SCHEMA Case Studies

Applying Systems Thinking to Urban Health and Wellbeing

Acknowledgements

SCHEMA Case Studies

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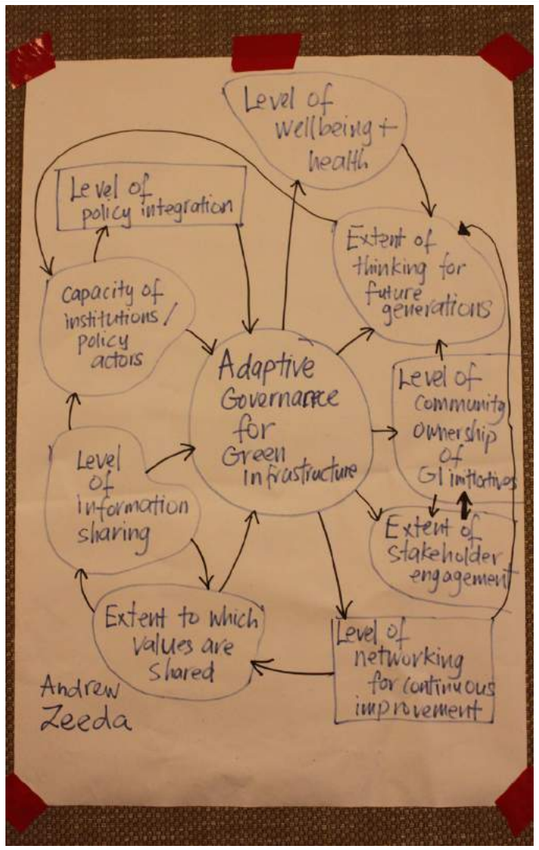
THE SCHEMA PROJECT

DAVID TAN

The SCHEMA project, also known as "Systems Thinking and Place-Based Methods for Healthier Malaysian Cities," seeks to explore linkages between important urban challenges and health, provide tools for navigating complexity, and establish new partnerships to motivate better decisions for healthier urban environments.

The project advocates a holistic, systems-based approach to urban health and provides tools suited to such an effort. Systems thinking helps trace the feedback loops that shape our environment and choices. With an awareness of these interactions, we can see why expanding road capacity cannot resolve traffic congestion over the long term, or why obesity has posed such challenges to governments at all scales, or why a multitude of other policy choices have gone astray. It teaches us to think beyond linear solutions and to look for leverage points in a larger system of relationships. Systems approaches also facilitate communication between disciplines and between experts and non-experts by providing a simple, visual language for explaining our understanding of cause-and-effect linkages.

Place-based methods are the other major tool in the SCHEMA arsenal. Every place—a city, a neighbourhood, a social gathering, a park, or a WhatsApp group—is unique. Context matters in understanding the workings of urban systems, and thus the challenges and lessons inherent in each place. For this reason, otherwise successful urban health interventions often fail when scaled up or implemented in new places. It is not enough to know that something worked—to draw the right lessons and translate solutions into new contexts, we must understand why it worked and the interactions and feedbacks that made success possible. Place-based methods help us recognise and navigate the distinctiveness of each place.



SCHEMA has promoting cross-cutting action and research and disseminated systems- and place-based tools through a diversity of channels, including through workshops, academic exchanges, and journal articles. The SCHEMA Case Study Series is part of that endeavour. It explores themes central to urban health that include land use, food consumption, transport, and community empowerment.

Each story is told using causal loop diagrams, the language of systems thinking. These are stories you are already familiar with, stories you see and experience in your daily lives, retold in ways that bring to light the linkages and feedback loops that lie at the root of the outcomes we see. The case studies come from a variety of contexts and scales. Some are at the national level, painted in broad strokes; others are specific to a specific place, a university or a river, for example; all hold valuable lessons for other places and times. As you explore these stories, we invite you to see how we think about urban health. In the process, we hope you will discover new insights that inspire you to rethink how cities work and reimagine the environment you want to live in.

"The SCHEMA workshop was a very engaging platform from the different fields of expertise to share their thoughts and inputs. It allowed amalgamation of different views and knowledge from the respective participants for a better understanding and finally conceptualizing a common framework to achieve the workshop goals and objectives. It should definitely be continued in the future."

- Dr. Zeeda Fatimah Mohammad, SCHEMA alumni

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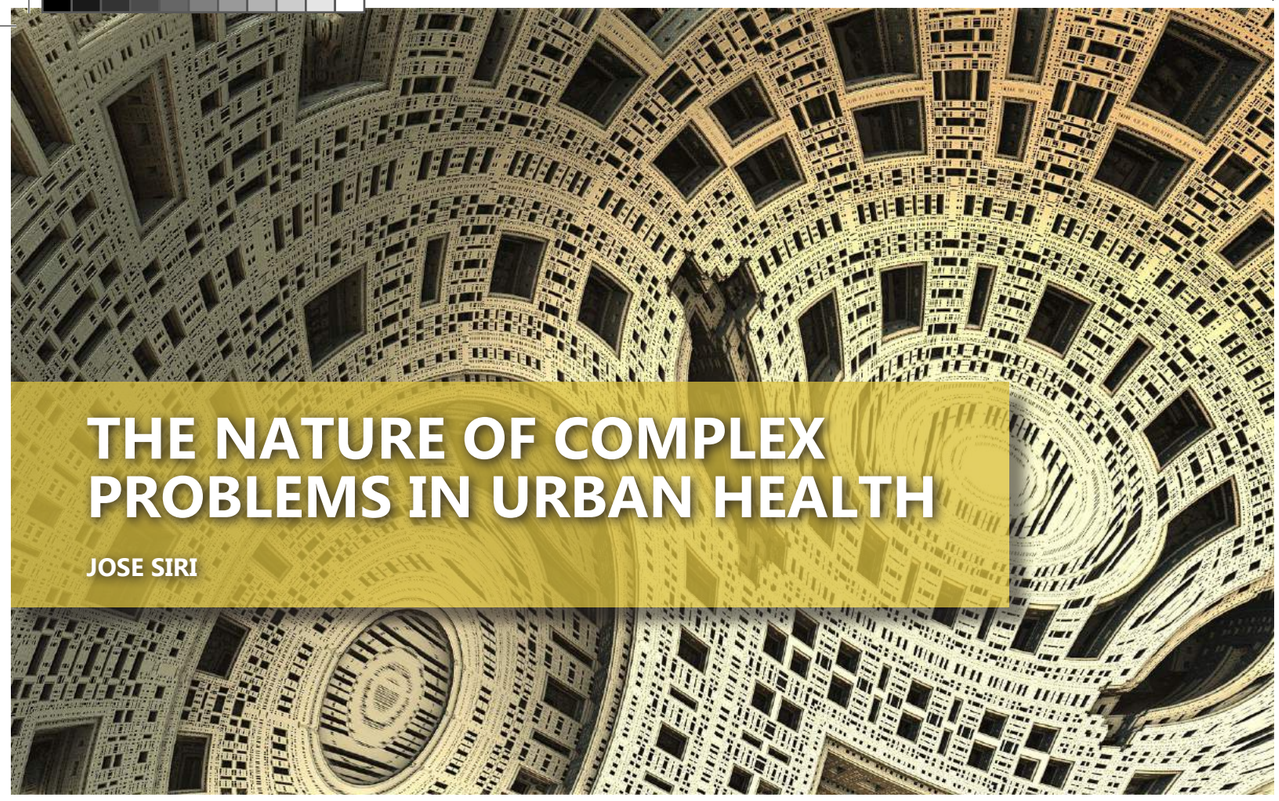

THE NATURE OF COMPLEX PROBLEMS IN URBAN HEALTH

JOSE SIRI

In 1948, the World Health Organisation defined health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." This lofty goal expresses a recognition of the complex nature of the determinants of health. And yet all too often, solutions to health challenges are narrowly defined in terms of the health sector. But health cannot be achieved through medical care alone. Certainly, our lifestyles and living environments have a tremendous impact on both wellbeing and disease. Unravelling the complex interactions of all these factors is a matter of survival, both in the narrow terms of individual human lives and with respect to the health of the planetary environment on which our civilization depends.

The habitats where we live are increasingly urban—in Malaysia, they now account for 75% of the population. To improve the health of Malaysians—and urban dwellers all over the world—we must therefore look to the way cities are planned, built, and run. Indeed, urban health extends far beyond the clinic doors. It is the air quality in our homes, schools, and workplaces. It is the interaction of urban heat islands with building design, which affects our vulnerability to heatwaves and the quality of our sleep. It is the sidewalks and parks that encourage us to get outdoors, be physically active, and interact with our neighbours and communities—or the lack of such amenities. It is time spent working and commuting, which in turn influences stress levels, food choices, physical activity, and family interactions. It is the multitude of ways in which gender, ethnicity, and socio-economic status affect access to municipal services and public spaces.

This picture, just a glimpse of the countless facets of urban health, gives us a sense of its complexity. Faced with a complex problem, it is human nature to break it down into smaller parts, and we have replicated this process at all scales. To manage urban complexity, we divide responsibilities among various disciplines, sectors, and agencies. Yet our organisational boundaries and the real-world workings of complex systems often fail to align. Moreover, informational and management silos, once formed, tend to be self-perpetuating, as specialists develop their own professional languages, codes of conduct, communication channels, and worldviews. Under these circumstances we are bound to miss causal links, overlook both risks and opportunities, and fail to recognize the cross-sectoral consequences of our decisions. Specialization is an important element of both science and governance, for urban health no less than in other areas. Yet developing holistic understanding is equally critical, and far less recognized. Transdisciplinary research—research that crosses disciplines and the research-practitioner divide—and cross-sectoral collaboration are important and necessary for improved decision-making.

When dealing with complexity, we also tend to simplify. Indeed, our dominant paradigms for science and policy are linear, based on simple cause-and-effect—we seek to evaluate the effect of X on Y, controlling for all possible confounders, and we search for silver-bullet policy solutions. On an individual level, we construct our mental models of the world based on processes that are easily observable, often failing to recognize outcomes that develop over long timeframes or at a distance. Yet most urban challenges involve dozens of complex processes and relationships, intersecting over varying timeframes in intricately interlinked chains of feedback loops. These are modulated by the continuous, often conflicting, simultaneous actions of legions of stakeholders with different motivations, perceptions and power. Indeed, decisions that shape the urban environment are often driven by economic, institutional, and political considerations, which may or may not align with health. Individual and societal choices thus shape the urban environment, which in turn shapes those continuing choices. It is impossible to make a single change in an urban system—pulling one lever sets many things in motion, and it is difficult to see where, across place and time, the ripples end. Is it any wonder that we are so often surprised by the unintended consequences of our actions?

Yet, there is room for real optimism, as we consider our relationship with the city. There is no question that the human mind is, in some contexts, admirably adapted for dealing with complexity. For example, each of us manages a startling mental web of relationships and dependencies among our friends, families, colleagues and acquaintances. More formally, systems science, applied to real-world problems of organizational efficiency, politics, environmental management, and, increasingly, health, has led to real successes. The SCHEMA Case Study series seeks to show how simple models can lead to a greater consciousness of the impacts of complexity, and therefore to more effective approaches to urban challenges for health and sustainability.

"The definitive factors in determining whether someone is in good health extend significantly beyond access to care and include the conditions in their life and the conditions of their neighborhoods and communities."

- John Auerbach, Centers for Disease Control and Prevention

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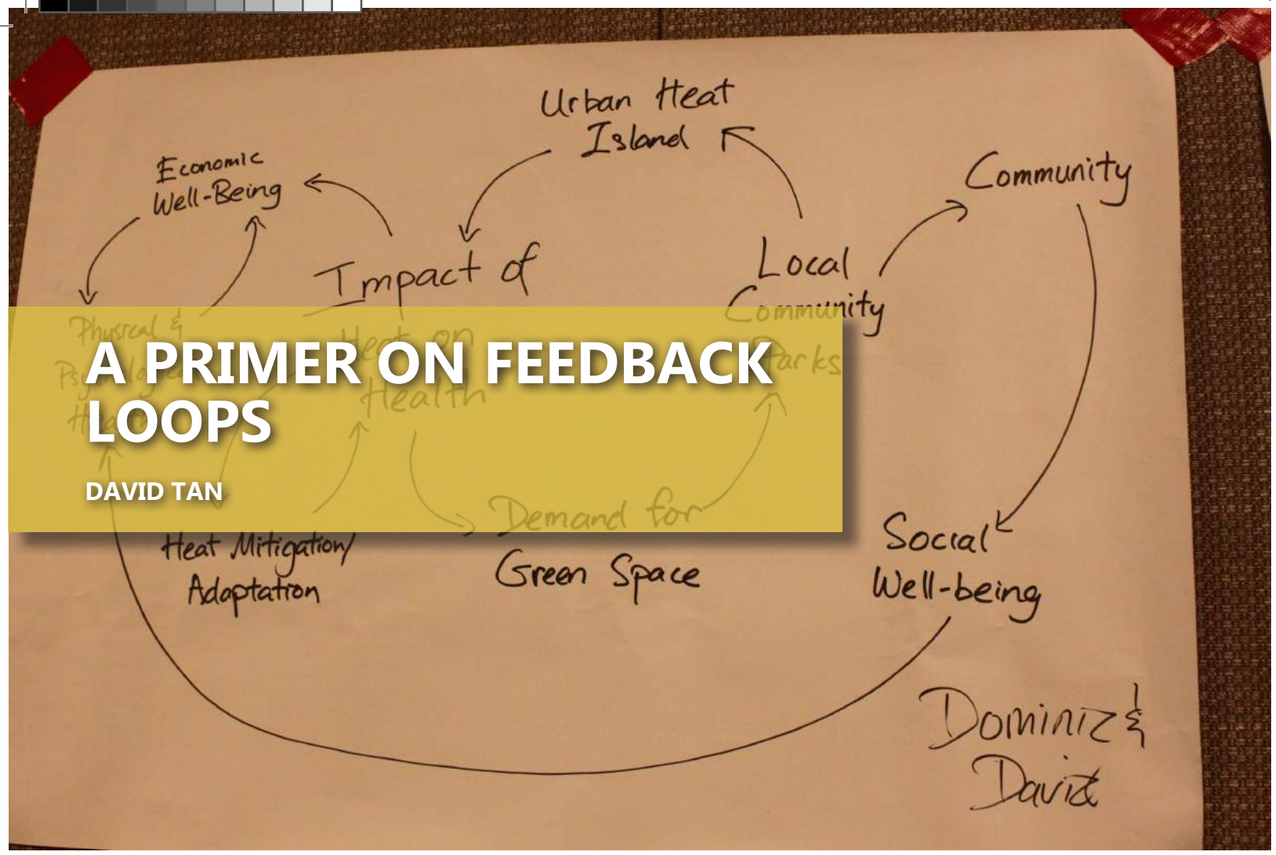

A PRIMER ON FEEDBACK LOOPS

DAVID TAN

Feedback relationships are a key feature of complex systems. In causal loop diagrams, they are represented as feedback loops. Consider the example of a restaurant: to attract customers, the manager might hire an interior designer to improve the ambience. The attractiveness of the ambience and the number of customers are positively related: as ambience increases, so does the number of customers, and as ambience decreases, the number of customers decreases too. This is represented by an arrow with positive polarity.

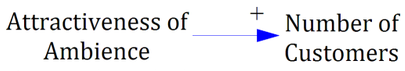

Figure 1: Positive relationship between attractiveness of restaurant ambience and number of customers.

Ambience is not the only factor determining customer traffic. The price of food is also important, but it acts in the opporite direction, i.e., it is negatively related to the number of customers. That is, the higher the price of food, the fewer customers, and the lower the price, the more customers. This kind of relationship is represented by an arrow with negative polarity.

Figure 2: Negative relationship between price and number of customers.

These arrows describe simple cause-and-effect relationships between two variables. However, system behaviour is often driven by feedback loops; i.e., by chains of relationships that feed back to affect the original variable. Thus, as the restaurant's customers recommend it to their friends, the restaurant gains customers, who then tell yet more friends. This forms a reinforcing loop.

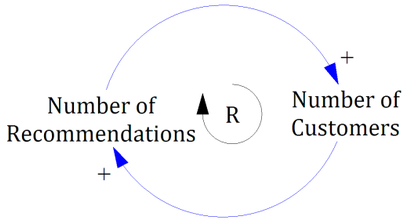

Figure 3: Reinforcing feedback loop showing the relationship between number of customers and number of recommendations.

This loop could also work the other way: if the restaurant loses customers for one reason or another, fewer people will hear about it through word of mouth, and fewer new customers will show up, creating a downward spiral.

Assuming, though, that the restaurant is gaining customers and recommendations, can this continue indefinitely? Unfortunately for the restaurant, the answer is no. In the real world, reinforcing loops are always limited by other factors.

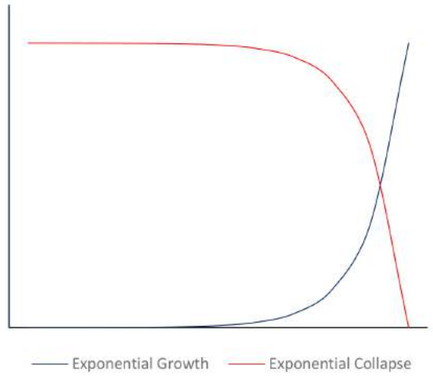

Figure 4: Exponential growth and collapse patterns observed in reinforcing loops.

In this case, one limit might be waiting time. As the number of customers increases, so does the waiting time for a table. Frustrated customers leave, thus reducing the waiting time for the remaining customers. We can represent this with a balancing loop.

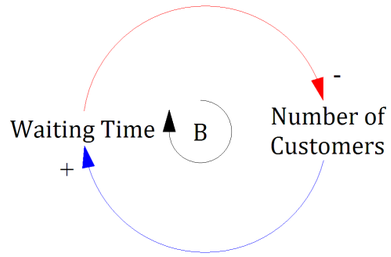

Figure 5: Balancing feedback loop showing the relationship between number of customers and waiting time.

Reinforcing loops result in exponential growth or exponential decay – growing or declining at ever-faster rates. Balancing loops, on the other hand, tend to converge toward a specific equilibirum. This is known as goal-seeking behaviour - though it should not be taken to imply a "desired" state for the system.

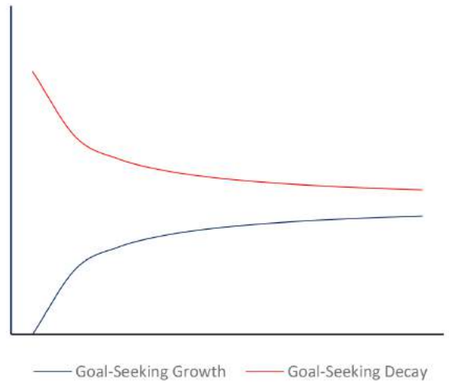

Figure 6: Goal-seeking growth and decay patterns observed in balancing loops.

Feedback loops drive system behaviour and can interact with each other and with interventions in surprising and unexpected ways. Casual loop diagrams can help us trace these patterns and identify leverage points for system change.

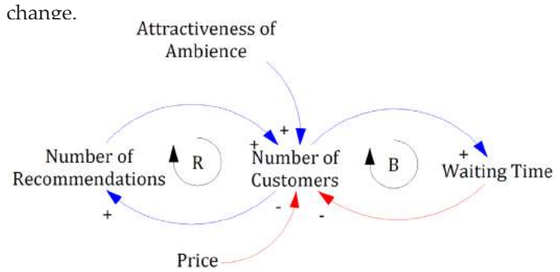

Figure 7: Combined system integrating the relationships shown in Figures 1-4. Efforts to draw in customers by improving the attractiveness of ambience and reducing prices can achieve success by increasing the number of customers and recommendations, but are limited by customer waiting time. Further gains will require, for example, an increase the number of tables and/or staff.

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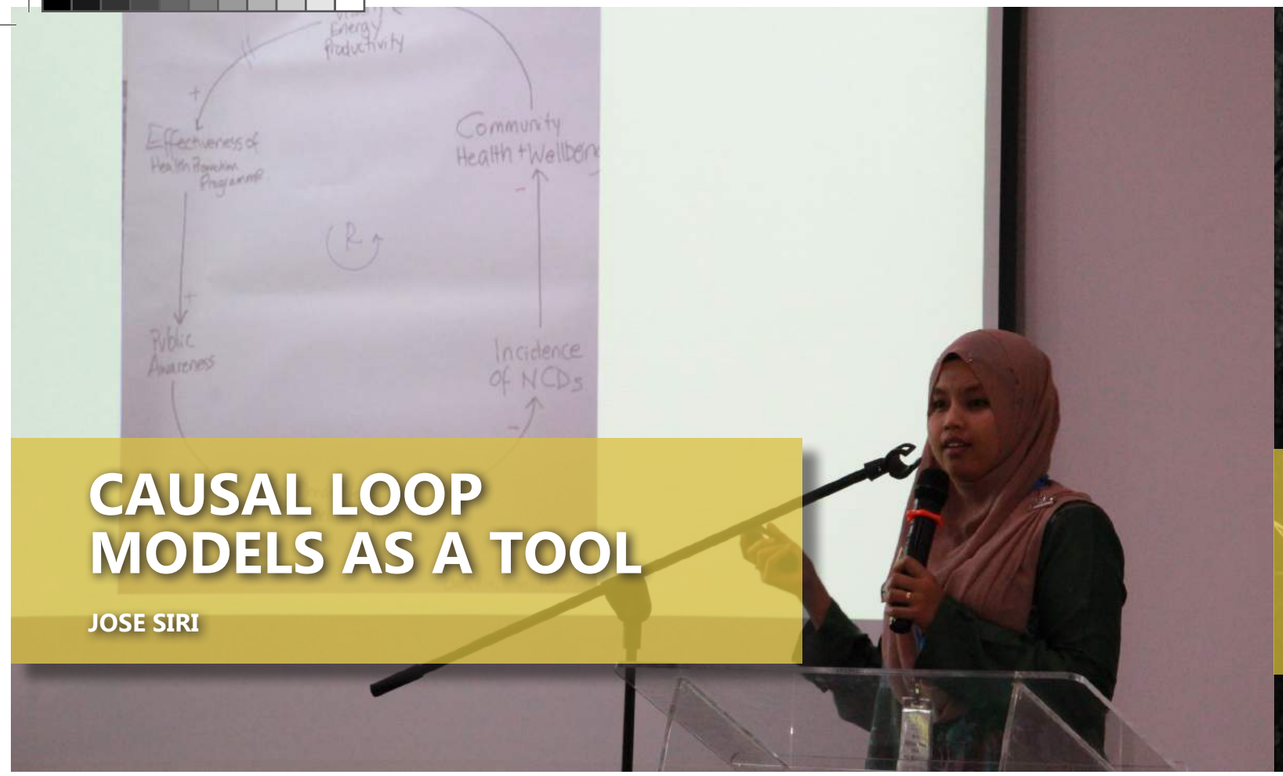

CAUSAL LOOP MODELS AS A TOOL

JOSE SIRI

A central assertion of the SCHEMA approach is that complex problems can often be addressed using simple models in transdisciplinary engagement. Indeed, simple models can be more powerful than highly complex ones, insofar as they identify critical feedback relationships and are mutually understandable by stakeholders operating at different places in a causal system. In such contexts, they can lead to surprising insights, better communication, and more effective action.

In the SCHEMA Case Study Series, causal loop models serve three distinct but interrelated functions. First, they are explanatory; each case study reframes an urban challenge to health and/or sustainability in terms of the feedback relationships that underlie outcomes. The goal is not to generate an estimate of effect sizes or definitively identify policy solutions—though these aims are indeed amenable to more detailed research projects. Rather, the studies here were chosen to represent a diverse set of problems of varying scales and scopes, and to show how understanding of simple feedbacks can generate understanding and suggest new potential actions.

Second, the studies are exercises in capacity-building. Each Case Study was developed via iterative communication between UNU-IIGH researchers and SCHEMA partners. During this process of mutual learning, partners gained experience with conceptualizing, delimiting and describing feedback relationships of progressively greater complexity, with defining the boundaries of causal systems, and with drawing policy recommendations from such work. All those involved gained a better understanding of the origins and persistence of the urban challenges described here.

Third, the collaborative construction of causal loop models in this Case Study Series is intended to break silos and improve communication. Through the extended communication over weeks or even months of refining the causal models presented here, authors learned to understand one another's ways of thinking and modes of expression, familiarized each other with disciplinary jargon, and created and strengthened personal bonds. We expect that the collaborative relationships developed here will lead to productive cross-sectoral collaboration that continues beyond the formal end of the SCHEMA project. Indeed, this function is a critical goal of the SCHEMA project, which is funded by an Institutional Links grant.

We present this SCHEMA Case Study Series, then, as one effective model for transdisciplinary engagement in service of sustainable, healthy, urban development.

CASE STUDIES AND PLACE

YI GONG

Systems thinking allows us to see and deal with the feedback relationships that drive complex systems. Using input from actors and observers, problems and key solutions are defined through chains of linked variables that form reinforcing or balancing feedback loops. But, thinking in systems is only one part of solutions for sustainable development—we also need to think in place.

The places we live in have profound effects on our health and behaviour, and on sustainable development itself. Scholars have examined how different aspects of place, including cultural, social, economic, and environmental contexts affect a multitude of outcomes. In daily life, place often appears to be a stationary stage on which existence plays out; yet, over time, these seemingly static places respond to our influences, revealing their dynamic nature. In research, place may be thought of as just as a site of data collection; yet these sites affect all aspects of our health and wellbeing. Moreover, each place is unique. The interactions and connections that bind us to places are often diverse, complex, and non-linear. They comprise mutually reinforcing relationships between us as individuals, with our communities, and with the physical aspects of our surroundings.

It is true that many ecological threats seem placeless. For example, climate change is driven by processes operating at a macro (i.e., planetary) scale. Nevertheless, the root of this global threat exists in behaviours and drivers at micro and local levels. Local context plays a fundamental role in moderating social, economic and environmental processes. Place-based analysis highlights how local processes shape and are shaped by processes operating at scales from micro to meso to macro. Human-environment interactions are strongly context-sensitive, so we must pay attention to the influence that places have on the operation of feedback loops in causal systems. Systems operating according to the same sets of causal influences can lead to drastically different outcomes depending on the relative levels of state variables in and relative strength of linking processes in local contexts, or other local factors like power relationships among stakeholders or social and cultural norms.

Place is an organizing concept that enables better integration of sub-systems for directed solutions in sustainable development. Adding place to systems thinking is critical to achieving the SDGs in Malaysia, as in other unique contexts. Understanding the operation of systems in place improves our comprehension of these systems, and thus our ability to translate theories and knowledge across contexts. This is especially important given that most theory and knowledge are based on case studies from Western countries.

Case studies are a particularly useful tool for understanding place – by their nature, they are snapshots of a particular context. As such, they offer insights into the similarities and differences in the operation of systems across space and time. Each case study in the following section illustrates and emphasize the role of place in systems thinking.

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SCHOOL CANTEENS AND STUDENT NUTRITION

SCHEMA CASE STUDY #1

Canteen - Last days of school by WHZang is licenced under CC 3.0.

UNU-IIGH

Li Fang Fang, David Tan, Jose Siri

The SCHEMA project seeks to improve decision-making for health and sustainability in Malaysian cities through the application of systems thinking and place-based methods. The SCHEMA Case Study Series describes a set of urban challenges and the actions that have been taken to address them, highlighting where systems thinking and place-based perspectives can shed light on underlying complexity and lead to more effective policies and interventions.

Overview

Childhood obesity is on the rise around the world, with consequences for health and wellbeing that persist into adulthood. At the same time, millions of children do not receive the necessary nutrition for healthy development of minds and bodies. Schools are a natural context in which to address these problems. But, ensuring that schools provide healthy food is challenging, given the different perspectives of regulators, canteen operators, schools and other stakeholders.

Local Context

In recent years, Malaysia has topped Southeast Asia in obesity and overweight rates. Nearly half of all Malaysian adults are now overweight, and this number continues to rise. In the Malaysian public school system, food provision is contracted out to local operators. Despite efforts to ensure high food quality, school canteen food in Malaysia is often of low nutritional value. This case study explores the underlying mechanisms in this situation.

Addressing the Problem

Two Malaysian ministries are responsible for regulating school food quality: the Ministries of Education (MoE) and Health (MoH). Three broad mechanisms are used, shown in Figure 1: food quality standards for school canteens, training programmes on food preparation for canteen operators, and monitoring procedures by schools. This system is designed to be self-correcting: when canteens fail to meet food quality standards, the monitoring system catches these failures, penalties are imposed, and canteen operators are motivated to improve quality. Training programmes ensure that canteen operators have the knowledge capacity to produce nutritious food.

Box 1: Training—Language Barriers

Training for incoming canteen operators is provided by MoH/MoE to develop operator capacity to provide nutritious food. Training is delivered in standard Bahasa Malaysia (the national language). However, Malaysia is highly culturally diverse. Many operators are non-Malay, with poor command of Bahasa Malaysia, and thus have difficulties benefiting from the training. This is a further challenge for school nutrition in predominantly non-Malay communities.

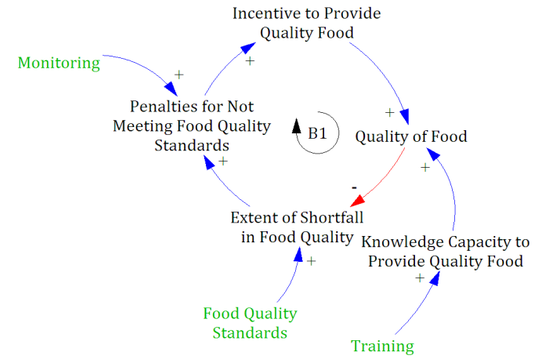


Figure 1: Regulatory interventions for improving food quality. Interventions are shown in green. Positive relationships are denoted by blue arrows (+) while negative relationships are denoted by red arrows (-). A central assumption is that penalties based on monitoring will provide incentives to maintain food quality – this is reflected in the balancing feedback loop (B1) seen here.

Exploring the System

Several obstacles complicate the MoE and MoH efforts. The effectiveness of monitoring depends on schools, but school administrations and teachers are tasked with many responsibilities beyond their primary goal of education. Monitoring canteen foods may not be a high priority.

Even when school personnel understand the value of nutrition to student health and educational outcomes, the perceived importance of monitoring depends on whether it is seen to achieve desired outcomes. However, canteen operators are rarely penalized for serving non-nutritious food; rather, action is taken only in clear cases of food poisoning.

School personnel may therefore come to view monitoring the quality of food as inconsequential, creating a self-perpetuating cycle (Figure 2): shortfalls in food quality go undetected or unreported, and opportunities for enforcing penalties are limited. This further reinforces the perception that monitoring is irrelevant. The monitoring feedback loop, meant to be a virtuous reinforcing cycle, becomes a downward spiral instead.

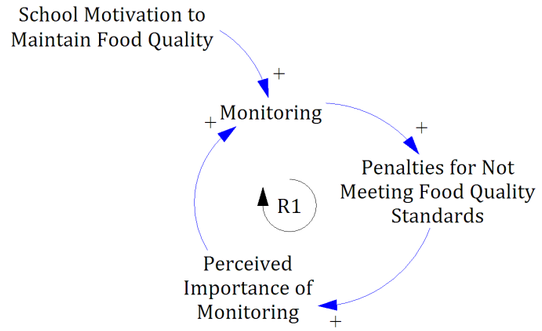


Figure 2: The effectiveness of monitoring by schools depends on intrinsic motivation for food quality and perceived importance of monitoring. If monitoring results in penalties when food quality standards are violated, this reinforces the importance of monitoring among school actors, encouraging continued diligence in monitoring. This is reflected in the reinforcing loop (R1) seen here.

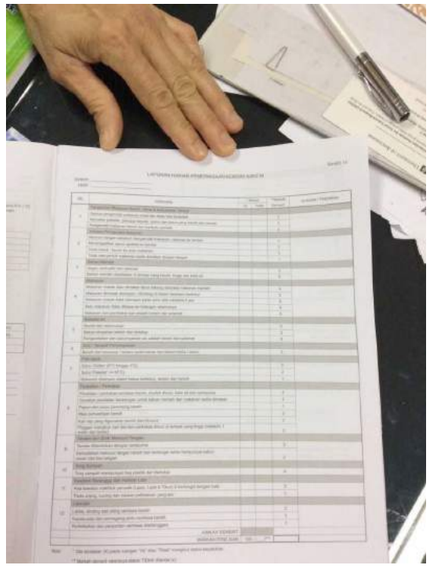


Figure 3: Daily monitoring check-list consisting of thirty-five items.

MoE and MoH policy must account for the influence of financial pressures on operator behaviour. Providing healthy food may require more expensive ingredients and higher labour costs, reducing profit margins. The rental auction policy (see Box 2) and the extent to which students and parents are willing to pay for healthy food also impact operator profits.

When profits are low, canteen operators may compromise food quality standards, creating a balancing feedback loop (Figure 4, B2) that works against the regulatory incentive loop (B1). Increasing penalty enforcement and severity might counteract this, but too much pressure may result in canteen operators opting out altogether.

Box 2: Policy Conflicts—Canteen Operator Tenure and Selection

School canteen operators typically receive two-year contracts, extendable for a third upon satisfactory performance. Contracts are non-renewable and regulatory barriers make it difficult for operators to shift to a different school. This policy, meant to share out the economic benefits of this opportunity, has the unintended consequence of limiting operator experience and increasing training costs.

School canteen contracts are awarded via auction, with the operator offering the highest rent winning the contract. While this generates funds for the school, it also creates an additional financial pressure for canteen operators, which in turn limits their ability and willingness to provide healthy food options.

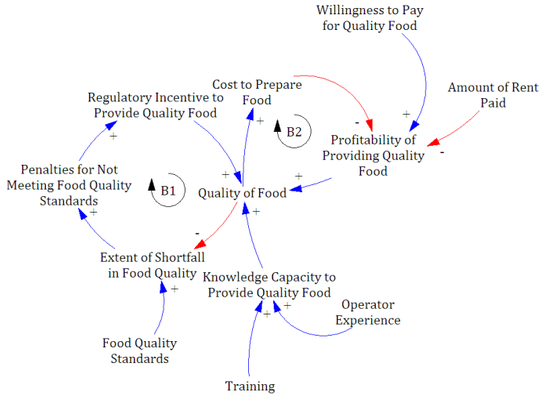


Figure 4: Regulatory interventions for food quality are counteracted by canteen operator financial pressures. Providing high-quality food raises costs and lowers profitability, and low profit margins reduce motivation and ability of operators to provide high quality food, reflected in the balancing loop, B2. Low parent and student willingness to pay for quality food and auction policies for school canteen contracts increase the pressure imposed by B2. Lack of contract renewal options limit operator experience and knowledge capacity.

Systems Solutions

Using systems thinking to examine the interactions between policy-makers, schools, and canteen operators reveals a set of incentives and feedback loops that explains some of the difficulties of providing healthy food in Malaysian public schools. This case study suggests several possible leverage points for interventions in this system to produce better outcomes:

1. Allow canteen operator contracts to be renewed, conditional on the provision of food that meets quality standards. This would not only generate incentive for canteen operators to provide healthy foods, but also create new reinforcing loops that increase operator experience and capacity (R2) and commitment to healthy food goals (R3).

2. Implement strategies to increase the willingness of parents and students to pay for healthy foods. This may include increasing awareness among parents of nutritious food benefits, expanding the supplementary food programme (Box 3) to cover more financially vulnerable students, and preventing competing sales of non-nutritious food (by school organisations in fund-raising activities or hawkers outside the school compound), which disadvantages compliant canteen operators.

3. Change the auction-based contract system. One alternative is for MoE/MoH to pay school canteen operators for a service, instead of canteen operators receiving payment from students. This would give MoE/MoH more control over menus and relieve financial pressure on canteen operators. Implementing such a change would require financial investment from both Ministries.

Box 3: The Supplementary Food Programme

The goal of the supplementary food programme (Program Rancangan Makanan Tambahan) is to improve the physical and mental health of vulnerable school children. Primary school children from families falling below the hardcore poverty line are eligible. Meals are provided via school canteens for up to 190 school days per year. The budgeted amount per meal is RM 2.50 in Peninsular Malaysia, and RM 3.00 in Sabah and Sarawak. There is also a free school milk scheme (Figure 5), targeted at the same demographic, with milk sponsored by private companies or NGOs in collaboration with MOE.

Figure 5: "One Malayisa School Milk." by CEphoto, Uwe Aranasm is licenced under CC3.0.

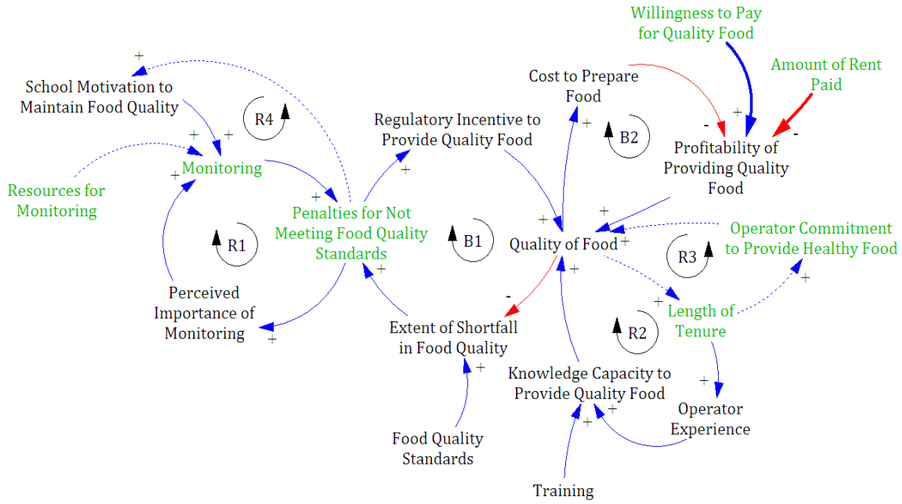


Figure 6: System of interactions between policy-makers, schools, and canteen operators, with proposed points of intervention shown in green. Dotted arrows reflect new causal linkages expected to arise because of these proposed interventions, creating desirable feedback loops (R2, R3, and R4), while thick arrows indicate changes to existing relationships.

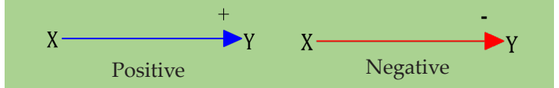
4. Improve the monitoring system by (i) enforcing penalties for failing to meet food quality standards, so that school personnel see their monitoring efforts as impactful; (ii) provide financial and personnel resources for schools to carry out nutrition monitoring; and (iii) create an incentive for schools to prioritize monitoring by conducting periodic MoE/MoH inspections, with penalties for schools that fail to achieve food quality standards, creating a reinforcing loop (R4) that improves monitoring.

Further Reading

1. "Ensuring healthier school meals" https://www.nst.com.my/news/2016/06/154725/ensuring-healthier-school-meals
2. "The supplementary food programme" http://www.moe.gov.my/index.php/en/bantuan-pembelajaran/rancangan-makanan-tambahan-rmt
3. "How school meals contribute to the Sustainable Development Goals: A collection of evidence" http://documents.wfp.org/stellent/groups/public/documents/resources/wfp290540.pdf

Reading Causal Loop Diagrams

Relationships between two variables are represented with arrows. Here, positive relationships (change in X results in a change in the same direction for Y) are described with blue arrows and a "+" sign; negative relationships (change in X results in a change in the opposite direction for Y) are described with red arrows and a "-" sign.



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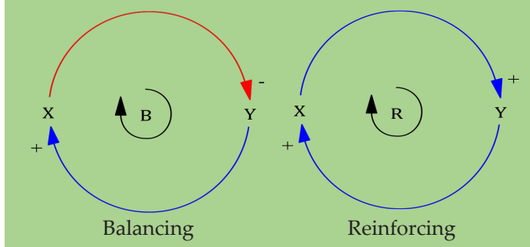

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HEALTHY FOOD CHOICES AND DIABETES

SCHEMA CASE STUDY #2

Penang Institute[ψ] and United Nations University[t]

Lim Chee Han[ψ], Esther Sinirisan Chong[ψ], and David Tan[t]

The SCHEMA project seeks to improve decision-making for health and sustainability in Malaysian cities through the application of systems thinking and place-based methods. The SCHEMA Case Study Series describes a set of urban challenges and the actions that have been taken to address them, highlighting where systems thinking and place-based perspectives can shed light on underlying complexity and lead to more effective policies and interventions.

Overview

In 2014, the World Health Organization estimated that 422 million adults were living with diabetes, making it one of the four most prevalent non-communicable diseases (NCDs). In most countries, including Malaysia, this prevalence is rising. Addressing the key risk factors for Type II diabetes-unhealthy diets and physical inactivity—is critical to taming this trend. In turn, this depends on remaking our daily environments, which, whether at home or in the workplace, strongly influence our decisions on what, where, when, and how to eat and be active.

Local Context

Diabetes is a major health concern in Malaysia, affecting almost one in five Malaysian adults. By 2025, 7 million Malaysian adults are projected to develop diabetes (Figure 1). To counter this trend, the National Strategic Plan for Non-Communicable Disease 2016-2025 established a national target for diabetes prevalence of 15% in 2025. Healthy food choices are essential to reaching this goal.

Figure 1: Projection on the Prevalence (%) of diabetes in Malaysia, 2015-2025, National Strategic Plan for Non Communicable Disease NSP-NCD 2016-2025.

Exploring the System

Food choices do not occur in isolation, but are influenced by many different factors. One such factor is simple familiarity

Box 1: Malaysian Food Culture

Food is so central to Malaysian society, that 'Dah makan?' (i.e. 'Have you eaten?') or the equivalent in other local dialects is a common greeting. Many towns are known for particular dishes, and day-trips to savour these culinary specialties are not uncommon. Twenty-four hour eateries have become a key part of the urban night life. Striking a balance between the maintaining a vibrant food culture and creating a healthy eating environment is a challenge.

(Figure 2). We tend to choose foods we are accustomed to, which in turn reinforces our preference for those foods—we become habituated to a certain diet (R1). When lifestyle factors or dietary norms lead us to healthy food choices, this reinforcing feedback relationship can act to help us maintain healthy diets; under these circumstances, we are also less enticed by unhealthy foods (R2). However, when other factors lead us to unhealthy food choices, these will also be reinforced, eroding our healthy eating habits.

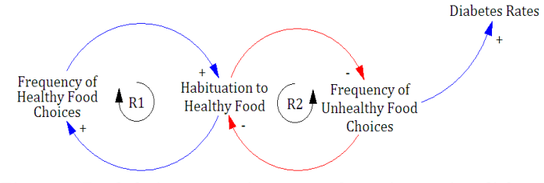

Figure 2: Food choices are an important factor in surging diabetes rates. When individuals are highly habituated to healthy food, they tend to choose such foods and avoid unhealthy foods. Each of these sets of food choices involves a reinforcing loop (R1 and R2) that strengthens the habit of eating well. However, when the extent of habituation to healthy food is low, these same causal structures can further erode the tendency to eat well: low habituation leads individuals to choose unhealthy foods and avoid healthy ones. These reinforcing loops form a "Success to the Successful" systems archetype, in which one outcome tends to dominate, making it hard to shift to the alternate state. In situations where unhealthy food choices are frequent, R2 will dominate, leading to lower habituation. Where healthy food choices are frequent, R1 will dominate, leading to higher habituation.

Food choices are also influenced by convenience and cost. The pressures of urban life, work demands, traffic congestion, and the rise of dual-income households have led to a decline in home cooking. Consequently, 64% of Malaysians eat at least one meal per day outside of the home. Such meals are less likely to be healthy than home-cooked food. Time pressure also reduces willingness to look for outlets serving healthy food, with many people making such choices based on time and cost alone. Increasing the number of healthy food options could make healthy food choices easier. However, food options are generally driven by market demand (Figure 4), with collective food choices creating another set of competing loops (R3 and R4) that

Figure 3: Malaysian "kuih"—bit-sized desserts.

influence whether healthy or unhealthy food options dominate. Indeed, healthy foods remain a niche market, with most products competing, instead, on the basis of cost and convenience—criteria that tend to favour unhealthy options.

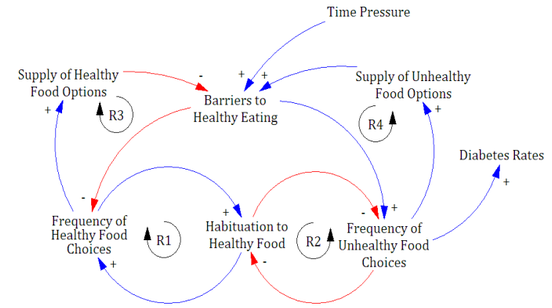

Figure 4: Modern urban life creates challenges for maintaining healthy diets. Time pressure from hectic lifestyles discourages home cooking, which is usually healthier than eating out. Also, healthy foods often cost more, and healthy food outlets are often scarce. These barriers to healthy eating encourage a higher frequency of unhealthy food choices. The supply of healthy or unhealthy food options is driven by demand; i.e., by the frequency of healthy or unhealthy food choices. Increased supply makes for easier access, thus making it easier (R3) or more difficult (R4) to eat healthily, and further reinforcing existing food choices.

Health Promotion and Knowledge

The foregoing suggests that maintaining the status quo with respect to food choices in Malaysia is likely to entrench unhealthy dietary habits and contribute to rising diabetes. Various groups have undertaken health promotion campaigns, assuming that increased knowledge of the consequences of unhealthy eating will motivate people to make healthier choices (Figure 5). Similarly, regulations for nutrition labelling and claims have been enforced since 2003, to improve food choices by supplying consumers

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Box 2: Sugar Intake

Average sugar consumption in Malaysia was 26 teaspoons a day in 2005—more than four times the recommended allowance. A large fraction of this sugar comes in the form of local "kuih," often consumed with meals and as snacks throughout the day, and condensed milk, added to tea or coffee.

with better information. However, most Malaysians do not read food labels, and those who do may not understand the implications. Furthermore, the continuing rise in obesity and diabetes rates in the face of increasing health literacy highlights the limitations of information as a mechanism for behavioural change.

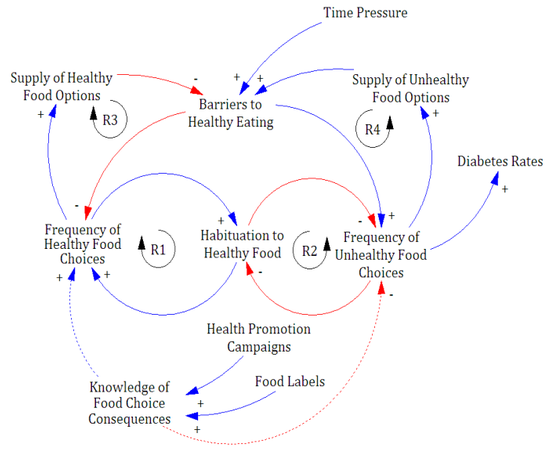

Figure 5: A variety of actors have made efforts to change individual dietary choices by providing better information—for example, through health promotion campaigns or food labels. The assumption is that better knowledge of the consequences of food choices will increase motivation to make healthy choices. However, in general, the strength of the knowledge on food and health has limited ability to affect healthy food choices—the dotted arrows in this diagram reflects this weak relationship.

Systems Solutions

Experience suggests that health information alone is insufficient to motivate healthier food choices at the levels necessary to reduce obesity and health consequences like diabetes at the societal level. In all likelihood, the solutions to these problems require structural changes to urban living environments that make healthy food choices simple and straightforward. The complexity of such environments and the persistence of these problems implies that multiple simultaneous points of intervention by many actors will be needed for effective change. A few possibilities are described here (Figure 6).

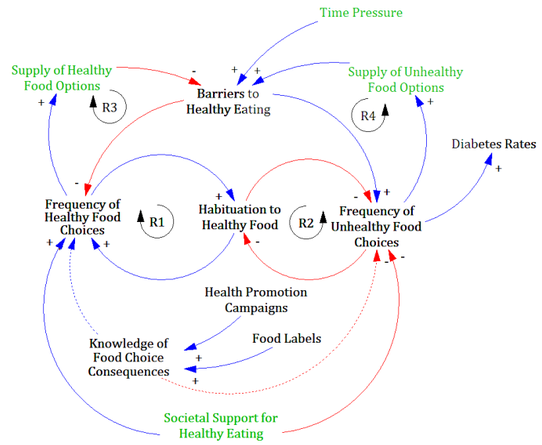

Figure 6: Changing food choices requires changing our relationship with food and the environment in which we made these choices. Some points for interventions, shown in green, include the supply of healthy and unhealthy food options, time pressure, and societal support for healthy eating.

Establishing new relationships with and around food may also affect the motivations that influence food choices. Community cooking activities can provide cooking skills and peer support, inspiring sustained interest in cooking in some individuals. Involvement with community gardens can also shape perceptions of and connections with food in ways that motivate healthy food choices, as can increasing awareness of traditional foods and food cultures.

Box 3: Fast Food - Symptom and Cause

The popularity of fast food, increasing among Malaysia's youth, is both a symptom and cause of broader unhealthy food choices. On the one hand, it reflects a desire for convenience and a reduced valuing of healthy food, factors that also drive other unhealthy food choices. On the other, accessible, affordable fast food increases habituation to unhealthy diets.

Various solutions have been suggested. Limiting exposure during formative childhood years may be important—fast food commercials are already banned during television programming aimed at children, and further restrictions could be considered. Another step could be restriction of local authority-issued operator licences, for example in the vicinity of schools. However, broader attempts to restrict fast food outlets may have unintended consequences: for example, they may lead to fewer but larger outlets and expansion of delivery services, counteracting the intended effect. Moreover, without addressing the factors that drive food choices, consumers may simply be diverted to other unhealthy foods.

Because the work environment is the site for a substantial fraction of food choices, employers have important roles to play. Dining spaces and kitchen facilities can be designed to encourage employees to bring home-cooked food. Flexibility in scheduling can provide time needed for cooking, while work-site programmes can encourage healthy lifestyles and support community activities.

There may also be better channels for delivery of diet-relevant health information than health promotion campaigns. Indeed, primary care providers can build relationships and provide targeted advice, linking diets to specific patient health issues. Primary care may thus strengthen the link between knowledge and behavioural change, while providing other health benefits.

These and other solutions (e.g. Box 3) take place at different scales and involve a variety of actors that may not be typically considered in health promotion efforts. Creative engagement and policy design will be needed to enable the multiple points of intervention necessary to change existing environments to support healthy food choices.

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3. The results of a worksite health promotion programme in Kuala Lumpur, Malaysia. https://academic.oup.com/heapro/article/21/4/301/687954
4. Obesity systems influence diagram. http://www.visualcomplexity.com/vc/project.cfm?id=622
5. Consumers' preference and consumption towards fast food: Evidence from Malaysia. https://www.researchgate.net/publication/277076342_Consumers%27_preference_and_consumption_towards_fast_food_Evidence_from_Malaysia

Figure 7: Morning greetings from a fast food giant tempt roadusers along a busy highway in the Klang Valley.

Reading Causal Loop Diagrams

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GREENING BUTTERWORTH: REJUVENATING SPACES

SCHEMA CASE STUDY #3

Daniel Lee[ψ], Murali Ram[ψ], and David Tan[ι]

Think City[ψ] and United Nations University[ι]

The SCHEMA project seeks to improve decision-making for health and sustainability in Malaysian cities through the application of systems thinking and place-based methods. The SCHEMA Case Study Series describes a set of urban challenges and the actions that have been taken to address them, highlighting where systems thinking and place-based perspectives can shed light on underlying complexity and lead to more effective policies and interventions.

Overview

In our increasingly urban world, the global population has reached 7.6 billion and counting, and more than 1 billion new urban dwellers are expected by 2030. As cities develop and urban populations grow and become denser, the green spaces that contribute to healthy lifestyles and environments are at risk of being replaced with greyer built environments, thus reducing quality of life.

Local Context

By 2030, 78% of Malaysians will live in cities. Growing populations are spurring the construction of concrete buildings to accommodate housing, lifestyle needs, and commercial uses, to the detriment of green spaces. In fact, over the last decade, land use in Malaysian cities has changed dramatically, as forests and green spaces are converted to built-up area. Such changes are visible not only in the Klang Valley, but also in smaller townships such as Butterworth, Penang.

The Butterworth Baharu baseline study sought to better understand land use and green space in this small city. The downtown area was identified as a place where issues of unused and unproductive space could be beneficially addressed. Downtown Butterworth has a population of 23,747, or 85 residents/ha, a high density relative to the rest of Butterworth and, indeed, to other urban centres in Malaysia. Only 4.8 ha of open space was identified in the downtown area, much of this poorly neglected and underused. This is woefully insufficient by both national (2 ha per 1,000 persons, National Urbanization Policy 2) and international (9 ha per 1,000 persons, WHO) standards.

Box 1: Butterworth Baharu Programme

The Butterworth Baharu Programme is an initiative to rejuvenate the city of Butterworth. The objectives of the programme are:

1. Improvements to and activation of public spaces
2. Realising land use potential
3. Celebrating historic Butterworth
4. Making a culturally vibrant and liveable City
5. Embedding a strong sense of community and place identity

Exploring the System

Local authorities play a key role in creating and maintaining green spaces and other public amenities, but have limited resources. Establishing new green spaces requires resources and increases subsequent maintenance demands, potentially making local authorities reluctant to do so, even when under-utilised or convertible spaces are available. We can visualize this as a balancing feedback loop which stabilizes the number or total size of green spaces available in a community (Figure 1).

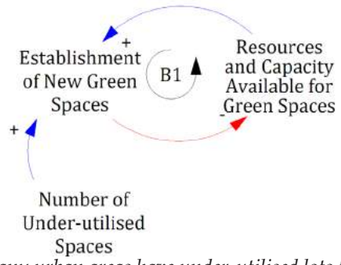

Figure 1: Many urban areas have under-utilised lots that could be repurposed into healthy green spaces. However, local authorities have limited resources for establishing and maintaining such amenities. Newly-established green spaces carry high costs and increase maintenance requirements, reducing both local resources and the capacity to establish other new amenities. This balancing feedback loop (B1) limits the overall quantity and quality of green spaces, unless further resources are allocated for this purpose.

Figure 2: Think City staff explaining the new design of Lebuh Kampung Benggali Pocket Park to residents at the launch of the revitalised park..

Maintenance of existing green spaces poses a further challenge (Figure 3). Typically, decisions must be made about how to allocate a set amount of resources designated for green spaces (B2). Well-maintained spaces attract more users and often yield economic and other benefits, generating incentives for authorities to continue funding maintenance activities, thus creating a reinforcing feedback loop (R1). Attractive and well-used spaces may also give rise to community ownership, which can promote behaviours that help local authorities maintain amenities, another reinforcing loop (R2). R1 and R2 can sustain maintenance efforts, but can also work in the reverse direction. When a space is poorly maintained due to a lack of resources, it becomes less attractive; fewer people use it and economic and other benefits fade away. The space diminishes in importance to the local authority and the community, further limiting incentives to allocate resources and undermining community ownership.

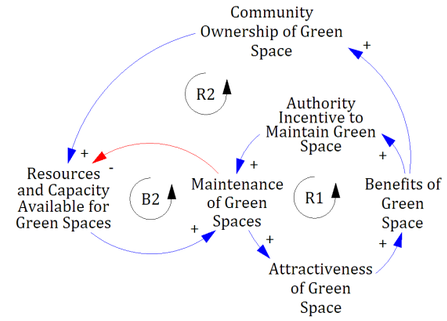

Figure 3: When a green space is well-maintained, it draws many users and provides various benefits, creating incentives for continued maintenance, a reinforcing feedback loop (R1). Local communities may also take ownership of these spaces; their involvement increases available resources and capacity (R2). Conversely, because local authorities must allocate resources and capacity among multiple green spaces (B2), under-investment in maintenance of a particular space may cause R1 and R2 to enter a downward spiral.

Addressing the Problem

One way to promote the development of urban green space is through efforts for urban rejuvenation, which can be undertaken by a variety of actors; such efforts may increase the attractiveness of existing spaces or even create new green space (Figure 4). They aim to catalyse the reinforcing feedback loops that lead to local authority and community support (R1 and R2).

The initial Butterworth study led to development of a plan to rejuvenate the city. Under this plan, local residents participated in community engagement sessions to communicate their priorities. Based on this information, two under-utilized locations were selected for transformation. The first instance involved restoration of the attractiveness and utility of a dilapidated green space, the Kampung Benggali Pocket Park, in February 2017, while the second involved the creation of a new green space, the Jeti Lama

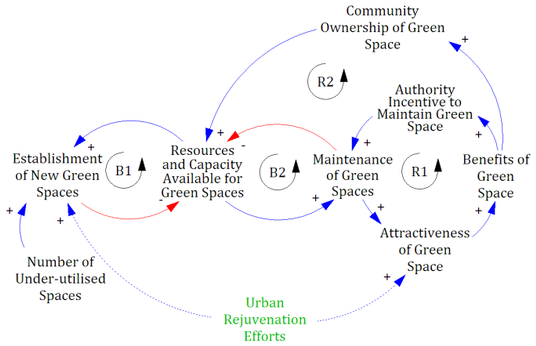

Figure 4: Civil society groups and other actors may invest resources in urban rejuvenation, shown in green, with effects on key variables shown with dotted arrows. This can increase the attractiveness of existing green spaces, driving the R1 and R2 loops in a positive direction, or increase resources for the establishment of new amenities, thus setting the balancing point of the B1 loop at a higher level.

Rain Garden, in a concrete landscape in October 2017.

Surrounded by high-rise apartments, the original Kampung Benggali park was infrequently used. Increasingly unattractive conditions, a lack of play and exercise equipment, and a low-cost fencing enclosure meant to safeguard users from the open drain made the space uninviting. Under the Butterworth Baharu programme, the park was restored, and now features native plants, a large swing, walking paths, and outdoor exercise equipment for community use. It is now well-used by residents and promotes community togetherness while contributing to physical health and mental well-being.

Box 2: Kampung Benggali

With its affable old town atmosphere, this veritable "downtown" space has possibly the highest concentration of multi-racial commercial outlets in Butterworth. The neighbourhood has a variety of community-based stores, coffee shops and restaurants in rows of shophouses.

The pleasant mix of Chinese, Malay and Indian outlets is reflected in the diversity of cuisine one finds here. The enclave is among the local hubs that long-time residents of Butterworth have been most familiar with and where the congenial urban essence of the town can be felt.

The second space, at the end of the Jalan Jeti Lama, was an under-utilised carpark. Littered with pigeon droppings, bird feed and discarded trash, it was only rarely used by visitors to the nearby market and temple. Save for two marginal periods of activity in mornings and evenings, it remained empty. Indeed, it was only fully utilised during two annual events: the Butterworth Fringe Festival and the Hindu fire-walking ceremony.

This space was reimagined as a rain garden, transforming the site and bringing life and vibrancy back to a hard landscape devoid of aesthetic quality or functional use. The project converted 810 m^2 of tarmac and an adjoining 210 m^2 of concrete into a park with dedicated parking facilities, while retaining its availability as an open space for events. Trees were planted, and the space features an interactive water pump for children. The garden also allows rainwater runoff to be absorbed into a local pond. These changes have, moreover, contributed to local biodiversity, enabling the return of dragonflies, frogs and other flora and fauna.

Box 3: Jeti Lama

This old precinct is a historic settlement that first appeared on a map of Butterworth in 1820, the principal town in Province Wellesley (Seberang Perai). The local name for Butterworth was Bagan, which means quay or landing-place. Butterworth and its immediate suburbs were dotted with piers along their coast, which served as entry points to the prosperous agricultural interior. Jeti Lama was where the old passenger jetty used to be for boats crossing the channel to and from George Town. Its early godowns, vintage shophouses and old public market still remain active today.

Figure 5: Butterworth Fringe Festival at the greened Jeti Lama carpark-turned-rain garden.

Sustaining and Replicating Success

The Kampung Benggali and Jeti Lama projects show how efforts by civil society groups and other actors can drive positive systemic changes to enhance public amenities. Local authorities are critical actors, but may lack the financial capital and manpower to implement desirable public projects alone, or to sustain efforts, particularly during economic downturns. In Butterworth, MPSP recognised these constraints and established a Public-Private-People Partnership programme, with 24 projects for parks and other public spaces initiated since 2012.

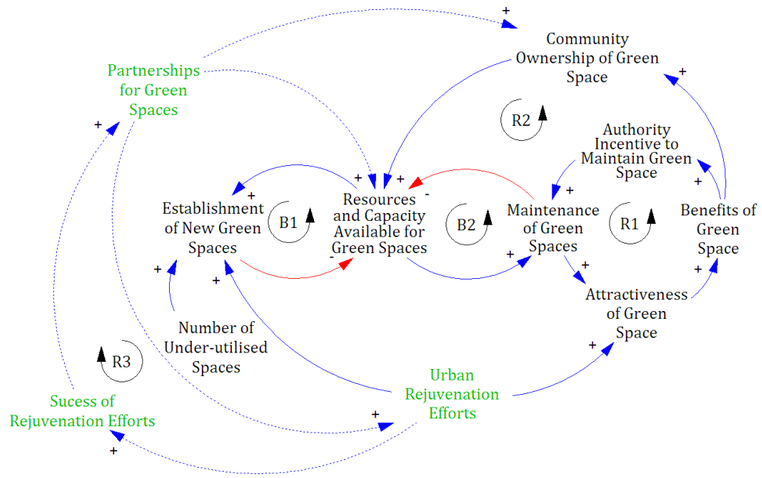

Figure 6: In good times, the reinforcing loops R1 and R2 act to bolster resources for establishing and maintaining green spaces. However, a shock to the system can shift these loops into a negative phase where they reduce such resources. Urban rejuvenation efforts can counter such effects, but are usually of limited duration. New variables and relationships, indicated with green text and dotted arrows respectively, show how the success of rejuvenation efforts can be leveraged to promote further action (R3).

The projects described here were designed to demonstrate the viability and value of reclaiming under-utilised urban spaces. Successful implementation can inspire other groups to partner with MPSP on similar efforts, and provide a roadmap for doing so. We can visualize this as a new reinforcing loop, R3, that promotes further partnerships (Figure 6). These, in turn, can secure resources and community-local authority cooperation for the long-term health of amenities. Ongoing visualisation and nurturing of partnerships will be crucial for maintaining green space in Butterworth.

Further Reading

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3. "Public-Private-People Partnership for public spaces in Seberang Perai, Penang Malaysia," in *Sustainable Infrastructure in the Tropics*. https://www.jcu.edu.au/__data/assets/pdf_file/0004/473503/SOTT-2017-Infrastructure-Report.pdf

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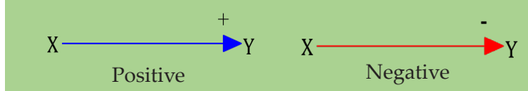

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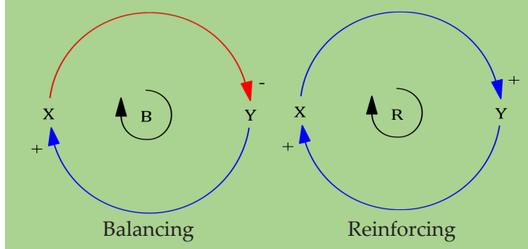

HOLDING ONTO A MISSION FOR CONSERVATION AND EDUCATION

SCHEMA CASE STUDY #4

University of Malaya [ψ] and United Nations University[t]

M. Sugumaran[ψ], David Tan[t], and Benjamin Ong[ψ]

The SCHEMA project seeks to improve decision-making for health and sustainability in Malaysian cities through the application of systems thinking and place-based methods. The SCHEMA Case Study Series describes a set of urban challenges and the actions that have been taken to address them, highlighting where systems thinking and place-based perspectives can shed light on underlying complexity and lead to more effective policies and interventions.

Overview

In many cities, high land use competition creates shortages of green space, which is important to healthy living environments. Yet older universities are often among the most land-rich of urban actors, having been founded on the outskirts of cities that then sprawled beyond them. In tandem with their educational capacity and mission, this uniquely positions such institutions to preserve urban green spaces and provide urban-dwellers with access to natural environments, along with the innate hidden benefits that lie therein. However, universities face many competing demands and missions, which place pressure on their desire and ability to fill this role.

Local Context

Rimba Ilmu (RI), Malay for "Forest of Knowledge," is a botanical garden established in the University of Malaya (UM) in 1974 to foster biodiversity conservation, nature education and tropical plant research. Situated between Kuala Lumpur and Petaling Jaya, it houses over 1,600 species of plants on 150 acres, constituting an important green lung for the metropolitan area and a facility for nature-related education. The garden's plant collections, permanent exhibition, and conservatory are essential tools for nature education (see Box 1), hosting hundreds of school classes and receiving visitors from all corners of the world. Such a unique facility is potentially of high value to UM, but has not been prioritised for investment in recent years. This case study explores the institutional opportunities and challenges RI faces in fulfilling its mission.

Exploring the System

RI is managed by the *Institut Sains Biologi* (Institute of Biological Sciences, ISB), the largest institute in UM, with many other research facilities and a wide variety of degree programmes. ISB founded RI with a mission of conservation and nature education, and made large investments into infrastructure and personnel to enable its success. The 1970s and 80s were intense periods of expansion and consolidation for the garden, with various core collections established. In the 1990s, UM's higher management invested in a multi-purpose administrative building for RI.

Box 1: Conservation and Educational Features of Rimba Ilmu

Key features of RI include: (1) plant collections, including medicinal plants, palms, citrus & citroids, ferns, bamboos and timber trees; (2) The Rain Forest and Its Environment, a permanent exhibition centre accessible to the general public, which operates as a self-learning facility highlighting the importance and biodiversity of the rainforest, as well as the consequences of deforestation; (3) the herbarium, a research and education facility with 74,000 specimens—dried plant materials that are stored systematically for taxonomical and conservation-related studies; (4) the Rare Plants and Orchids Conservatory, with over 200 living species of wild orchids and other rare plants under pressure from habitat destruction.

However, ISB's primary measures of success have always been the number of research publications produced and the number of students graduated. RI's conservation and education work supports the broad mission of research and teaching at the ISB, but lacks a direct impact on these key productivity indicators. Thus, maintaining the ISB's interest in and support for RI's mission is a challenge. Indeed, there is a tendency, in many institutions, for a failure to achieve goals to be met with lowered expectations rather than the increased effort and investment needed (Figure 1).

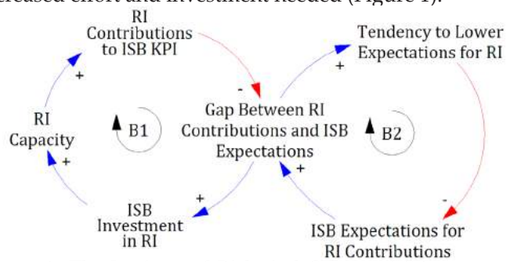

Figure 1. The Institute of Biological Sciences (ISB) invests in Rimba Ilmu (RI) monetarily and in terms of academic staff inputs. Ideally, when RI's outputs fall short of ISB's expectations, ISB should increase their investment, creating a balancing feedback loop that brings RI outputs back on target (B1). However, an alternative option is to respond to shortfalls by adjusting goals downward, creating a second balancing loop (B2) that lowers expectations. In practice, the second loop is often favoured because it requires less investment of resources and because reaching targets often involves a time delay. This causal structure, involving two balancing loops, is well known as the systems archetype, "Drifting Goals."

This challenge was initially met by ISB's Heads of Department (Figure 2). They upheld conservation and lifelong education as ISB priorities, and RI's outputs met those priorities. They set and kept high standards for RI, off-setting the tendency to reduce expectations, and ensured that ISB invested in RI, maintaining and expanding RI's capacity.

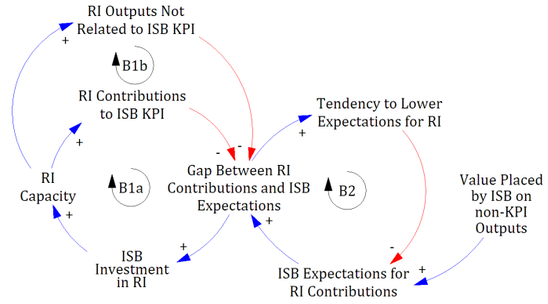

Figure 2: The tendency for goals to shift had previously been balanced by Heads of Department (HoD), who placed a high value on outputs not related to ISB KPI (e.g. conservation, informal education, access to nature, etc.). In doing so, they ensured that these outputs factor into the gap between contributions and expectations, (B1b) which determines investment.

However, this reliance of the system on individual champions (ISB HoD) to hold a mission together poses a risk: shift in staff members can undermine programmes. Loss of key persons, shift in university-level priorities toward peer-reviewed publication outputs, and reduction in IBS resources due to university funding cuts (especially from year 2012 onwards) have made it difficult to support groups like RI whose outputs are not easily quantifiable (Figure 3). This is exacerbated by competing demands for ISB funding, such as the upkeep of the department's other teaching and research facilities.

For this reason, while the University does fund major upgrades of RI facilities, these tend to be few and far between: once a decade or so. Consequently, RI has been maintained as a static resource, with higher management viewing RI as primarily an outdoor museum, with little emphasis on its conservation, educational and health benefits. The success of RI is tied to its mission, expectations and capacity. RI's resources and capacity have been built over several decades, and its reputation within and without the campus has developed likewise. Thus, although the University's direction and priorities have shifted, the public and other stakeholders still expect traditional outputs from RI (Box 2). Unfortunately, RI's capacity to deliver this is gradually being eroded by withdrawal of consistent, reliable support.

As with most complex issues in urban health and sustainability, many stakeholders are involved. While ISB, understandably, seeks first to meet its internal priorities, it seems likely that a broader consultative process would

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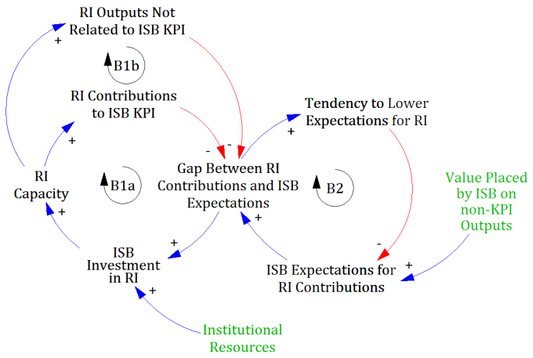


Figure 3: Several issues have emerged that have undercut investment in RI, highlighted in green. There is a loss of congruity between the RI mission and university priorities, due to an increasing emphasis on academic publications. This, combined with changes in ISB HoDs have reduced the value placed by ISB on RIs non-KPI outputs. Additionally, funding cuts to the university have limited ISB resources, pressuring ISB ability to invest in RI.

allow new insights into the existing and potential value of RI for its broad mission of conservation and education.

Systems Solutions

How can RI's mission and capacity for conservation, education, and healthy environments be kept alive while operating within ISB and UM institutional priorities? There are various possibilities, each with various potentials and pitfalls (Figure 5).

1. The simplest solution would be to realign RI's mission to better fit UM's research and financial priorities. This could be viewed as producing high-impact research articles with available facilities, together with maximising income-genearing activities in RI. This may gain better institutional support from the ISB and UM, at the risk of compromising RI's historical focus on life-long education and conservation.

2. Realigning UM's institutional structure, such that management of RI is partly or entirely given over to another institutional entity that places higher value on non-academic outputs like conservation and lifelong learning. One such possibility would be splitting the management of RI between the UM Department of Development and Estates Maintenance (JPPHB) and ISB. In this scenario, JPPHB handles general maintenance of RI's garden and buildings, reducing the financial burden in ISB, while ISB oversees the academic operations, educational programmes, and garden interpretation such as the setting up of new collections. This is only effective to the extent that the new supporting institution is aligned with RI's mission. Otherwise, withdrawal of support could compromise RI in the future, with the further complication of navigating multiple managers.

3. Moving towards partial or complete self-sufficiency. This involves engaging donors and business activities, and developing sufficient volunteer capacity and/or enough income to support dedicated non-UM staff (see Box 3), that is limited by RI staff capacity to manage and train volunteers. Furthermore, this may only be possible with significant upfront investment (e.g., to train and monitor volunteers), and it is not certain that ISB would allow or support such a move.

Figure 4: Rimba Ilmu's guided walks attract local and international visitors across all walks of life. This is educational recreation: learning and reconnecting with nature while having a good dose of exercise. Image courtesy of Sugumaran Manickam.

Box 2: Multi-stakeholder Dimensions of an Urban Forest Reserve

Hewn out of the Bukit Arang forest reserve complex, RI was set up in an attractive site with hills, valleys and natural running streams. Over the years, RI's value has extended beyond supporting research and teaching at the ISB to supporting the wellbeing of UM staff, students and visitors, and more generally, of urban residents. As with all urban green space, RI contributes to improving air quality and moderating urban heat; it is also an area where visitors can have deep contact with nature, with all the attendant benefits for health. RI plays an important role in facilitating access through guided tours, and through such experiences, visitors develop a closer bond with natural systems, a critical need in cities where such opportunities are few and far between. In addition to public use, it has benefited medical, pharmacy, and built-environment students who learn about medicinal and landscaping plants. While upkeep of the garden and protection of RI may have become a diminished priority, various questions remain about RI's role in the context of space, place, and society.

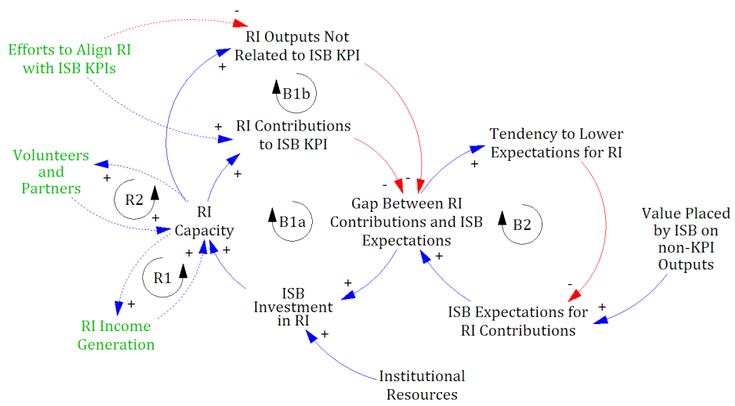


Figure 5: There are several strategies Rimba Ilmu (RI) can attempt to address its capacity challenges. Proposed strategies are shown in green. Dotted arrows show new causal linkages. RI may attempt to strengthen realign its mission to better reflect IBS KPIs. Alternatively, RI could seek support from another UM institutional entity that better fits its mission (not shown in diagram). Finally, it could move toward greater self-sufficiency by investing its capacity in income-generating and volunteer and partner building efforts, creating self-sustaining R1 and R2 loops.

These possibilities all involve working within or around ISB and UM institutional priorities and paradigms. An alternate approach—engaging with, and attempting to change these priorities and paradigms is presented in the Rimba Project SCHEMA case study (SCHEMA Case Study #5).

Further Reading

1. "Rimba Ilmu Botanical Garden." http://rimba.um.edu.my/

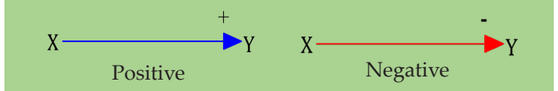
2. "Barriers and Strategies to Connecting Urban Audiences to Wildlife and Nature: Results from a Multi-Method Research Project https://content.ces.ncsu.edu/barriers-and-strategies-to-connecting-urban-audiences-to-wildlife-and-nature

Box 3: Rimba Ilmu, the Rimba Project, and Maintaining Third-Party Support

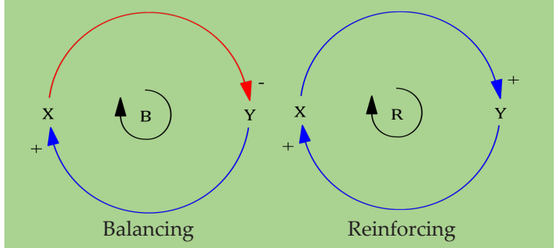
Over the last few years, RI has seen a renewed interest in the eyes of higher management. The incumbent Deputy Vice-Chancellor (Development) (DVC(D)) has attempted to address shortfalls and deficiencies in RI's management. The Rimba Project, a campus sustainability Living Lab co-funded by the DVC(D), is one such strategy. In contrast with preceding third-party interventions, the Rimba Project is deeply embedded within Rimba Ilmu, functioning as a go-between for collaborations with external parties such as NGOs, hobby groups, social enterprise and volunteers. One recent success is the Trailblazers initiative, a volunteer-led creation of new trails and interpreted sections in Rimba Ilmu (the first in nearly 20 years) that was overseen by the Rimba Project. In return, the DVC(D) has given RI and the Rimba Project a mandate to assist UM's Department of Development and Estates Maintenance (JPPHB) in improving conservation and management of UM's landscape and green spaces.

Reading Causal Loop Diagrams

Relationships between two variables are represented with arrows. Here, positive relationships (change in X results in a change in the same direction for Y) are described with blue arrows and a "+" sign; negative relationships (change in X results in a change in the opposite direction for Y) are described with red arrows and a "-" sign.



When two or more variables interact in a loop, the effect can be reinforcing (acting to amplify change), or balancing (acting to oppose change and maintain equilibrium). These loops and their interactions with each other drive systems behaviour, often in surprising ways.



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CHALLENGING LAND-USE PARADIGMS IN A UNIVERSITY CONTEXT

SCHEMA CASE STUDY #5

University of Malaya

Benjamin Ong and Faisal Rafiq Mahamd Adikan

The SCHEMA project seeks to improve decision-making for health and sustainability in Malaysian cities through the application of systems thinking and place-based methods. The SCHEMA Case Study Series describes a set of urban challenges and the actions that have been taken to address them, highlighting where systems thinking and place-based perspectives can shed light on underlying complexity and lead to more effective policies and interventions.

Overview

What is the purpose of a university? The scope of its vision determines what it strives to achieve and the resources it commits to these endeavours. Graduates and research are often the most tangible products, but, universities can also be living laboratories for investigating and demonstrating approaches to sustainability and wellbeing. Because universities shape societal paradigms and norms, this can be a pivotal role. University institutions that enable critical conversations and challenges to established conventions strengthen their ability to fulfil this role.

One debate on the role of universities involves the development of urban spaces. Like other urban institutions, universities face tremendous pressure to develop land, leading to competing paradigms: on the one hand, that unbuilt land is underutilised, and on the other, that it has intrinsic value, providing environmental and health benefits for the university and surrounding community (Figure 1).

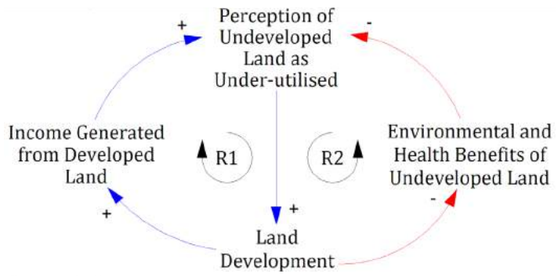

Figure 1: The extent to which undeveloped land is perceived as underutilised affects the extent of new development, which can, in turn, generate new income (R1) and/or lead to the loss of environmental and health benefits from unbuilt spaces, including green spaces (R2). Conversely, when unbuilt land is perceived as valuable, low rates of development will preserve environmental and health benefits, but limit new income. These competing paradigms involve two reinforcing feedback loops. Over time, one of the two paradigms will tend to become dominant, determining university land use decisions.

Local Context

Recent national budget cuts have removed substantial public funds from university operating budgets. Universities, in turn, have sought alternative sources of income (Figure 2). For example, University Malaya (UM) proposed to commercialise a portion of its land adjacent to the Section 12 suburban residential area to construct a mega-hospital, the UM Health Metropolis, a proposal strongly opposed by local resident groups that felt it would aggravate traffic and disrupt the character of their community.

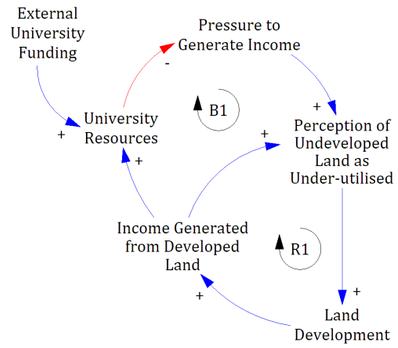

Figure 2: Pressure to generate income may spur development of university land. The resulting income alleviates this pressure, creating a balancing loop (B1), which can limit R1. However, reductions in external university funding have reduced university resources, changing the balancing point of the B1 loop and strengthening the R1 loop. One such result was the plan to turn a rewilded space into a medical centre.

Box 1: Language and Land Paradigms

The concept of development in Malaysia itself complicates land-use. The Malay word for 'development' is 'pembangunan' (development) or 'pemajuan' (progress), words that in the local context are typically associated with the act of clearing land for commercial purposes. This is often coupled with visions of skyscrapers and hi-tech infrastructural development, advances that are typically perceived in a positive light. Undeveloped land is associated with words like 'terbiar' (neglected); perceived imperfection of such land banks gives it low value in the eyes of developers and conservationists alike. The idea of "unproductive land" does not sit well with a development agenda that still largely promotes anthropocentric agency, influence and control over land.

Addressing the Problem

The Section 12 conservation project was an initiative commissioned by the Deputy Vice-Chancellor for Development (DVC(D)) and executed by the Rimba Project, a campus sustainability Living Lab initiative for landscape management and biodiversity conservation. The Rimba Project was tasked with conducting a biodiversity survey on the proposed project site, as a form of ecological impact assessment prior to development (Figure 3).

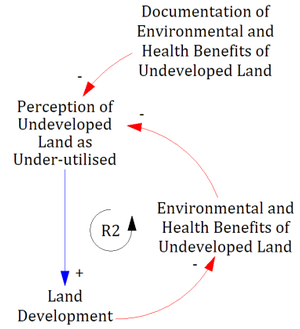

Figure 3: Efforts to document the history, biodiversity, and environmental benefits of university land can reinforce the perception of the intrinsic value of land (R2), thus reducing land development. Over time, this perception can solidify into a paradigm whereby it is assumed that land is intrinsically valuable. In this case, documentation led to a change in the land use decision for Section 12.

Unexpectedly, the 15-acre land parcel proposed for development was found to host a diverse range of plants and animals, including species, like fireflies, not commonly found in urban areas. The Rimba Project's efforts in documenting the history, biodiversity, and environmental benefits of the Section 12 land bank reinforced the perception of the intrinsic value of this undeveloped land. Driven by the Rimba Project's results, the DVC(D) advocated for preservation of the land, also suggesting that the principle of "planned negligence"—allowing land to lie fallow for ecological benefits—be considered in developing University land use strategies. Ecological surveys have also been made mandatory in the context of any campus development proposal. All these factors favour the paradigm that recognises the intrinsic value of unused land, seen in R2 of Figure 1.

While the present University management has decided to invest in capacity for environmental studies and ecological surveys, the example of Rimba Ilmu (SCHEMA case study #4) shows this may not always be the case. Furthermore, forgoing income from development to preserve environmental and health benefits further constricts the University's financial resources. This, in turn, forces University actors to re-evaluate resource allocation, potentially undermining capacity for campus sustainability research (Figure 4).

Systems Solutions

An examination of the feedback loops that drive university land use paradigms suggests that, to sustain an openness

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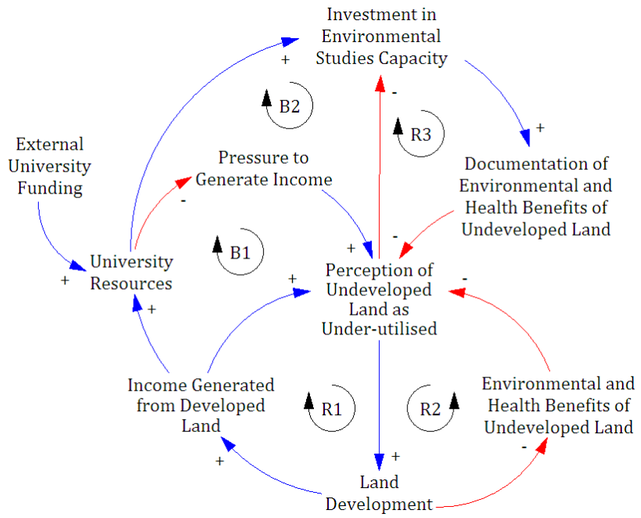

Figure 4: Perception of the environmental and health benefits of undeveloped space spurs investment in environmental monitoring capacity, which in turn generates evidence that strengthens this paradigm, a reinforcing feedback loop (R3). However, forgoing income from development to preserve environmental and health benefits limits university financial resources, creating a balancing loop that may constrain investment in monitoring capacity (B2). Indeed, the same financial pressures that spur development of university land threaten to undermine investment in capacity, causing R3 to spiral downward, eroding the intrinsic value paradigm.

to alternative ways to utilise land, other benefits from sustainable land use must be identified, valued, and leveraged. Examples of such benefits are shown in Figure 6.

1. Publications can improve the University's reputation. *The Backyard Before You*, a Rimba Project publication on the ecology and biodiversity, reinforces a shift in narrative: from the University as insensitive land developer to the University as an experimental space for development of contextualised sustainable development solutions. Such publications can motivate continued investment in capacity, as can academic publications that contribute to the University's key performance indicators.
2. Reputational benefits can also be monetised, for example through edu-tourism initiatives. Recently, the University of Malaya won the Kuala Lumpur Mayor's Edu-tourism Award. Initiatives like the Rimba Project and other Living Labs can help drive meaningful and successful edu-tourism, which in turn can improve university finances and ability and willingness to invest in environmental monitoring capacity.

Figure 5: In this campus sustainability model, Living Lab staff work alongside academics and experts, as well as student volunteers. Here, a bat researcher from UM's Institute of Biological Sciences leads the Rimba Project team in sampling bats from the bungalow site. This study contributed to a peer-reviewed article on the diet of urban bats, providing valuable data for conservation decision making.

Box 2: UM Living Labs and the Rimba Project: Operating Outside Traditional Organisation Structures

The UM Living Labs are a flagship initiative jointly managed by the Sustainability Science Research Cluster and the Deputy Vice-Chancellor (Development). They are tasked with enhancing campus sustainability on the ground, dealing with a range of complex issues from water security and waste management, to biodiversity conservation and sustainable transport. The Living Labs operate on the interface of research and practice, functioning very much like an "NGO" on campus. And yet, the Rimba Project's function as a whistleblower in the Section 12 case study has been a double-edged sword. Some observers were pleasantly surprised that the DVC(D) was party to the whistleblowing and had empowered young researchers to make a difference, taking their findings seriously; others were a bit suspicious, wondering if this was some ploy by UM for a softer interface with the community given the involvement of student volunteers. Navigating multi-stakeholder decision-making scenarios, in conservation especially, is a delicate undertaking.

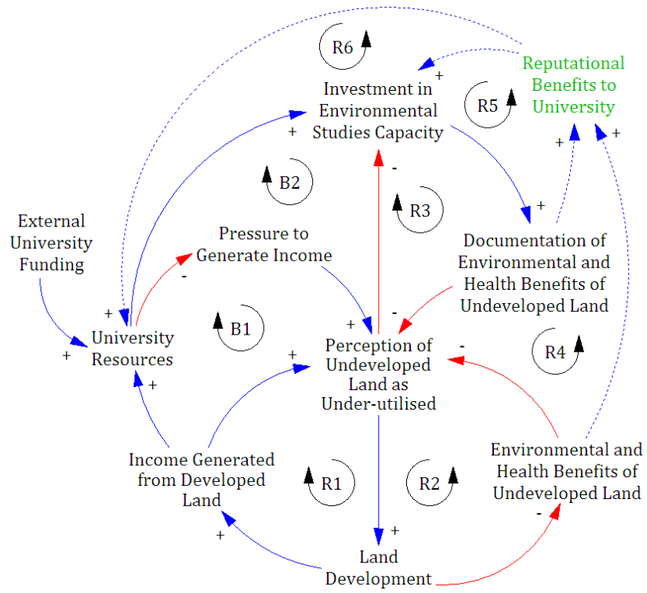

Figure 6: To strengthen the sustainable land use paradigm, benefits of this paradigm must be realised. Reputational benefits, shown in green, can be leveraged to create new causal relationships, indicated with dotted arrows, that create new feedback loops (R4, R5, and R6), motivating continued investment in environmental studies capacity by the university and possibly generating monetary benefits.

1. The environmental and health benefits accruing from university land also improve its reputation with neighbouring communities and individual users. Provision of clean, green spaces for recreation is an increasingly rare asset in the city, and land-rich institutions like universities can lead the way in promoting this aspect of urban wellbeing.

Further Reading

1. "Living labs and co-production: university campuses as platforms for sustainability science." https://www.sciencedirect.com/science/article/pii/S1877343515000573
2. "Vacant land in cities could provide important social and ecological benefits." https://www.thenatureofcities.com/2012/08/21/vacant-land-in-cities-could-provide-important-social-and-ecological-benefits/
3. "Understanding institutions: different paradigms, different conclusions." http://www.sciencedirect.com/science/article/pii/S0080210716308238
4. "Unintentional landscapes." http://www.tandfonline.com/doi/full/10.1080/01426397.2016.1156069

Reading Causal Loop Diagrams

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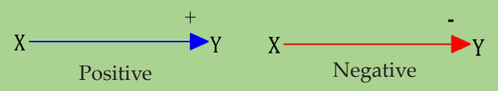

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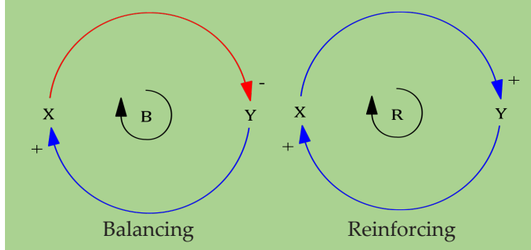

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SUSTAINABLE RIVER MANAGEMENT: THE PINANG RIVER

SCHEMA CASE STUDY #6

University Sains Malaysia and Penang Water Watch

Lai Chee Hui and Chan Ngai Weng

The SCHEMA project seeks to improve decision-making for health and sustainability in Malaysian cities through the application of systems thinking and place-based methods. The SCHEMA Case Study Series describes a set of urban challenges and the actions that have been taken to address them, highlighting where systems thinking and place-based perspectives can shed light on underlying complexity and lead to more effective policies and interventions.

Overview

Because rivers are complex socio-ecological systems, river management can pose significant challenges. Managers must account not only for the physical and ecological characteristics of the riverine environment, but also for the varying needs and contributions of relevant stakeholders. Local communities often play a vital role in the sustainability of river systems. In many developing countries, however, limited stakeholder engagement in river conservation is a key challenge for the health of river ecosystems. In Malaysia, 33 out of 477 rivers monitored by the Department of Environment were classified as polluted in 2015, and a further 168 were considered slightly polluted. Improving river management requires effective public engagement.

Local Context

The Pinang River, 3.2 km in length with a 51 km^2 catchment area, flows through the heart of George Town, the capital city of Penang. It has been severely polluted for over a decade — at one point, it was even declared dead, as no aquatic life could be found.

Domestic waste from local communities is a major source of pollution in the Pinang River. In theory, this should create a balancing feedback loop (B1) that acts to protect the river (Figure 1). As water quality in the river decreases, the gap between the desired and actual river water quality increases. This, along with associated impacts on the health and wellbeing of local communities, should increase community participation for protecting the river. However, low awareness of risks and capacity for waste management are obstacles to community efforts, as is the challenge of collective action when upstream communities have little incentive to reduce pollution. These variables dampen the action of this balancing loop, reducing the water quality of the Pinang River.

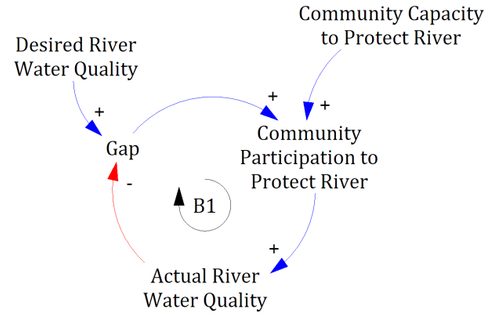

Figure 1: The gap between actual and desired river health should spur affected communities to protect the Pinang River, creating a balancing loop (B1) that stabilizes river health. Unfortunately, communities have limited knowledge and tools to tackle river pollution. This diminishes the efficacy of B1, resulting in poor health for the Pinang River.

Technological Solutions

The condition of the Pinang river has put pressure on the state government to remediate the river. Technological solutions are attractive as they promise a direct means of addressing the problem (Figure 2). Indeed, over the years, a variety of technologies have been implemented for the Penang river, with limited results. Water quality indicators have largely remained at Class Three, short of the Class Two goal (safe for human contact).

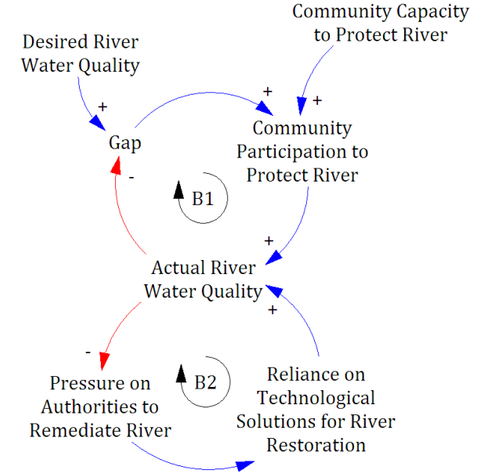

Figure 2: Persistently poor river water quality leads to pressure on authorities to remediate the river. Technological solutions are a quick and direct way for governing authorities to address the problem. This creates another balancing loop (B2) for river restoration.

As technological solutions are implemented by government agencies, largely bypassing river stakeholders, these efforts reinforce the perception that government agencies, not local communities, are responsible for managing the river, undermining the paradigm of river health as community responsibility (Figure 3). This creates a reinforcing feedback loop reducing community participation in river management and increasing reliance on the government-implemented technological solution (R1). Indeed, the amount of rubbish intercepted from the river increased more than three-fold between 2013 and 2015, a sign of increased waste dumping. This further impairs water quality, increasing dependency on and cost of technological solutions.

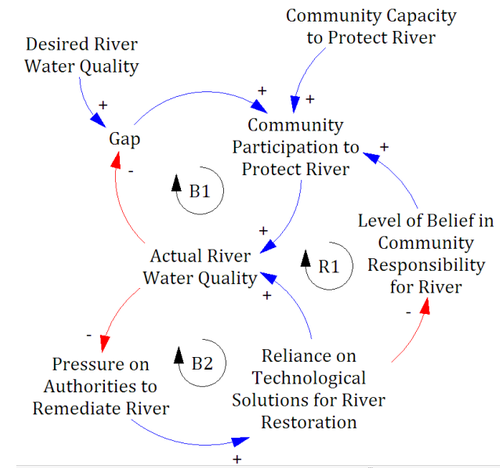

Figure 3: Reliance on technological solutions shifts the perception of community members as to who is responsible for protecting the river, such that community sources of pollution are not addressed, and may even worsen due to a lack of consequences. Over time, the paradigm of the river as a responsibility of the community is undermined, creating a reinforcing feedback loop (R1) that exacerbates the underlying problem. This causal structure replicates the system archetype known as "Shifting the Burden," where treating the symptoms of a problem removes the motivation for solving the fundamental conflict, and may even exacerbate it in the long-term.

Community-Based Approach

Figure 3 suggests that strenthening community capacity and responsibility is an alternative to technological solutions for

Figure 4: Secondary school quiz competition

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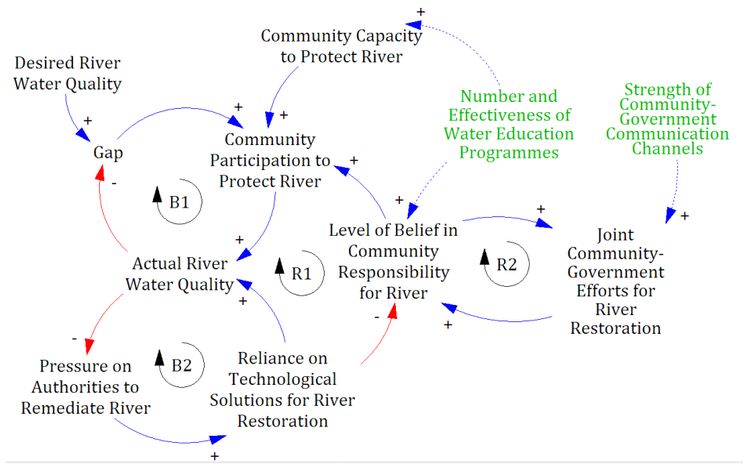

Figure 5: Two sets of interventions were carried out by Water Watch Penang, shown in green. Dotted arrows show new causal relationships with key variables driving the system. Forums and other channels for community-government communication were created to enable joint community-government efforts for river restoration. These efforts empower communities along the river, strengthening the paradigm of the river as a community responsibility and creating a new reinforcing feedback loop for community-government cooperation (R2). Water education programmes target community attitudes toward the river and improve the capacity to act.

river restoration. A pilot project was undertaken by Water Watch Penang (WWP), a non-governmental organisation based in Penang. The project aimed to increase community participation by strengthening the perception of river management as a community responsibility, increasing community capacity, and creating channels for community-government partnerships (Figure 5).

During the first stage of the project, activities focused on local communities, raising awareness about the Pinang River and highlighting their role in river conservation. WWP organised an outdoor learning programme for kids, a quiz competition for high school students, and a river clean-up activity that connected young adults with villagers living along the Pinang River (Box 1), targeting different age groups to increase impact.

The second stage of the project aimed to expand the target audience and link communities with government bodies. A social media campaign was carried out, centred around a short video presentation, to generate awareness and conversation on the Pinang River in the broader community. This was followed by a public forum to foster discussions among politicians, government agencies, community organisations, and academics, and exchange ideas for improving the health of the Pinang River.

The WWP project achieved direct contact with 360 people and connected with a further 40,000 Facebook users. The one-time nature of these activities may have increased knowledge and awareness among the engaged participants, but translating this into long-term, self-sustaining community action remains a challenge.

Figure 6: River Clean-Up Activity at the Pinang River.

Experiences from the project show that the biggest challenge is not in educating the communities, but in changing long-standing paradigms to foster collective action. Indeed, while local communities are aware of their role as a pollution source to the Pinang River, individual households see themselves as negligible contributors, or as powerless to influence the behaviour of others in their community. This suggests that the community ability to act collectively needs to be developed. Sustained engagement with community stakeholders and governing authorities will be necessary to develop capacity and partnerships capable of delivering lasting results.

Box 1: Outreach

Activity	Participants
Outdoor Learning Programme	35 children (age 9-12) and 20 parents
Inter-School River Quiz Competition	88 secondary school students (age 13-15)
River Clean-Up Activity	55 young adults (16-23) and five local villagers
Social Media Campaign	40,000 views, shared by 1,290 Facebook users
Public Forum	130 represntatives from various stakeholder groups

Figure 7: Speakers share their perspectives on the Pinang River at a public forum. The event connected representatives from civil society, academia, local government, and other environmental-related government agencies.

Further Reading

1. "Save the Sungai Pinang Video." https://www.facebook.com/USMTV/videos/1005068889543045/
2. "Water Watch Penang's Facebook Page." https://www.facebook.com/waterwatchpenang/
3. "Reducing the Pollution of Sungai Pinang, Stop the Pollution at Source." http://www.buletinmutiara.com/hentikan-pencemaran-di-punca-untuk-sungai-pinang-yang-lebih-sihat-dan-bersih/
4. "River basin management and community: the Great Ouse Basin, 1850–present." http://www.tandfonline.com/doi/full/10.1080/15715124.2017.1339355

Box 2: Pinang River Recyclable Solid Waste

Waste Type	Percent
Plastic	68
Metals	3
Glass	1
Paper	25
Rubber & Cloth	3

A survey of rubbish collected during a clean-up activity for the Pinang River showed that 89% of dredged items were recyclable, with plastic being the most-common material type. This suggests that reducing use of plastic and implementing effective recycling programmes could be important for cleaning the Pinang River.

Reading Causal Loop Diagrams

Relationships between two variables are represented with arrows. Here, positive relationships (change in X results in a change in the same direction for Y) are described with blue arrows and a "+" sign; negative relationships (change in X results in a change in the opposite direction for Y) are described with red arrows and a "-" sign.

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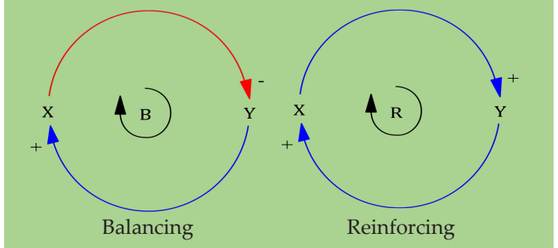

BIKE SHARING FOR MULTI-MODAL TRANSIT

SCHEMA CASE STUDY #7

oBike

Afiq Azfar and Ian Goh

The SCHEMA project seeks to improve decision-making for health and sustainability in Malaysian cities through the application of systems thinking and place-based methods. The SCHEMA Case Study Series describes a set of urban challenges and the actions that have been taken to address them, highlighting where systems thinking and place-based perspectives can shed light on underlying complexity and lead to more effective policies and interventions.

Overview

Multi-modal transit (MMT) is increasingly viewed as an important component of smart- and liveable-city solutions. MMT aims to provide urban residents with viable alternatives to automobiles—walking, cycling, public transit and more—for everyday transportation needs, enabling more active and healthier lifestyles. It also ensures that those without cars have access to places of employment and to a full range of amenities, contributing to a more equitable society. To ensure ease of use of and sustain demand., MMT requires a critical mass of infrastructure and users (Figure 1). While some cities have succeeded in designing and implementing walking, biking, and public transit infrastructure, many others continue to be designed for and around cars.

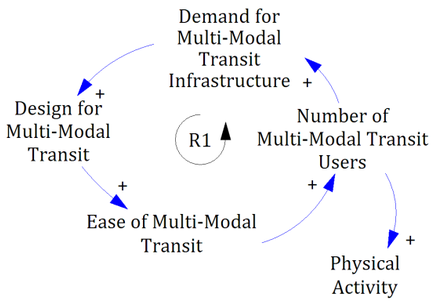

Figure 1: Design for multi-modal transit makes it easier to choose alternatives to automobiles. This increases the number of users, in turn generating greater demand for infrastructure to support multi-modal transit, and creating a reinforcing feedback loop (R1). Multi-modal transit benefits health in various ways, including through increased physical activity.

Local Context

Rapid economic growth in Malaysia has led to large increases in car ownership. In 2017, there were 13.3 million cars and 12.9 million motorcycles registered in Malaysia, or 0.74 private vehicles for every Malaysian. This, coupled with historic under-investment in public transit, reduced the modal share of public transit from 34% in 1985 to 11% in 2008. Dependency on private motorised transit has created unwanted side-effects. The World Bank estimates that time lost, additional expenditures on petrol, and air pollution from traffic congestion in Greater Kuala Lumpur carries an aggregate economic cost of RM 20 billion per year.

Figure 2: Traffic in Kuala Lumpur, Malaysia, by Uwe Schwarzbach is licensed under CC 2.0.

While MMT can alleviate congestion and other costs associated with private motorised transit, moving away from the existing car-centric paradigm is very difficult. Successful MMT systems require appropriate city design. When city design makes MMT convenient, commuters will switch from private to public transport, increasing the number of MMT users. However, high dependency on cars has created demand for car-centred design and infrastructure, as local councils are pressured to supply parking spaces, construct new roads, and expand existing roads. These choices often impede the development of MMT, further increasing preference for driving, and creating a reinforcing feedback loop (Figure 3, R2). Furthermore, driving and MMT compete for a limited pool of commuters and government resources. The dominance of the car-centric paradigm crowds out the investment required to make MMT possible.

Addressing the Problem

Despite these obstacles, there has been a push to improve public transit in Malaysian cities, with many public transport projects and services in recent decades. Initiatives include expanding the intracity rail transit system in the Klang Valley, revamping bus networks, and setting up dedicated bus lanes. These efforts have helped to halt and reverse the declining modal share of public transit, which now stands at close to 20%, up from the previous low of 11%. Nonetheless, major obstacles remain that continue to limit the use of MMT. One such issue is the first- and last-mile problem: the challenge of getting to and from transit stations.

Public transportation systems remain poorly integrated, with little connectivity between many residential areas and public transport stops. The land public transport authority (SPAD) has set a goal of ensuring that 80% of the population has a public transit stop within 400 m of their residence by 2030. At present, however, feeder bus routes, frequency, and reliability do not meet many commuters' needs, and improving these services is economically challenging and lengthy. For those not within walking distance of a rail station—that is, most prospective users—this leaves Park and Ride or Grab and Uber services as the only options for access to the rail system. While these motorised transit alternatives have a role to play in MMT, they greatly increase journey costs while still contributing to traffic congestion.

Cycling is an under-utilised solution to the first- and last-mile problem. It can substantially increase the distance

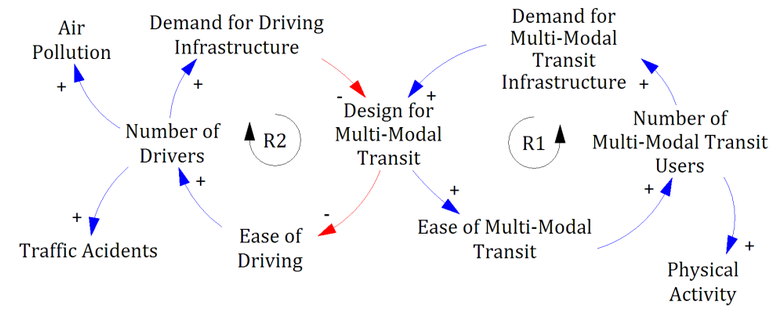

Figure 3: Driving is the predominant transport paradigm in most cities today, with car-centric design creating obstacles for multi-modal transit (R2). This results in health dis-benefits including air-pollution and traffic accidents. The two reinforcing loops (R1 and R2) form a "Success to the Successful" archetype, in which two options compete for the same resources; the winner gains resources at the expense of the loser, setting it up for further success. Since driving is the dominant paradigm, there is a large demand for driving infrastructure and resistance to multi-modal design choices that may inconvenience drivers, making it difficult to generate support for multi-modal transit design.

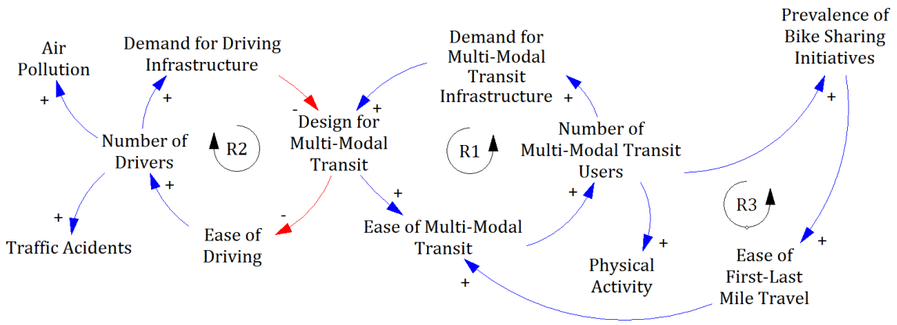

Figure 5: The first/last-mile problem—that is, getting to and from public transit station—is a major obstacle to use of public transit and the uptake of the multi-modal transit paradigm. Bike sharing initiatives can help address this issue. By easing the use of multi-modal transit and encouraging more users, these initiatives can generate customers (R3). Because of expected returns, bike sharing companies can make the investments necessary to initiate this cycle, which strengthens the R1 loop for multi-modal transit.

Figure 4: Public transit in Kuala Lumpur. ART Mark II train at Kelana Jaya station by Sirap Bandung is licensed under CC 4.0. Photo by CEphoto, Uwe Aranas is licensed under CC 3.0

commuters can travel without having to rely on motorised transit, increasing access to public transit stops. There are, however, several barriers to uptake of cycling. First, most commuters cannot simply borrow a bicycle, but must invest the full cost to experience whether it is a viable option. Second, bicycle storage facilities may not be available, especially to those living in high-rise buildings. Third, bicycle parking facilities are lacking at public transit stops. Bike sharing (Box 1) can mitigate these barriers and increase access to MMT, forming synergies with public transit systems (Figure 5).

Box 1: Bike Sharing

Bike sharing is a service with which bicycles are made available for usage for short periods of time, sufficient for single trips. With dock systems, users begin and end their journeys at designated stations. More recently, dockless bike systems have developed such that users can leave the rented bikes at their destination, increasing flexibility. Bike sharing is integrated with smart technology systems that help users find and rent bikes through mobile applications. Bikes are typically equipped with smart locks and global positioning systems.

Further Systems Issues

There are other obstacles to cycling, especially the issues of safety and of supporting infrastructure (Figure 7). Bike sharing can increase the number of cyclists, which increases cyclist safety (Box 2) and generates demand for cycling infrastructure. Bike sharing companies can also act as advocates – to the public to encourage cycling and other forms of multi-modal transit – and to governing authorities, raising the visibility of cycling issues, and facilitating collective action. Finally, bike sharing companies can collect cycling data and share this with relevant authorities. This data can enable better infrastructure planning and resource allocation, not only for cycling, but also for broader transportation needs.

Bike sharing is becoming an integral part of multi-modal transit, lowering barriers, facilitating advocacy, and providing data for decision-making. It has many synergies

Figure 6: Bike share as a last-mile option for traveling from a transit station.

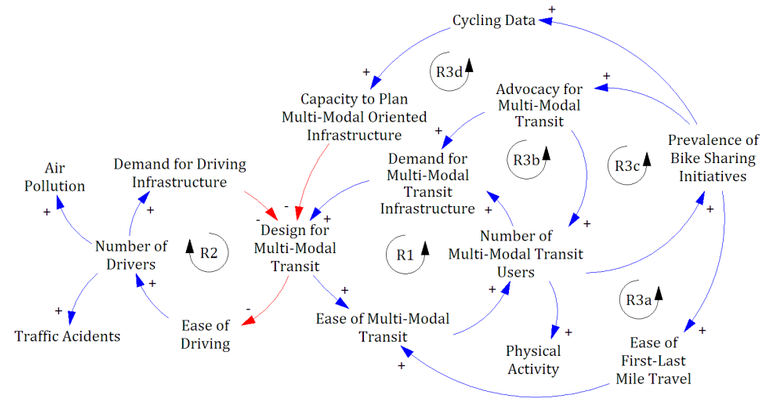

Figure 7: Bike sharing initiatives can make additional contributions to the R1 multi-modal transit loop. These groups can act as a concerted voice for cyclists, advocating for cycling and other forms of multi-modal infrastructure (R3b). They can also encourage cycling though direct advocacy and by providing users feedback on carbon emissions saved and calories burned, changing users' perceptions of transit and encouraging cycling behaviour (R3c). Finally, by collecting data on users' cycling routes and preferences, bike sharing initiatives can provide data that improves local authorities' capacity to plan for multi-modal transit (R3d).

with existing public transit infrastructure, benefiting from and increasing the user base. Together with other endeavours to provide transit alternatives, it can strengthen the multi-modal transit paradigm and facilitate the shift away from car-centric cities, thus reducing traffic congestions and improving urban sustainability, health, and well-being.

Box 2: Safety in Numbers

The safety of cyclists from motorised vehicles improves with increasing number of cyclists, as drivers become more aware of cyclists and their needs. This leads to a change in driver behaviour over time. Furthermore, as the number of cyclists increase, planners are more likely to consider cyclist safety in traffic planning, through integration of bicycle lanes and better design of intersections to accommodate both cyclists and cars. As cyclist safety improves, more people are likely to cycle. Ensuring the safety of early-adopters is important for developing a critical mass of cyclists.

Further Reading

1. "Bicycle sharing and transit: does Capital Bikeshare affect Metrorail ridership in Washington, D.C.?" https://www.researchgate.net/publication/271273828_Bicycle_Sharing_and_Transit_Does_Capital_Bikeshare_Affect_Metrorail_Ridership_in_Washington_DC
2. "The future of transportation." https://www.citylab.com/special-report/future-of-transportation/

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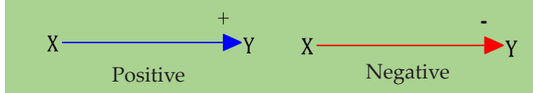

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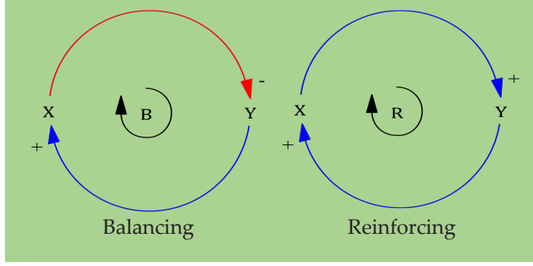

The *SCHEMA Case Studies* are brief explorations of challenges in urban health and wellbeing. These stories are situated in and have features unique to the Malaysian context, yet reflect experiences shared by urban dwellers around the world.

Health extends far beyond medical care. Healthy cities are planned, built, and run in ways that support and promote healthy living. Healthy societies have values and set priorities that create healthy cities.

Health results from the dynamics of socio-ecological systems. The network of relationships that govern these systems—and health—are not always easy to see. Until we recognise them, however, we are unable to effectively address health challenges.

In these case studies, systems thinking and place-based methods are introduced as tools for understanding a set of problems related to urban health and wellbeing.

SCHEMA

Systems Thinking and Place-Based Methods for Healthier Malaysian Cities