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"COMPLEXITY AND URBAN GOVERNANCE"

Complexity is a powerful lens that can illuminate for us the challenges of urban governance, and what we can do in response. This is because cities, like all human systems, are enormously complex.

The Emergence of Cities

But it was not always so. Until about 12,000 years ago, people lived in small nomadic groups as hunter-gatherers. Then, during the Neolithic Revolution, agriculture emerged and people began to produce food, instead of just hunting for it. Agriculture meant a surplus of food. To store this surplus for future needs and for redistribution, a fundamental shift started. The nomadic life of the hunter-gatherers began to be replaced by more sedentary societies based in human settlements like villages and towns. Villages and towns grew into cities over time.

This trend has continued unabated to the present day. The tipping point arrived in 2012 when more than half of humanity were living in cities. By 2030, 60% of the projected world population of eight billion will be urban dwellers.

Evolution Increases Complexity

The urban milieu became the catalyst for the development of a multitude of new human capabilities. Over time, people were no longer just hunters or farmers. They became builders, craftsmen, businessmen, entertainers, teachers, scholars, and so on. As inhabitants of towns and cities took on increasingly specialised roles, and as cities grew, social and economic complexity increased.

The Impulse to Reduce Complexity

But the human impulse is to reduce complexity. The complexity that began to emerge in towns and cities created an imperative for a new form of organisation – government – to manage it. An early, rudimentary form of government was the Council of Elders, which governed through consensus rather than imposed rules. Before written records became

widespread, knowledge was passed down by word of mouth. Naturally, the elders had the most knowledge and wisdom. Hence, the people trusted their judgement, and gave them the power to decide for the group by applying precedents from the past.

But cities evolved, they grew larger and more complex. Furthermore, ambitious rulers began conquering other cities and extending their reach of power. The challenges of controlling geographically diverse and complex cities demanded a more sophisticated form of urban governance than just the Council of Elders.

Establishing Rules and Laws to Manage Complexity

The Code of Hammurabi, dating back to around 1754 B.C., provides clues as to how early civilisation managed urban complexity. The Code comprised some 282 laws covering a variety of subjects. It prescribed punishments for those who flouted it. Through the Code, Hammurabi maintained political order and managed the complexity arising from the different practices, precedents and norms in the Babylonian empire.

What is interesting is the way in which the Code appears to have promoted economic freedom and diversity: the Code paints a picture of an economy driven by private property, as the King did not own any land. The Code was an instrument to manage an early form of capitalism. Today, we recognise in it many aspects of the modern economy: the enforcement of property rights, the protection of the weak against the strong, and the use of commodity as money and credit. The Code freed up the economy, which in turn promoted long-term growth.

Economic Complexity

Literacy, political structures, levels of industrialisation, and per capita income, are conventional indicators of economic health. However, the economists Ricardo Hausmann and César Hidalgo have suggested that the most important predictor of growth is economic complexity, or the diversity of products that an economy possesses.

Countries with the most natural resources tend to have simple economies, as they do not produce unique goods. Thus, economies that are dependent on a particular kind of export – for example, oil or timber – may do well when demand for these products are high, but fail in the long run because they are not diversified and cannot compete in other sectors.

The Decline of Detroit

A case in point is Detroit, a city that built its fortunes on the automotive industry. Detroit became highly reliant on the automotive industry. But after the Second World War, auto manufacturers began to move to suburban areas, outside the city proper. This in turn led to residential movement to the suburbs. From a peak of 1.85 million in 1950, Detroit's population today is less than 700,000, a decline of more than 60%. Population flight led to loss of tax base and jobs. Detroit declared bankruptcy in 2013, and its unemployment that year was 23.1%.

Reducing Complexity vs Catalysing Complexity

The ability to produce unique goods and services depends on the amount of "productive knowledge" in an economy. This is the kind of knowledge derived from experience and exposure to different sectors and domains of production. Invention and innovation occurs when these bits of productive knowledge are connected. Improvements to economic growth can be achieved either by harnessing existing capabilities in new combinations, or by accruing new capabilities to expand the productive potential of the country.

So urban governance is not all about reducing complexity – far from it. Instead, in some cases, it should catalyse complexity, by creating more networks to connect multiple economic domains.

The Rise and Fall, and Rise, of Boston

In contrast to Detroit, Boston is a city that was shocked and surprised, but then re-invented itself, at least three times in its 400-year history.

Harvard economist, Edward Glaeser, tells of how Boston, in the 17th and 18th centuries, was the leading port in America. It thrived as a conduit of goods between the old world and the new. But by the mid-18th century, Boston as a port had been eclipsed, first by Philadelphia, then by New York.

What saved Boston from the fate of other New England ports was a large population of Irish immigrants. By the late 19th century, Boston had transformed itself into a centre of manufacturing built on immigrant labour, and it prospered on the back of America's industrialisation.

But Boston's heady period of growth was over by 1920. Population growth slowed and even began to shrink after 1950.

However, in the last two decades of the 20th century, Boston again re-invented itself, this time from an industrial city in decline into a high-tech, service-based economy. Its population grew rapidly between 1980 and 2000, reversing 50 years of stagnation and shrinkage.

Boston is now a centre of the information economy. Today, education is the dominant factor in Boston's economy. Boston ranks highly in its share of employees in managerial and professional jobs. Its top four export industries today are all skills-based: technology, finance, education and healthcare.

Lessons from Boston

Using the lens of economic complexity, the Boston case shows us that the ability to re-orientate and create new value hinges on economic complexity. From its earliest days, Boston was never just a port. Artisans manufactured some of the goods traded on Bostonian ships. Boston had banks, brokers and insurers from its seafaring days because shipping needed financial services. Education was always valued in the colony – Harvard University was founded in 1636 with government money.

Its rich, complex strengths and competencies enabled Boston to reach within itself to find new connections and value propositions. These enabled Boston to re-invent itself time and again when other more brittle, less economically complex cities like Detroit, heavily dependent on manufacturing, went into terminal decline.

Complexity Is Good, But Not Too Much of It

The anthropologist Joseph Tainter is famous for his study of complex societies. His proposition is that as complexity increases in a system, eventually the marginal value of complexity diminishes. At this point, the flow of information is throttled. There is less sharing and redistribution of resources.

My interpretation of Tainter's work is that there is a point of optimality where complexity enhances rather than reduces value. Towns and villages are too small – so they often end up as laid-back sleepy communities, undiversified in their offerings to the world.

On the other hand, many countries are too large – they are clearly closer to the points of marginal disutility and collapse in Tainter's characterisation. He cites the Western Roman Empire as a prime example: while it had great military power and resources, it had grown

too big and barbarian invasions and plague began to weaken the empire. The empire finally disintegrated when an increasing number of communities were lost to invaders.

Cities, being somewhere in-between, are more resilient because they have sufficient complexity to sustain themselves. But it begs the question of what will happen to the mega cities, where populations threaten to burgeon into unthinkably large urban sprawls?

Wicked Problems

As complex systems, cities produce *wicked problems*. Political scientist, Horst Rittel, described wicked problems as highly complex issues: large, intractable, with no immediate or obvious solutions. They have causes and influencing factors that are not easily determined *ex ante*. They hardly ever sit conveniently within the responsibility of any single agency or authority. Worse, wicked problems have many stakeholders who not only have different perspectives, but who also do not necessarily share the same goals. It is not difficult to find wicked problems in an urban setting: ageing, environment, transportation, urban planning, and so on.

In other words, wicked problems cause big headaches for governments.

Boundaries and Complexity

Boundaries are very often used to reduce complexity. This is achieved by drawing boundaries around smaller parts of a larger system in order to make things easier to manage. Nations are divided into provinces, provinces into cities, cities into municipalities, and so on. Companies are organised into departments, and governments into ministries.

This approach is useful and necessary – up to a point. But it is often not adequate for addressing wicked problems. The reality is that no single government agency is really equipped to deal with wicked problems in its entirety. Letting ministries and government agencies tackle different of a wicked problem on their own often leads to duplication or contradictions, waste and sub-optimal policies, and even to new wicked problems.

The Whole-of-Government Approach

Breaking down organisational silos is key to tackling the wicked problems of complexity. Because wicked problems are inherently complex in their scale of uncertainty and disagreement, they are best tackled by diverse teams, drawing on different knowledge systems and experiences, and sharing information drawn from large parts, if not the whole, of the government system. In Singapore, we call this effort the Whole-of-Government approach.

We adopt the Whole-of-Government approach in urban planning. While other countries have large land areas, which allow new cities to develop and replace other cities that may decline in relevance and fortune, Singapore as a small island nation does not have that luxury.

Urban Planning as a Wicked Problem

Instead, urban planning in Singapore needs to take into account emergence and the complexity of packing in housing, green space, industrial land, commercial and retail space, land for transportation needs, and military training areas, all within the confines of a small island of about 700 square kilometres. This is about half the size of London, and two-thirds the size of New York.

The Whole-of-Government approach to urban planning enables us to consider long-term scenarios, devise implementation strategies and plans, and control and coordinate developments on the ground – all in a coordinated and integrated way.

In Singapore, the entire process, from the review of our strategic Concept Plan to the implementation of a detailed land-use Master Plan, involves close collaboration among economic, social and development ministries and agencies, as well as consultations with various stakeholders in the private sector and the general public. This Whole-of-Government approach enables all stakeholders to better understand interdependencies and implications of land use and strategic decisions.

One specific example of the Whole-of-Government approach in coordinated and strategic land use is the Marina Barrage. It is a huge fresh water reservoir created by damming the mouth of the Singapore River. It is located right in the middle of the Central Business District, an astonishing achievement Singapore's small size. Yet it had been planned more than 20 years ago, because the policy-makers and urban planners understood even then that issues such as climate change and increasing demand for water would emerge in the future.

Today, the Marina Barrage serves multiple functions. It alleviates flooding in low-lying city areas by keeping seawater out, and boosts Singapore's water supply by storing rainwater during the monsoon seasons. It is also used for recreational water activities.

The Whole-of-Government approach should naturally lead to a Whole-of-Society approach that aligns government, business and community toward common goals. In Japan, in densely built-up cities like Osaka and Tokyo, there is a strong public-private partnership that builds their vast and sophisticated underground malls. Likewise, cities like New York and Bilbao have the PlaNYC and the Bilbao Ria 2000 respectively, which successfully serve to align the public, private and people sectors towards common goals.

The Main Obstacle to Whole-of-Government

However, the Whole-of-Government approach has to overcome the deeply-ingrained bureaucratic instinct to operate within silos, rather than to collaborate horizontally across organisational boundaries. It is easier said than done, and depends critically on strong leadership at the top setting the tone. Whole-of-Government is in many ways an aspiration: we have to keep trying to reach it, but will never attain it perfectly.

Complexity and Experimentation

The challenges that complexity throws up cannot be overcome simply by replicating what worked well in the past. In complex systems like cities, the Newtonian characteristic of clear cause and predictable effect is often absent. It is not always possible to use deterministic, linear analysis to work out the effects of a policy input.

Governments must be willing to put aside "tried and tested" perspectives, and instead to experiment with new approaches and solutions. In complex operating environments, exploration and experimentation are often more valuable than predictions of analytical models. As military analysts would say, in unknown terrain, a compass is more useful than a map. So rather than plan exhaustively for every contingency, we must be prepared to experiment, even if we cannot be entirely certain of the outcome. Pilot programmes, prototypes and "beta versions" should be the norm in dealing with wicked problems. If they succeed, then they can be expanded. If they fail, then the damage is contained.

Experiments in Behavioural Science

In Singapore, we have taken this approach in addressing the problem of congestion on public transport systems. Traditional approaches to alleviating congestion on public transportation systems often involve supply-side measures such as increasing the frequency of train and bus services, growing fleet sizes, using vehicles with larger capacities, or building new routes.

However, new strategies are also needed given the rise in complexity and diverse expectations. In Singapore, we are currently experimenting with a palette of behavioural levers to encourage commuters to make changes to their travel patterns to help reduce transportation demand during peak hours. These include providing free travel on rail trips into the city in the earlier part of weekday mornings, working with various organisations to pilot flexible work arrangements that stagger reporting hours or enable working offsite, or cash rewards for making morning off-peak trips on the rail system. These experiments carry relatively little risk, but enable us to try out new ways to address the congestion problem.

Learning How to Exploit Underground Space

We have also experimented with new urban solutions to address our land constraints, especially in the use of underground space. Some of the major experiments include:

- The Underground Ammunition Facility of the Singapore Armed Forces, which is built into a solid granite core in the centre of Singapore. By moving the storage of ammunition from the surface to underground, large pieces of land previously sterilised are now freed for other uses.

- A Deep Tunnel Sewerage System (DTSS) helps to reduce surface land-take for sewage utilities.

- The Jurong Underground Rock Cavern, dug out of sedimentary rock under the seabed, is now used for oil storage, reducing surface land usage, and creating new economic activity.

The success of these experiments convinced the government to exploit underground space systematically, and it has now embarked on developing a comprehensive masterplan for underground space.

Complexity Causes Uncertainty

The complexity of the operating environment of cities creates uncertainty. As a result, governments often have to make big decisions, and develop plans and policies, under conditions of incomplete information and uncertain outcomes. This is an additional source of complexity *across time*, and not just within a specific time frame.

Prediction is not possible when dealing with inter-temporal complexity. Instead, the approach should be to reduce uncertainty where possible. An orientation towards thinking about the future in a systematic way is the right approach. Some of us call this process foresight, or futures thinking.

The practice of foresight in government is really about identifying the factors that will shape the future. This is so that policy makers can devise strategies and formulate policies to maintain positive trajectories and shift negative ones in a more positive direction. The goal is to make better decisions today and shape the future, not to predict what it will be.

Scenario Planning

Scenario planning is one way to do this, in the sense that it projects different possible futures based on our understanding of the operating environment today. Used intelligently, it can be a very important tool for planning, and can help overcome cognitive biases by challenging our mental models. Scenarios are one of the most popular and persuasive methods used to provide a plausible description of what might happen in the future. They assist in the selection of strategies through the identification of possible futures. Scenarios make people aware of problems, uncertainties, challenges and opportunities that such an environment would present, and opening up their imagination and initiating learning processes.

For the past two decades, the Singapore government has been using scenario planning. National scenarios are developed at the Whole-of-Government level every few years. These then help the ministries and agencies in anticipating in their policies, plans and even budgets of the challenges and opportunities that could arise in the future.

Our urban Concept Plan and Master Plan are based on scenarios developed for a Singapore many years into the future. Scenarios have therefore been very useful in helping our city-state to navigate complexity across time.

Big Data and Complexity Science

Jane Jacobs, in her influential book "The Death and Life of Great American Cities" describes urban complexity this way:

> "City processes in real life are too complex to be routine, too particularized for application as abstractions. They are always made up of interactions among unique combinations of particulars, and there is no substitute for knowing the particulars."

The agents within a complex system like a city – the people, public and private institutions, markets and networks – all generate a lot of data, much of which is location-based. Combined, this constitutes what we now refer to as *big data*. Complexity science offers a way to marry different tools – such as agent-based modelling that is used *inter alia* for traffic flow dynamics, combined with insights from big data using data analytics – to gain a better understanding of the city in all its complexity.

From the point of view of urban governance, this approach can help agencies and decision-makers to track and monitor the development and staging plans of key infrastructure in tandem with population and economic growth. It can also be harnessed to support strategic long-range scenario planning in land-use, transport and infrastructure. In the development of new housing towns, big data can be mined to understand the demographic profiles, needs and social aspirations, so as to better provide amenities, facilities and options for the residents.

The tools of complexity science combined with the insights from big data can help us to 'see' the city differently, through new lenses. What then are the fresh possibilities to 'imagine' and 'shape' a different and better city for the future? And if we can imagine a different city of the future, we can take active steps toward realising it.

We could imagine driver-less taxis that allow shared trips to reduce pressure on the roads while meeting passengers' demand. We could also imagine traffic lights that change in response to traffic conditions that are monitored by sensors on the roads. In societies that are rapidly aging, like in Singapore, this could mean placing a network of sensors in the homes of the elderly, which could monitor and track their daily living movement and patterns, and to send out alerts to family members or neighbours when they deviate from daily norms, such as the frequency of use of the toilet, fall detection, and so on.

Conclusion

The complexity of cities needs to be managed. Too little complexity can lead to brittleness. The right level of economic and social complexity that gives a city the resilience of say, Boston, is partly due to good luck, but mostly due to good governance. The example of Boston teaches us that nothing is forever, and that the most adaptable and flexible cities, are the ones that will survive and succeed over the long term.

The rise of complexity in the world today throws up enormous challenges for urban governance. Foresight will help governments to better deal with complexity and its challenges. So too will the exploitation of big data and the new tools of complexity science. But fundamental changes are also needed to the organisation of government. The Whole-of-Government approach should be nurtured and extended, where possible, to include business, civil society and other actors. Collectively, they contribute to the broad concept of governance, even if they are not part of "government", traditionally defined. The future of urban governance lies in such systems-level coordination, to facilitate better forward planning, foresight and futures thinking.

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