Seeking Higher Ground raises critical questions about how our neighbourhoods, cities or metropolitan regions can better support population health, and considers some of the ways we can work to promote and manage healthy city-building.

Part One: Getting To Know The Built Environment As A Complex System

The built environment, comprised of the physical structures and elements of man-made living, working, travelling and recreational environment, is a complex and multi-layered system governed by a web of ecological, social, cultural, economic, and political relationships.[3, 4] These relationships operate at multiple scales from individual households to neighbourhoods to entire metropolitan regions, thus adding to the level of complexity, risk and unpredictability inherent in urban systems.[3, 5] As people move more freely between communities for work or career opportunities (i.e. living in the suburbs, but working in the city centre) their sense of place and community becomes malleable making municipal boundaries less distinct. The blurring of lines between urban, suburban and rural communities can complicate the efforts of local governments to gain insight into and address regional issues emerging from the dynamic interaction of "society, behaviour and biology."[6, 7] Significant land use, resource consumption, and a high population density are among the elements of urban complexity that can make large metropolitan cities like Toronto vulnerable to poor environmental health conditions.[3] In recent public discussions and debate, transportation and public transit have surfaced as critical issues in the built environment and its relationship to the social determinants of health. This commentary will approach the built environment as a complex system. Using transportation and local travel as illustrative examples in the built environment, we will examine and explore fundamental concepts like complexity, systems thinking and simulation modelling.

Urban planning is, by nature, a complex field due to the multitude of decisions, actions and actors involved at most or all stages of the city-building process. Some contemporary planners and policy-makers even go so far as to say that "*all* planning problems are essentially 'wicked' – intractable and indeterminate," further pushing the boundary of urban complexity.[8] The phrase "wicked problem" was coined by two American urban planners in the 1970s after grappling with several complex social issues including racial segregation, poverty and crime, which seemed interrelated and unsolvable. Despite the dedication of time and resources to studying these social phenomena, experts have struggled to clearly define and explain each problem, making it that much harder to chart a path to a solution.[9]

Despite the fact that wicked planning problems can seem to defy solution, systems thinking can be both a useful and an appropriate tool for addressing complexity in the built environment. Systems thinking reveals how a group of interacting, interconnected and interdependent elements affect each other within a whole.[10] By balancing focus on the whole and its parts, systems thinking helps us see and understand the world in an integrative way.[11] This view provides deep insight on how underlying relationships drive human activity patterns and behaviours, thereby unearthing pathways to affect change and potentially resolve complex problems.[11] Systems thinking can enable planners and public health professionals to better understand how the built environment influences health.

The built environment influences health through air quality, social capital and physical activity, among many other pathways.[6] Research on the built environment shows that even if people are not greatly or directly influenced by individual elements of walkability, like sidewalks, connected streets and proximity to key destinations, they are likely to partake in "active living" because of these overall improvements to the built environment. In this context, active living includes both destination walking and recreational

walking. Greater exposure to a walkable environment with diverse opportunities for physical activity (as a whole) increases the likelihood of a healthier population.[6] This finding highlights the value of a systems lens by demonstrating how the properties of individual elements may work in unison or interact in a broader pattern or arrangement to trigger an outcome. While urban design, transportation, economic development and environmental planning each individually contribute to population health at the neighbourhood level, their interaction and relationship to one another shapes and influences the performance of the system overall.

Systems thinking enables us to understand and manage complex and uncertain situations.[5] It offers a way of looking at the world by emphasizing important relationships and patterns, which are helpful in understanding the system as a whole as well as its parts.[6, 12] Through these relationships and patterns, one can start to deconstruct complex problems and better understand their impact on people, places and health. By recognizing the built environment as a complex system, we highlight the importance of and interconnections between core elements like transportation, housing, green space, and urban design. The interconnections among these elements can contribute to key aspects of population health and quality of life, as they facilitate access to a diverse mix of infrastructure, services and resources. Complexity and systems thinking enables us to look at the interacting behaviours of elements and actors in the urban system. Capturing the multi-dimensional and multi-directional impacts of these relationships may have great relevance for municipal planning processes and policies.[5] Systems thinking emphasizes the importance of interconnections and non-linearities in every aspect of life, ultimately reformulating the way we see ourselves as actors (and our values) in the urban system as well as transforming the way we design and grow the environment in which we live.

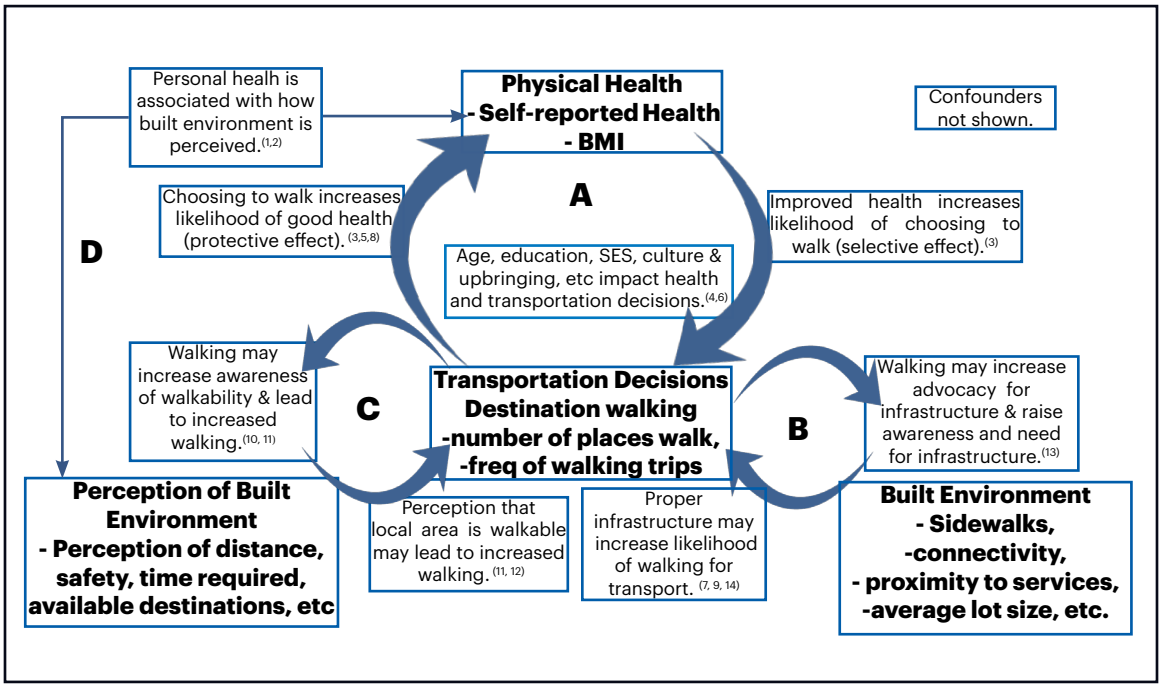

Diagram 1: Conceptual pathways between the built environment and physical health [6]

Diagram 1 illustrates how the built environment influences physical health through mediating factors including travel behaviour, perceptions of built environment features, and access to different modes of transportation.[6] This shows the inherent complexity and interconnection of elements that can operate within and across the built environment system. By illustrating the non-linear and cyclical connections between these concepts, one can better understand how urban systems (and their components) affect our decisions, activities and overall health.

Systems Thinking Tools To Help Us Tackle Complexity

A systems approach allows us to better predict and track any unintended consequences arising from relationships within the system, or interventions, with the aid of both qualitative models (for example systems maps) and qualitative models (for example computer simulation models).[5, 12] Systems maps and qualitative models are visual representations or diagrams of the system's relationships and patterns to better understand its overall complexity. Simulation modelling involves using a mathematical model or computerized prototype of real-life systems and are used to gain insight into problems that often have dynamic and structural complexity.[13] These models study the system's behaviour over long periods of time without disturbing the real system and also have the capacity to identify the variables driving the system's processes. Urban simulation models have evolved to meet the operational needs of planning policy, especially in determining the future capacity of transit corridors, settlement and employment areas based on urban land use and travel patterns.[14]

> "*Models are the means by which a systems thinker comes to terms with complex real-world problems.*" [12]

In their simplest form, systems diagrams use a network of arrows to illustrate that causes are often also outcomes in complex systems. Models are considered conceptual tools that stimulate learning and action through foresight.[12] In other words, these models offer a way to visually represent knowledge about the world around us, and demonstrating how, using data from current trends can help to give shape to different scenarios.[15] These future scenarios can help planners to consider some of the short and long-term impacts of policy and investment decisions. Though many changes in the built environment remain unpredictable, these "artificial planning experiences" can provide valuable insight and inform decision-making.[16] For example in transportation planning models contribute to an understanding of how municipal transportation networks can accommodate travel behaviour and activity patterns. This has implications for understanding the connections between transit as a component of the built environment and population health.

One study, based in the Netherlands, looked at developing an activity-based simulation model of travel demand based on people's observations of the built environment.[15] The model simulated activity-travel patterns based on daily scheduling decisions. This research found that people use their knowledge of the built environment (transportation network, modes of transit and activity destinations) to inform and develop travel habits. Also, the study showed that individuals may have different assumptions about how urban areas are structured due to their experiences or occupations. This study illustrates how models can help us analyze how people interact with the built environment by giving insight into how their perception of mobility informs their activity patterns and travel behaviour. By understanding

what drives behaviours, we can organize land uses, transportation pathways and urban design features in a way that enables people to make healthy lifestyle decisions and improves overall population health.

Systems models allow us to scope out complex planning problems, construct different hypotheses and investigate the outcomes of different courses of action.[17] For example, models can be used to explore different built environment issues, such as predicting traffic dynamics in a specific geographic setting, or illustrating changes in mobility patterns or migration trends as a result of built environment interventions such as massive investment in a particular form of transportation to mitigate traffic congestion. A study out of the University of Nebraska describes the use of a simulation model to estimate future traffic volume and travel time associated with the location of a hypothetical transportation facility in a hypothetical region.[18]

The use of models can provide a starting point for policy experimentation and an integrative view of how cities can adapt to socio-economic pressures and changing demographics without compromising urban health.[5] Not only do these models describe the dynamic relationships between land use systems and social, economic and cultural factors, but they can also reveal the values and beliefs underlying our city-building process.[19] Models can help in contextualizing the level of commitment to invest in neighbourhood-level health infrastructure and programs, both in the short and long-term. For example, modeling can be used to explore how factors like economic conditions, political support and legislation shape budget allocation to policy portfolios relevant to the built environment. Such portfolios might include industrial development, residential development, commercial development, parks and recreation, infrastructure services and urban design.[17] Despite the wide range of possible applications, it is important to remember that models represent a simplification of reality. Rather, they allow us to explore "what if" questions and plausible future outcomes which in turn helps us map effective policy directions. They give us a glimpse into the possible outcomes of different actions and a chance to determine which would best serve our needs.

A systems thinking perspective can encourage us to move away from a siloed approach in urban policy and governance and encourages sharing of research expertise across departments, disciplines and sectors.[20] By acknowledging all system elements as well as the links among its components, planners and public health professionals can argue for more enhanced community consultation and stakeholder involvement at various stages in the decision-making process.[20] A complex systems approach to planning draws on "bottom-up evaluation and connected networks of agents" to determine the values which shape decision-making.[20] For example, researchers at the University of Washington use the Value Sensitive Design (VSD) approach to support democratic and deliberative urban planning discussions amongst planners and stakeholders (i.e. residents, developers, environmental agencies etc).[21] The Value Sensitive Design approach facilitates stakeholder engagement with urban simulation models like UrbanSim, which projects land and transportation patterns as well as the environmental impact of policies, by taking account of human values like privacy, fairness and democracy, in the design process [21]. Since UrbanSim is complex modeling software which is often inaccessible to a layperson, the VSD approach is especially important in contextualizing results so that participants can interpret its outputs from a viewpoint that acknowledges and integrates their values.[21] Participants can go on to extract useful information from these simulated scenarios with the comfort that any subsequent policy decisions have been informed by stakeholder principles and values.

Are There Special Relationships We Should Pay Attention To In A Complex System?

Because of underlying complexity, some determinants of health like the built environment do not shape population health through a direct pathway, but operate through multiple and interconnected feedback loops (which are cyclical routes which can lead to a reinforcing or a balancing feedback).[6] Although feedback loops may serve a range of purposes, all contribute to an understanding of the system as a whole, its individual parts and the internal processes which drive change at all level.[12]

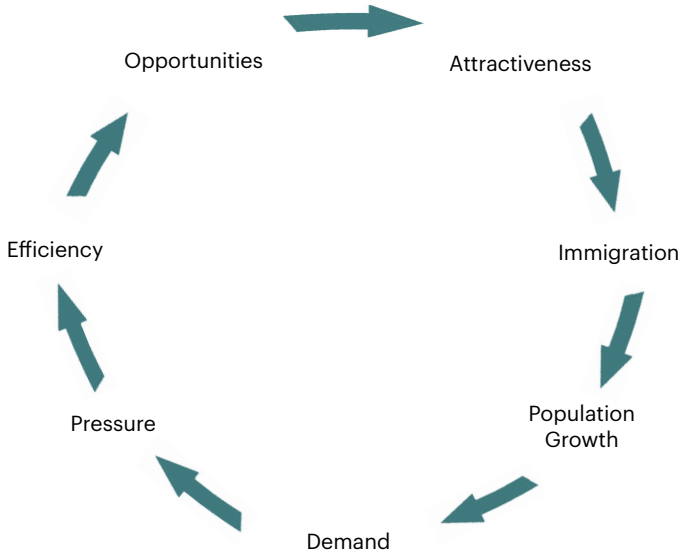

Diagram 2: Feedback loop in a typical urban system [22]

The diagram above is a feedback loop diagram showing the cyclical movement of multiple variables in a typical urban system. Diagrams, such as this, help to illustrate the interactions and relationships within a system. They are a visual representation of a system's pattern of relationships, allowing us to see the connection between cause and effect.[22] Though this diagram's arrows flow in one direction, it is important to note that this is not always be the case as systems are dynamic entities capable of evolving organically. Urban systems such as the one depicted above are also vulnerable to external change or intervention, resulting in a rearrangement of elements, relationships and patterns. For example, the introduction of free exercise equipment in public parks could have implications for levels of physical activity and social engagement among residents, both of which are linked to population health.

An example of another feedback loop detected in the built environment relates to the demand for transit and transportation which is typically generated by the spatial distribution of housing, employment, retail and cultural or recreational facilities. Changes in the pattern of access to these built environment elements will trigger changes in mobility (traffic flow and congestion levels) as well as the spatial distribution and location of people *and* activities, which feeds back into the level of demand for transit and transportation.[5] Embedded in this feedback loop are several opportunities for elements of the built environment like transportation infrastructure, employment hubs, and recreational spaces, to impact population health.

In this case, urban form and design could offer people access to good health via opportunities for safe and convenient travel to various key destinations, foster opportunities to acquire income to sustain a household, and/or help to build social cohesion through the use of shared community spaces.

Feedback loops provide avenues for an iterative approach to decision-making.[20] Identifying different points in the feedback loops, can give planners and public health practitioners a better sense of how the interconnections between the built environment and other determinants of health operate. This can create opportunities for intervention where elements like access to health care, food security and social cohesion can be leveraged to improve population health.

How Does A Systems Approach To Urban Planning Change Our Perception And Treatment Of The Built Environment?

Municipal governments are in need of new analytical frameworks and tools for understanding and building sustainable, equitable and healthy cities. A systems thinking approach focuses on understanding the interdependent components of complex urban systems. These relationships and patterns can give some insight on how to interpret the pathways that exist between the built environment and population health through the detection of patterns and feedback relationships. With this knowledge, we can better understand our role in managing complexity and influencing system components to achieve a desired outcome.[22]

Urban simulation models and cognitive maps can offer a methodology for critiquing, refining and clarifying planning theories, practices and associated investment decisions. They offer an avenue for learning, debating and reflecting on what worked, what worked well, and what did not work, as well as carving out spaces for reflective processes in planning.[19]

> *"When we look at how we the last years have changed from society emphasizing automobiles and the access on roads, and how we today turn towards a society which increases the demand for public transport, electrical cars and bike lanes which degrade the value of cars and the demand for petroleum. These interests are due to changes in the environment and changes in the values of the society."* [22]

Systems thinking offers a path to stepping outside of the traditional urban planning discussion to reflect the progressive values of an increasingly urban generation in the form and structure of their city.[16]

How Can A Systems Thinking Approach Be Useful For Thinking About The Built Environment And Health?

Systems thinking helps us better understand how and why the built environment shapes individual and population health. It provides a conceptual and an analytical lens towards looking at complex connections between physical and social environments and human behaviour and activity patterns.[23] With a better understanding of these connections, it is possible to identify leverage points within local environments or systems. This enables us to construct interventions at different levels (legislation, regulation, and policy) for encouraging desired behaviours (building health promotion into neighbourhood systems and built landscapes). A systems thinking perspective is useful in reflecting on the multi-level health impact of the built environment and structuring interventions to respond and adapt to residents' needs in a constantly

changing environment.[5] By helping practitioners navigate urban systems and multi-layered networks, apply interventions at appropriate (sometimes multiple) levels and improve the quality of interventions and associated health outcomes, systems thinking can help to bridge the gap between research, policy and practice. In other words, it facilitates the alignment of urban planning and public health.[23]

Urban models and cognitive maps provide an illustration of how system components are connected to each other. These tools force us to acknowledge that an intervention in one area of the system can trigger significant changes in other areas of the system, whether positive or negative. Many systems experts believe that this attribute encourages organizational communication and intersectoral collaboration to achieve optimal socio-economic and health outcomes.[24]

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