

Evaluating Strategies to Encourage Active Transportation in Urban Areas for Sustainable Development



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11th International Scientific Conference on Energy and Climate Change
10-12 October, Athens-Greece

Partners



Universidade do Minho



UNIVERSITÀ DI BOLOGNA



ASSOCIATION FOR SUSTAINABLE
INNOVATIVE DEVELOPMENT IN
ECONOMICS, ENVIRONMENT AND
SOCIETY



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ERA-NET Cofund Smart Urban Futures Call



URBAN EUROPE



This project has received funding from the European Union's
Horizon 2020 research and innovation programme under grant
agreement No 726744

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Introduction

- People in the U.S who reside in areas where walkability levels are low, drive 39 miles more than those where walking activity is high – a 30% gap (SMARTRAQ)
- When examining weekend travel, they found the gap to be 40% (SMARTRAQ)
- Neighbourhoods with higher vehicle use
 - consume an average of 1,048 gallons of gas
 - Relative to neighbourhoods with lower vehicle use, spend \$2,600 more on gas per year (SMARTRAQ)
- The World Health estimated that 1 in 9 deaths are caused by air pollution worldwide
- Air pollution has detrimental environmental and health effects as well as adverse impacts on wildlife
- Air pollution is thought to promote incidence and progression of some diseases such as asthma, lung cancer, ventricular hypertrophy, Alzheimer's and Parkinson's diseases and psychological complications to name a few (Azam et al, 2016)



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Introduction

Cont'd

- Urgent need to address the critical climate change
- Current literature on urban planning methods fail to capture the systemic effects that result from their strategy implementation.
- Research on structural changes in urban areas and land use can aid in potentially decreasing greenhouse gas emissions and pollution, by reducing transportation energy-use
- Active transportation could be paramount to decreasing energy needs and consumption.
- We define active transportation as a means of transport whereby individuals actively move; such as walking or cycling
- Though governments can implement a number of strategies to support active mobility, over the years they have sought to improve traffic network conditions. But such policies are usually improperly assessed



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Introduction

Cont'd

- We present a system dynamics model to analyse the effects of walkability on energy savings and greenhouse gas emissions
- The proposed model gives plausible long-term strategies can be evaluated prior to their implementation, in order to enhance the willingness of people to engage in active transportation
- This is carried out in a computer simulated environment, whereby all costs and benefits are estimated in a dynamic form
- The new regulatory framework includes a binding renewable energy target for the EU of at least 32% by 2030 against 27% so far (ETIP SNET)
- Policy & regulation are lacking, but picking up to deliver what is needed (ETIP SNET)



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Existing Literature: Qualitative Studies

- Cao & Li (2011) deliberate how low-carbon eco-city planning designs and development strategies will not only encourage, but also lead to sustainable urban development and living
- Consequently, businesses and industries will be given plentiful opportunities in which they can progress and grow, leading to further advancements within industries.
- Lizarralde et al (2015), who carried out a document analysis and conducted interviews that revealed the tensions involved in sustainable development
- Pojani and Stead (2015), examine nine highly considered possibilities for promoting sustainable urban transport in cities belonging to developing economies and critically assess them
- Important and constructive propositions can materialise from such qualitative studies on certain aspects of planning

Existing Literature: Qualitative Studies Cont'd

However.....

Existing Literature: Qualitative Studies Cont'd

- It is worthwhile acknowledging that what emerges from these studies, are ultimately subjective views that could be a target of heavy criticism
- This necessitates the need of such studies to be supported with quantitative methods

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Existing Literature: Quantitative Studies

- Serrenho et al (2017), evaluated the potential emission decrease in Great Britain until 2050
- They argue that this will incentivise manufacturers to regard the advantages of reducing vehicle weight (which current policies failed to do)
- Their findings support their hypothesis that there is room for cumulative reduction in emissions by 2050 as opposed to other inducement policies.
- US energy department discovered:
 - Areas with greater population densities and more walkable streets, resulted in less vehicle use.
 - Improving built-up areas could also lead to a fall in U.S transportation energy and greenhouse gases from anywhere up to 10% by 2050.
 - Growing federal efforts to fund urban development and support more efficient and effective land use, could also reduce energy transport use.

Existing Literature: Quantitative Studies Cont'd

- Quantitative studies provide more reliable conjectures backed by empirical findings

But.....

- These examine relationships in isolation missing the interdependencies that exist with other entities of the system
- They also rely on static and past data, which may not necessarily hold for changes which take place in the future
- In contrast, our research centres on utilising dynamic data suggesting an integrated holistic model

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Existing Literature: System Dynamics Studies

- Han et al (2009), adopted Shanghai as a case study to showcase how an integrated model could examine the dynamics of urban growth
- Their model indicated that road network planning could potentially play a significant role in the establishment of newly urbanised land
- Fen et al (2013), also opted to construct a system dynamics model to analyse the course of CO2 emissions in Beijing from 2005-2030
- Found that policies controlling for population growth, enhancing development and promoting a change in energy structure from carbon rich fuel as coal to low-carbon fuel as natural gas in Beijing, will play a vital role in the demand for energy consumption.
- Tsolakis and Anthopoulos (2015), utilise system dynamic techniques within an eco-city framework to establish firstly, a paradigm for decision makers
- They assess how such models can aid decision makers in appropriately planning for the future and making suitable future decisions as well as predictions

Existing Literature: System Dynamics Studies Cont'd

- Even though system dynamics methods have been applied in a variety of city planning studies, in the case of walkability and active transportation, research has been rather limited
- Also the effects of active mobility on energy consumption and climate change in the current literature are not adequately analysed
- To contribute to this line of literature, we propose a system dynamics model dedicated to promoting walkability and sustainable active transport
- In our model, we take into consideration energy consumption and socio-economic benefits

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The Model: Introduction to System Dynamics Modelling

- Orchestrate a “computer-aided approach to policy analysis and design” with the intent of inferring plausible strategies for active transportation
- Construct a network of interdependent, mutually interactive, information feedback and circular causality systems to establish their links and aid us in unveiling appropriate active transportation policies accordingly
- The model is coupled with causality and feedback loops
- **Causality loops** demonstrate information feedback from one dynamic system to another with the aim of contriving the interrelatedness of these systems
- **Feedback loops** dictate the structure of the multiplex system by adopting the notion that system outputs, are routed back into the system as inputs. In other words, the system can be said to feed back into itself.

The Model: Introduction to System Dynamics Modelling

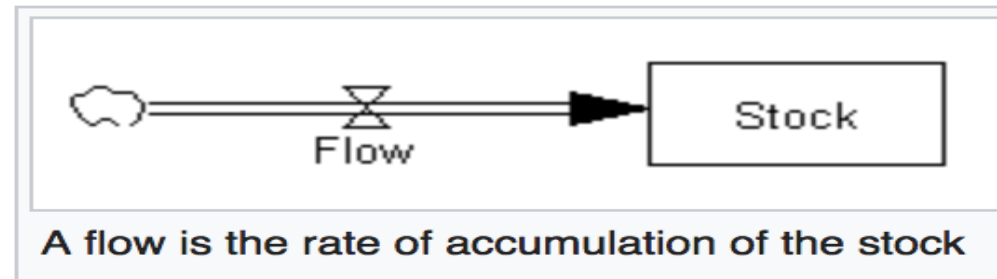
Cont'd

- System dynamic models have used to address global issues including population growth, healthcare delivery and epidemics to name a few
- Computer simulation is used with non-linear, first order differential/integral equations
- Simulated time is subdivided into discrete intervals of length dt , stepping the system through time one dt at a time
- The intuition for establishing links is also heavily reliant on the nonlinearity and influential power of a loop relative to others
- **Endogeneity** is pivotal to system dynamic models
- Exogenous factors only stimulate changes in the behavioural aspect of the system but causes are confined to within the structure of the system.

The Model: Introduction to System Dynamics Modelling

Cont'd

- System dynamics models require the employment of stocks (levels) and flows (rates)
- A stock can be thought of as any container (for instance consider a bathtub) that has a capacity to be filled
- Flows (inflows or outflows) can be described as a faucet that fills or drains the stock
- If there are more inflows than outflows, the number of entities in the stock will increase and vice versa
- Outflows equalling to inflows, signals a dynamic equilibrium within the dynamic system setting

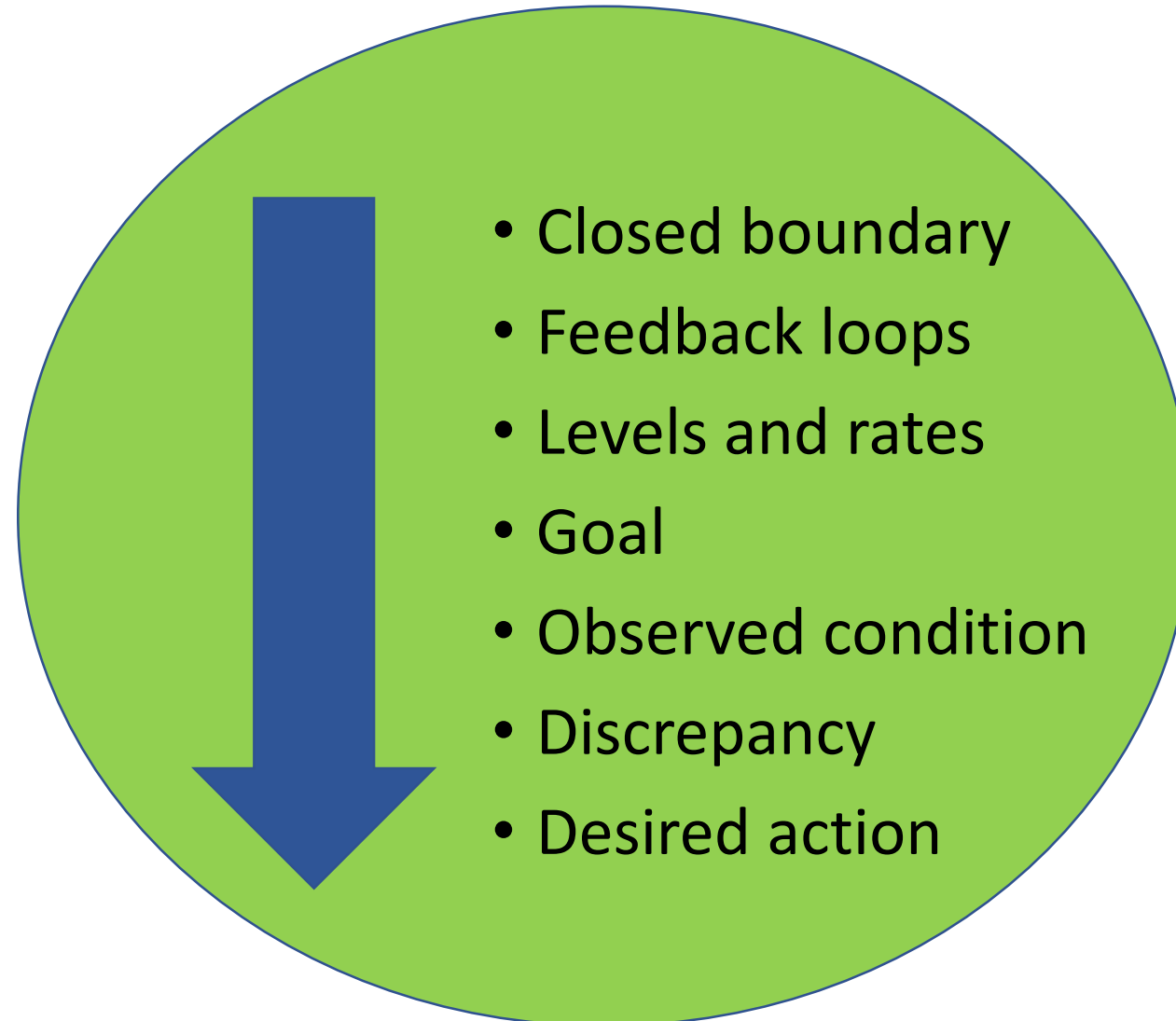


- To exemplify the concept of stocks and flows in the case of active transport, consider the behavioural system. An individual's attitude towards active transport (*the stock*), is governed by different aspects of an individual's life, such as upbringing, concern for the environment and area of residence (*the flows*)

The Model: Introduction to System Dynamics Modelling

Cont'd

Our system structure follows the one engineered by Forrester (1969):



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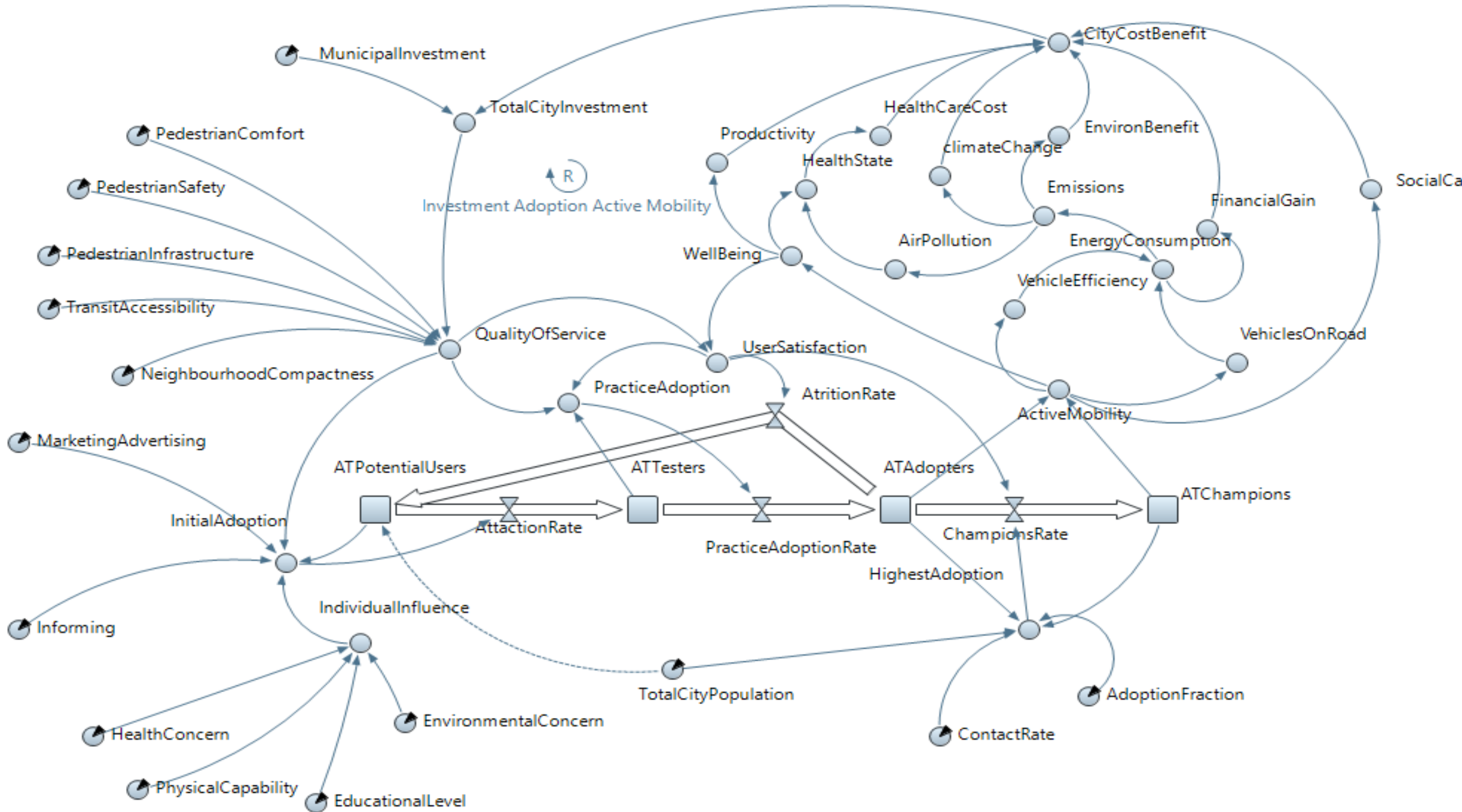
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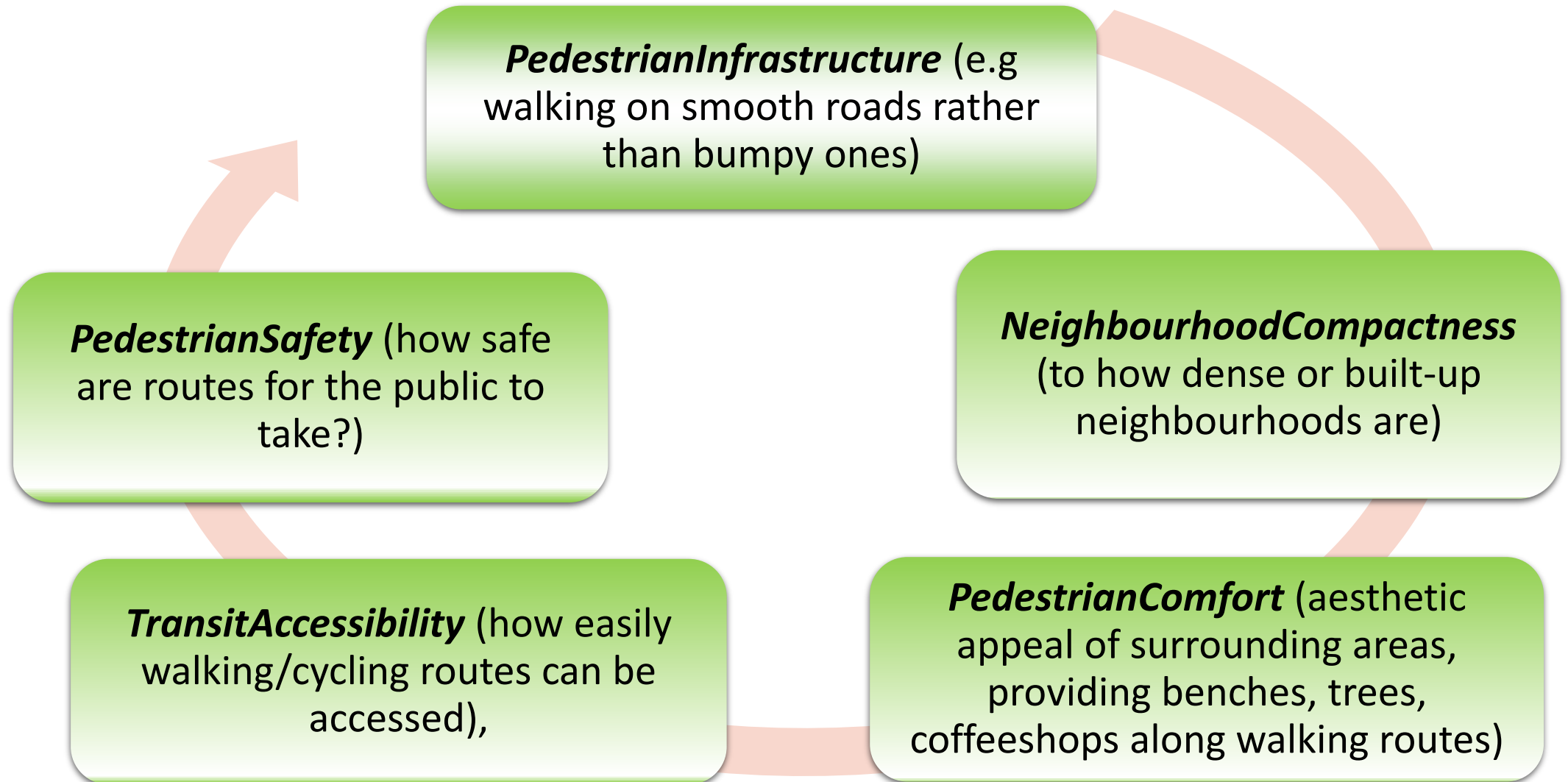


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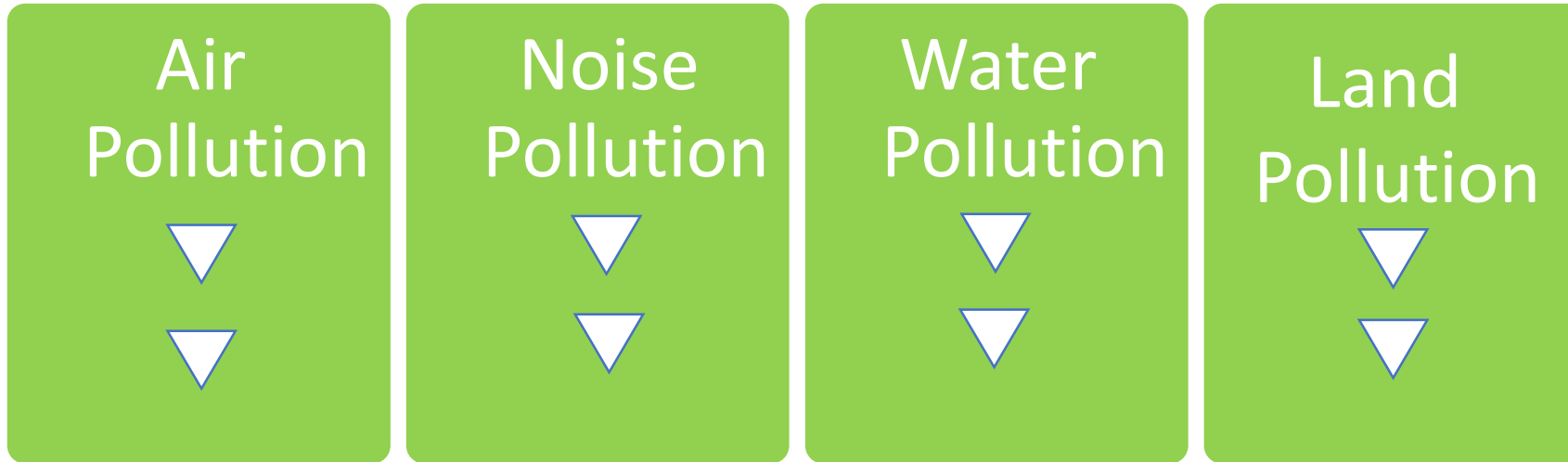
Our System Dynamics Model Cont'd

- Plausible Public Strategies include:



Our System Dynamics Model Cont'd

- In this way, many forms of pollution are reduced



Our System Dynamics Model Cont'd

- What can further be observed are the private benefits to the individual of engaging in AT



**Financial
Gains**



**Health
benefits**



**Greater Social
Interactions**

Our System Dynamics Model Cont'd

- As well as benefits on a wider scale...



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Discussion and Conclusion

Current policies to improve infrastructure for congestion are ineffective, costly and time-consuming



This issue calls government bodies and researchers to steer their attention to sustainable methods and encourage individuals to adopt active transport where possible



Active transport has the potential to encourage individuals to substitute immobile transport means with mobile ones, thus aiding to reduce CO2 and greenhouse gas emissions.



Benefits are reaped on a private level and wider scale



As seen, a myriad of factors play a part in influencing this outcome

Discussion and Conclusion Cont'd

Our system dynamics model instigates a network that enables us to include key parameters and factors that influence our stocks and flows

This execution provides insight into how optimal strategies can direct the course of active transport

Such matters need to be evaluated with dynamic data which allows the structural and institutional differences across different urban areas

No two areas are the same and if we are to improve on the existing quantitative methods, we need to employ dynamic means so that policies can be tailored to different organisational, systemic and governmental systems.

By constructing our model, we will build on these foundations, pairing them with mathematical means and simulations to produce viable results that will guide us to optimal strategic policies

We can apply such policies to various urban cities and test the significance of such policies

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