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SUARA INNOVASI

An Innovative City is a Sustainable City

KLCSI
KUALA LUMPUR CENTRE FOR SUSTAINABLE INNOVATION

Infrastructure Gets Smart

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FOREWORD

Dr Thomas S.K. Tang
Managing Director, ***KLCSI***

Welcome to the third issue of Suara Innovasi and our first for 2017.

The last six months have been quite busy for the KLCSI team. We witnessed the launch of Social Progress Malaysia, a nationwide initiative to measure the country's position with regard to a set of social indicators. We also participated in a number of smart city discussions mapping out the future of Kuala Lumpur and other cities which are striving towards greater sustainability and livability. In addition to these, we also signed a prestigious memorandum of understanding with Dewan Bandar Kuala Lumpur as part of the LA21 urban farming initiative.

In our last issue, we looked at two of our core areas: KL's ageing population and urban mobility. This time, we focus on the third key area of our portfolio - food waste.

Each day, Malaysians throw about 15,000 tonnes of organic waste away. This puts a huge burden on our landfills and is quite literally a waste of resources. We devote a special chapter to this topic in this issue and put forward a solution to this massive problem through what is called 'the circular economy'.

Cities cannot function without infrastructure. In this issue, we consider the challenges facing cities because of urbanization and the need for new infrastructure, besides the looming issue of ageing infrastructure. Pipes and sewers get old and deteriorate over time. With the advent of modern and faster technology like the Internet of Things and Big Data analytics, how do we combine this advancement with infrastructure to create cities of the future? Please read our articles on biomimicry and blue-green infrastructure for further insight.

I hope you will enjoy reading about KLCSI's journey towards making cities more livable. Your comments and feedback are valuable to us. Please let us know how together we can make a difference to the way we live and how we can leave the world in a better place.

I would like to take this opportunity to thank KLCSI's directors for their support, especially our Chairman Datuk Rozman Isli, and a special thanks to our contributing authors.

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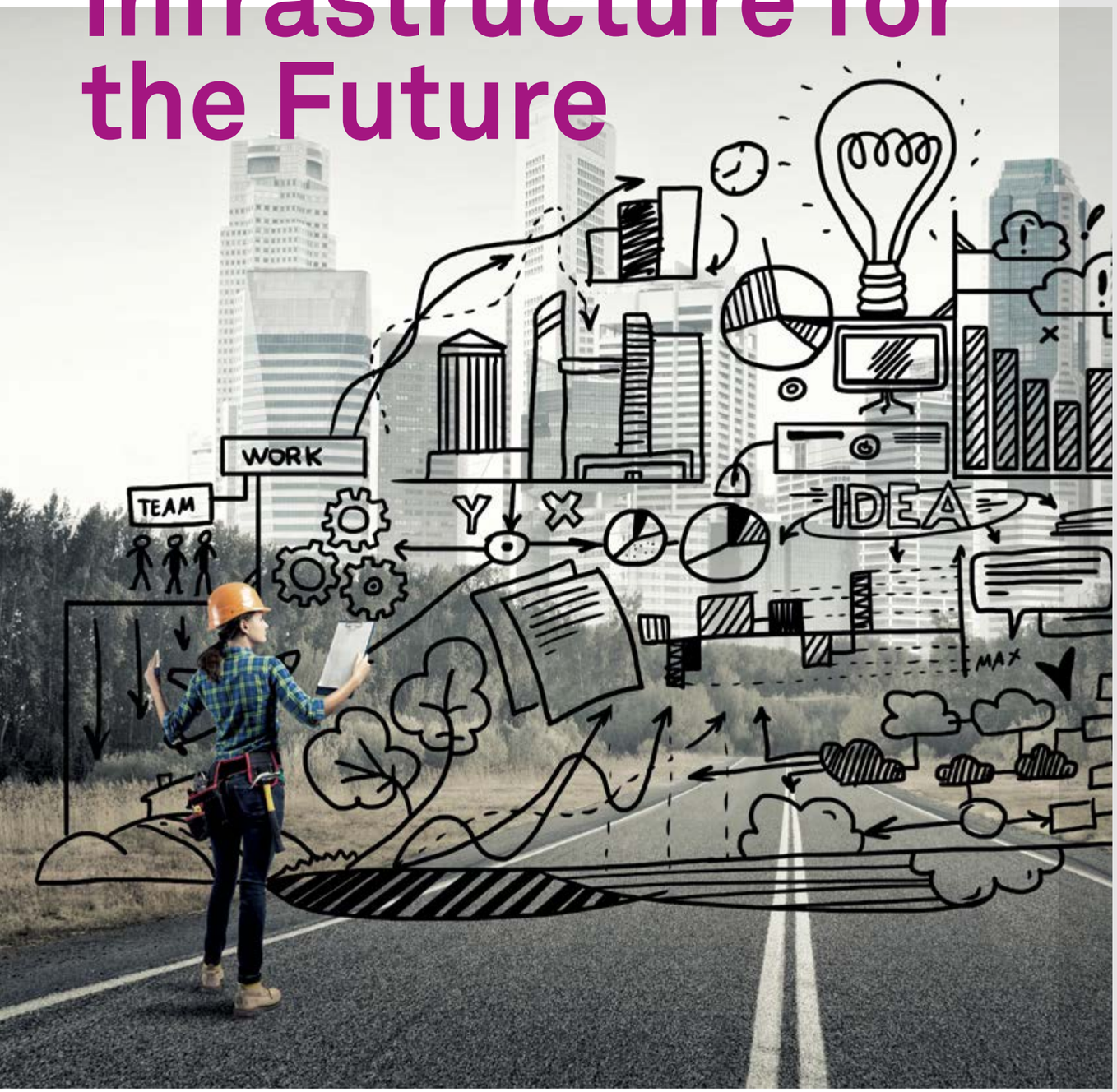
Infrastructure for the Future



Infrastructure consists of structures, systems and facilities that serve a city's economy and functions. It is typically a term to characterize 'technical structures' such as roads, bridges, tunnels, or other constructed facilities such as loading docks, cold storage chambers, electrical capacity, fuel tanks, cranes, overhead clearances or components of water supplies, sewers, electrical grids, telecommunications. Infrastructure can also be defined as "the physical components of interrelated systems providing commodities and services essential to enable, sustain, or enhance societal living conditions."

Infrastructure is necessary for:

- Conveying energy to power the city's numerous systems from lighting the streets and running air-conditioning in buildings to complex IT systems and essential equipment for the city's wellbeing
- Moving people and goods across and beyond the city using road and rail transport and connecting neighbourhoods and communities
- Supplying clean water to households and commercial premises and in return taking away waste water (like sewage) for safe disposal
- Collecting and disposing of solid waste from domestic and industrial sources through landfill or thermal treatment
- Connecting cities with each other through airports, ports, rail and roads, as well as through telecommunications and internet means.

Growing Needs

With growing urbanization, the need for infrastructure is increasing. According to UN Habitat, the world's cities occupy just 3% of the Earth's land, but account for 60-80% of energy consumption and 75% of carbon emissions. The 2030 Agenda for Sustainable Development comprises a set of seventeen Sustainable Development Goals (SDGs) to end poverty, fight inequality and injustice, and tackle climate change by 2030. Of particular importance is Goal 11 – Industry, Infrastructure and Innovation - which seeks to "make cities and human settlements inclusive, safe, resilient and sustainable." Targets include:

- Access to adequate, safe and affordable housing and basic services
- Access to safe, affordable, accessible and sustainable transport systems for all
- Reducing the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters
- Reducing the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
- Providing universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

All of this is made possible by infrastructure. In Asia, according to PwC consultants, it is estimated that the amount of infrastructure to be installed amounts to about US$8 trillion up to 2020 to meet growth requirements of the respective countries in the Asia Pacific region. The infrastructure deficit for Asia (excluding Australia, New Zealand and Pacific countries in North and South America) is most acute in public infrastructure. The highest lies in power (US$4.1 trillion) followed by roads (US$2.3 trillion) and telecommunications (US$1.1 trillion).

Keeping Up With Moore's Law

We live in an evolving world of technological change. Moore's Law is a computing term which originated around 1970; the simplified version of this law states that processor speeds, or overall processing power for computers will double every two years. With this in mind, it is no surprise that the combination of computing power and infrastructure has transformed cities into much 'smarter' versions.

Some experts believe that the notion of smart cities has been overly driven by IT companies. There are a number of reasons for this:

- The enthusiasm of IT companies to identify solutions that their own hardware and software can offer
- Practitioners (architects, planners and especially engineers) failing to engage properly in the debate. Engineers are singled out here as the profession that historically has held the role of harnessing emergent science and technology to improve the environment
- A lack of understanding at the municipal leadership level

Ideally there should be a single, 'smart', shared control system enabling more informed decision-making and more rapid deployment of measures to deal with emerging situations. There is a need for 'middleware' which sits between the city infrastructure 'hardware' and the operational 'software' controls and (in the future) City Apps. The problems associated with the integration of individual functionally-focused systems are the lack of common interfaces and operating systems and the ability to cope with the vast amount of data generated. It is clear that open IT architecture with standard interface protocols and the ability to plug 'n' play new applications and hardware will make it much easier to link systems as well as opening the market to new entrants with valuable fresh thinking.

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Infrastructure Gets Smart

We live in an age where infrastructure development is fundamental. Roads, ports, energy generating facilities, water and waste management systems are essential in ensuring increased connectivity between rural and urban areas in the future. They also play a vital role in giving local and regional markets better access to the global economy, increasing the circulation of goods, services and people, and improving economic and social development.

By 2030, there will be 5 billion people living in cities. This will put an added burden on utilities, mobility needs and housing. Meeting this demand will be a challenge for designers, planners and engineers who are already facing issues brought about by ageing infrastructure while being expected to construct new ones for the growing population.

Building Smart

How do we get there? We need to build smarter infrastructure which cater to the needs of expanding populations while fixing the problems of maintaining and upgrading existing ones.

We have to come up with reliable energy and water systems, efficient building management and better mobility. The supply of reliable and affordable energy and water is an essential condition for economic growth and livability. The grid system and the water supply network will have to be agile to manage our demands. Efficient control of the built environment improves working and living conditions as well as reducing the carbon footprint of buildings. Better mobility improves accessibility and affordability of public transport systems and leverages technology to utilize alternative modes of transport like cycling and pedestrian paths. The logical direction is to link up the application of technology to traditional brick-and-mortar solutions so that we can find methods to improve efficiency and to satisfy user demands. This is the so-called 'smart' infrastructure.

The key to this is the development of integrated masterplans — one for land use and the other for digital networks and services. It's all about data. The type of data we collect and how we collect it is crucial. We are creating intelligent infrastructure that learns and adapts to people's needs. Cities can use information and communications technology to integrate essential civic data into city dashboards that will enable live city-wide monitoring. Sensors and supervisory control and data acquisition (SCADA) technologies will help with managing and recycling waste. It is anticipated that smart wastewater systems can recycle 100 percent of domestic and industrial wastewater.

Smart Infrastructure Examples

Pipeline systems are responsible for transporting vital resources such as water, oil and gas. Any leakage in the pipe can cause major financial losses and possible environmental damage. In buried pipeline monitoring, sensor nodes are deployed in soil. Traditional methods for pipe monitoring are acoustic measurements, pressure measurements, vision-based systems, ground penetrating radar-based systems, fibre optic monitoring and multimodal systems. The trend now is for underground wireless sensor networks for non-invasive monitoring on existing and new pipes to monitor their structural integrity. Underground wireless sensor networks offer many advantages over the other methods, such as concealment, ease of deployment, retro fitting, reliability and coverage density.

Heavy rainfall, especially in the tropics, often causes flooding if storm water is not removed quickly enough. Drainage is affected by pipe layout, nature of the pipes and availability of retention areas. Smart drains are monitored by sensors, and water flow data is sent to a control centre to open and close drainage channels as needed. A good example of this is Kuala Lumpur's Smart Tunnel, a storm drainage and road structure which extends 9.7km long, making it the longest storm water tunnel in South East Asia and second longest in Asia. The main objective of building this tunnel was to solve the problem of flash floods in Kuala Lumpur and also to reduce traffic jams during rush hours. There are two components of this tunnel, the storm water tunnel and the motorway tunnel. Under normal weather conditions where there is no flood, no flood water will be diverted into the system. When a flood occurs, the tunnel is activated and flood water is diverted into the bypass tunnel underneath the motorway tunnel. The motorway section would still be open to traffic at this stage. In extreme cases, the motorway would be closed to all traffic. After making sure all vehicles have exited the motorway, automated water-tight gates will be opened to allow flood waters to pass through. After the flood has ended, the tunnel is inspected and cleaned via pressure-washing, and the motorway will be reopened to traffic within 48 hours of closure.

The city of Barcelona uses smart sensors in public waste bins to tell the authorities when the bins are full, letting public waste collectors know when to empty the bins. This has reportedly saved the city 30% in waste handling and transportation costs. In Singapore, pneumatic waste chutes are being constructed in housing developments for occupants to send their waste to collection bins. A pilot scheme was devised in Marina Bay to utilize a smart service tunnel to sort the waste into different categories (metals, plastics, glass and paper) so that the chutes would be diverted at selected times and the different materials could be sorted for recycling or reuse.

Getting electricity to users is necessary for cities to function. The advances in power supplies and grid design now mean that we can have smart grids which enable us to draw and put back electricity as needed. A smart grid consists of a variety of operational and energy measures such as smart meters, smart appliances, renewable energy resources, and energy efficiency resources. Electronic power conditioning and control of the production and distribution of electricity are important aspects of the smart grid. To date, many cities are adopting features of the smart grid, such as smart metering, but none have so far come up with the comprehensive version. Experts estimate that the size of the smart grid market is currently about US$170 billion worldwide.

Building automation systems which control energy in buildings are also considered part of smart infrastructure although they are not part of networks. Advances in so-called 'smart' buildings allow occupants to enjoy a comfortable and healthy environment and at the same time achieve cost savings. Smart systems now deploy predictive logic which charts the history of weather and other factors in order to 'predict' conditions so that the systems can adjust controls (like heating and cooling) accordingly. On a district scale, cities like Brisbane, Toronto and Helsinki have adopted smart district cooling systems harnessing natural resources to deliver chilled water to a network of buildings, maximizing scales of efficiency in energy and water resources.

The Standard Future

There are many other examples of smart infrastructure. As cities grow, more innovative ideas will emerge. What does the future hold? Already organizations like ISO are setting standards such as the ISO 37120 for smart infrastructure and smart cities. The British Standards Institute is developing PAS 181 as a smart city framework while the International Electrotechnical Council (IEC) is producing its own framework.

Other features such as resilience and sustainability will form part of the basis for infrastructure design. The Institute for Sustainable Infrastructure, based in Washington, is a network of organizations and individuals concerned with the planning, design, construction, and maintenance of infrastructure and it has come up with a sustainability rating system for all civil infrastructure. The Global Infrastructure Basel Foundation has developed a standard for sustainable and resilient infrastructure called SuRe® to make infrastructure projects comparable and attractive to invest in. This global voluntary standard was developed using a multi-stakeholder approach and helps to integrate state-of-the-art sustainability and resilience aspects into infrastructure development and upgrades.

Without infrastructure, cities cannot function. It is vital for us to build better, smarter and more sustainable infrastructure for our future.

A special thanks to Jugal Makwana and Katherine Schneider for contributing to this article.

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Planning for Resilience

In 2012, Hurricane Sandy hit New York City with wind gusts of up to 155 km per hour. The total damage it caused, which included the flooding of the New York subway system, devastation of over a hundred homes in the Queens District and loss of electricity for several days, was estimated at US $32 billion.

Closer to home in Asia, 2013's typhoon Haiyan caused a storm surge with tidal waves of over 5 meters in height striking the city of Tacloban and other nearby areas in the Philippines, resulting in the loss of 10,000 lives, the displacement of 630,000 people and the wholesale destruction of homes and facilities. According to the UN's Global Assessment Report, the annual average losses in the built environment associated with disasters such as earthquakes, tsunamis, floods, tropical cyclones and volcanic ash are already in the order of US $314 billion. This figure would be higher if the impact of chronic events, such as droughts, temperature variations and agricultural damage are considered. With this evidence, the need to be prepared for climate-related and other types of disasters is borne out by the cost incurred through asset damage and human suffering.

Resilience is defined as "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions."

Building Resilience

Building resilience in communities and cities is a way of coping with disasters. Disasters are caused by three factors: hazards, vulnerability and exposure. Vulnerability affects communities that lack capacity to deal with disasters. For instance, as urbanization increases, populations migrating to cities from rural areas are often unprotected as they are outside of a city's jurisdiction. Another example would be slum dwellers who have no choice but to live in dire housing conditions as other options are too expensive in the city. Exposure is best described as hazardous locations such as coastal positions or low-lying areas which are likely to be affected in severe weather conditions. Vulnerable populations who live in exposed and hazardous areas are hence impacted the most each time a disaster strikes.

When it is not possible to keep communities out of hazardous areas, cities try to build resilience in order to prepare for, handle, respond to, and recover from disasters. This in turn reduces disaster risk.

$$\frac{\text{Hazard x Vulnerability x Exposure}}{\text{Resilience or coping capacities}} = \text{Disaster Risk}$$

Resilience can be formulated under mitigation, preparedness, emergency response and recovery

Mitigation

Mitigation refers to efforts undertaken before an event to reduce or eliminate the risks from hazards that may affect human lives and property. The Federal Emergency Management Agency or FEMA, in the US, identifies several forms of mitigation:

- **Community protection works** – large engineered structures such as dams, levees and seawalls designed to protect against natural hazards.
- **Land use practices** – various forms of development regulations and zoning approaches designed to keep developments out of hazardous areas.
- **Building construction practices** – building codes and special utility codes designed to lessen structural damage due to flooding and high winds.
- Building content practices – such as securely mounting key equipment on walls and erecting protective bunds around critical installations.
- Maintaining protective features of the natural environment by protecting sand dunes, wetlands, vegetation cover and other ecological elements that absorb water (which are forms of non-structural mitigation).

Preparedness & Emergency Response

Disaster preparedness on the other hand requires putting in place practices that protect human lives and property. These include establishing a risk and hazard profile of the community, determining the types of resources and actions needed to deal with hazards, knowing which populations are likely to be at risk, developing contingency action plans and providing incident management procedures. In the event of a disaster, emergency response activities involve securing the impacted area, warning the population, evacuating the impacted area, conducting search and rescue for the injured, providing food and emergency care, and sheltering the evacuees.

Recovery

Post disaster relief is both short-term (restoration of access to affected areas, re-establishment of economic activities, restoration of critical infrastructure and restoration of community services) and long-term (rebuilding of houses and major structures like bridges, roads and buildings). As governments tend to take on the responsibility of short-term measures, it is often left to the private sector to lead in the reconstruction process. In many cases, a 'build back better' approach is undertaken in order to restore livelihoods as well as constructing more robust infrastructure and communities.

As the vulnerability of communities depends on critical infrastructure and facilities that represent lifelines such as bridges, utilities, water, sewers, power, communications, fire and police stations, hospitals, post offices and radio stations, critical facilities are an important component for emergency response and disaster recovery. It is advisable not to site these facilities in exposed and hazardous areas as loss of critical infrastructure means that the recovery is slower and can have significant impacts on public health and safety.

Plan to be Resilient

Lastly, achieving resilience starts with planning. Measures such as development regulation, land use management, building standards, natural resource protection, property acquisition, critical facilities policies and public education are significant for promoting hazard mitigation.

In planning for resilience, the following should be considered:

Physical infrastructure

stormwater drainage, wastewater, solid waste and water

- Avoid locating facilities in high risk areas.
- Has resistance and redundancy been incorporated in the plans?
- Are at-risk assets climate proofed?
- What are the impacts on local supply, demand and infrastructure networks?

Economic development plans

- Have local economic capacity and exposure issues been identified?
- Have opportunities for the socially and economic vulnerable been identified?
- Are green development opportunities being developed?

Land use planning

development zones and land use policy

- Have local hazard areas (e.g. flooding areas) been identified?
- Have low development and nodevelopment plans been designated?
- Is there a framework for frequent evaluation of local development and growth patterns?

Public health plans

- Are health impacts and socioeconomic risks included?
- What are the health risks (e.g.heatwaves, waterborne disease)?
- Are there local strategies to minimize adverse effects?

Transportation plans

connectivity by road, pedestrian, transit and bicycle infrastructure

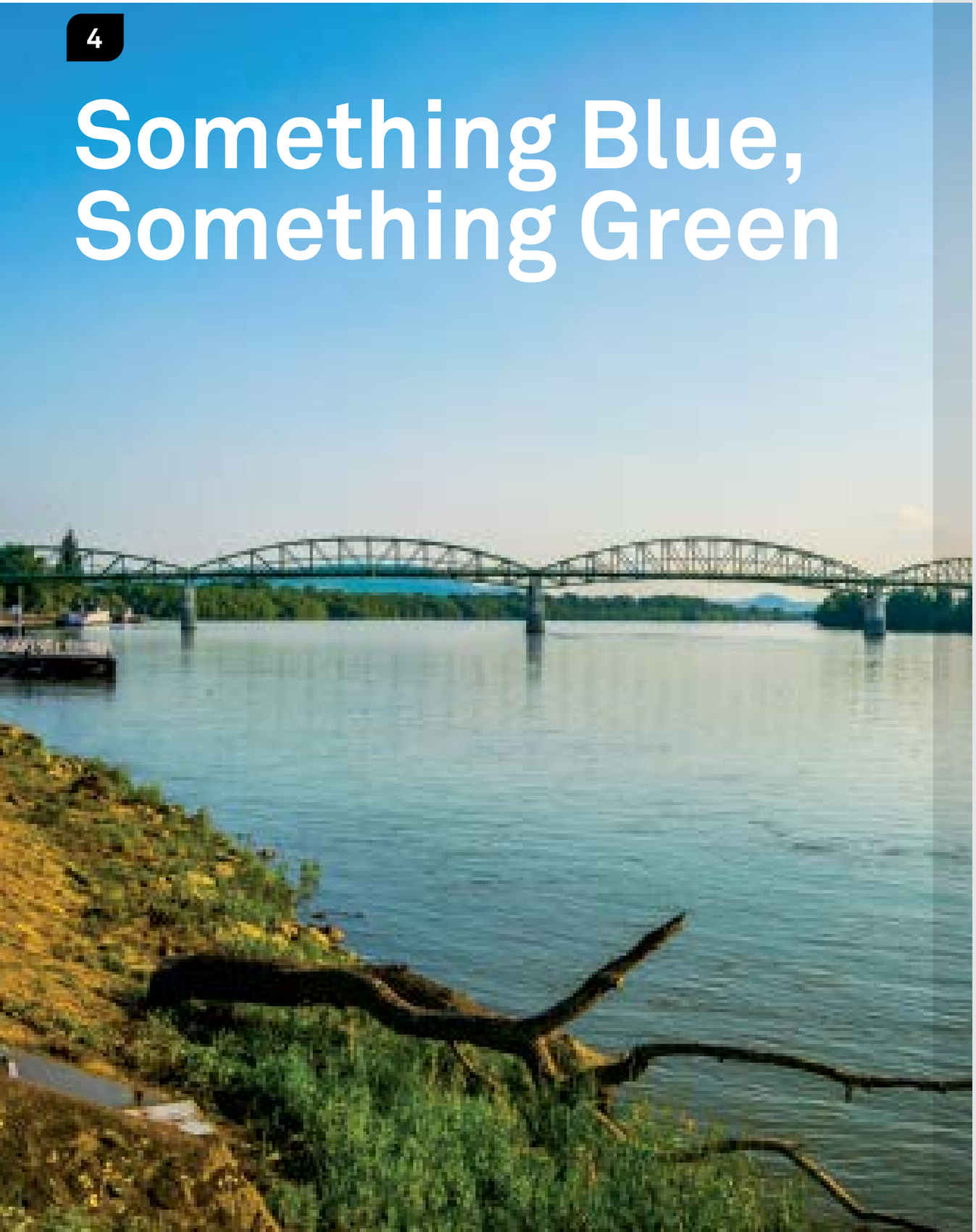
- Have weak transportation links been identified?
- Are the emergency transportation networks coordinated?
- Have at-risk assets been identified?

In conclusion, as urban communities grow our propensity for vulnerability and exposure increases as we are forced to take up dwellings in hazardous areas. Climate change and other factors mean that the occurrence of disasters like flooding and severe storms is likely to be more frequent. Infrastructure that was designed for milder conditions will be compromised; this problem is exacerbated by ageing assets and urban population expansion. To address this, we need to design resilient infrastructure (e.g. drainage channels, storm protection facilities and weatherproofed buildings) for future communities.

Infrastructure alone will not achieve resilience. Sound development plans that are predicated on disaster risk assessments and land use policies advocating mitigation and preparedness are needed. In addition, members of the community will also have to play a role in learning how to be resilient. Nature when unleashed has no mercy nor boundary. It is down to mankind to deal with these stresses. Resilience will be a path towards our survival, a journey rather than a process for humanity.

4

Something Blue, Something Green



Climate shocks and stresses affect many urban centres worldwide. A resilient urban centre has the ability to survive this shock as well as to anticipate it and continue to thrive despite climate changes. Resilience involves a number of measures, which include provisions for storm floods and droughts. Rather than conventional stormwater drainage systems, an eco-system approach could be more effective as not only does it create a natural buffer to alleviate peak flow, but surface water can also be conveyed, cleansed and stored for local reuse through multifunctional green infrastructure.

The Eco-System Approach

The 'ecosystem approach' according to the Convention on Biological Diversity (CBD) " is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way", which aspires to maintain the natural structure and functioning of ecosystems.

Ecosystem approaches address the crucial links between climate change, biodiversity, ecosystem services and sustainable resource management and thus have the potential to simultaneously contribute to the avoidance and reduction of greenhouse gas emissions and the enhancement of sinks through increased carbon sequestration. These approaches also maintain existing carbon stocks, regulate water flow and storage, maintain and increase resilience, reduce vulnerability of ecosystems and people, help to adapt to climate change impacts, improve biodiversity conservation, promote livelihood opportunities and provide health and recreational benefits.

Blue Green Infrastructure

Green infrastructure is based on the principle that the same piece of land can frequently offer multiple benefits if its ecosystems are in a healthy state and the spatial structure of natural and semi-natural areas are retained. Investments in green infrastructure are generally characterized by a high level of return over time, job opportunities and a cost-effective alternative, which can be complementary to 'grey' infrastructure and intensive land use change.

Blue-green infrastructure combines the water component with an eco-system approach using a stormwater management model that seeks to avoid or minimise development impacts on the natural environment and environmental value. This approach protects, restores, or mimics the natural water cycle and allows a way of managing surface water as close as possible to where it falls. There is usually a connection between the built landscape with locally-generated water resources, serving to provide a mechanism to reconnect individuals and local communities with the natural landscape.

Blue-green infrastructure includes protected areas, areas of high nature value outside protected areas, natural landscape features, restored habitat patches, artificial features such as eco-ducts or eco-bridges, multifunctional zones where land uses maintain or restore healthy biodiverse ecosystems, areas where the general ecological quality and permeability of the landscape can be improved, and urban elements such as green parks, green walls and green roofs.

Examples of the advancement of blue-green infrastructure include:

- National promotion in USA by the US EPA via the Green Infrastructure Strategic Agenda 2013
- Best Practice demonstrated by the successful application of blue green technologies in Philadelphia.
- In Melbourne, Water Sensitive Urban Design (WSUD) is be used for storm water planning policy
- In the UK, Sustainable Drainage Systems (SuDS) is mandated in all new developments via legislation and planning approval framework.
- The new wastewater discharge permit issued by the Milwaukee Metropolitan Sewerage District is the first in the U.S. to mandate green infrastructure.
- Instead of using electric-powered water treatment plans, New York City brings its drinking water through aqueducts connected to protected areas in the nearby Catskill/Delaware forests and wetlands – demonstrating how protecting watersheds can provide residential areas with drinking water and flood and pollution protection at low cost.
- New national 'Sponge City Construction Guidelines' provides a clear framework for delivery of a Low Impact Development City in China. National Funding is being provided for 'Sponge City' pilot provinces and cities that implement 'Sponge City' projects.

We explore three areas of blue green infrastructure, namely river revitalisation, retention facilities and sustainable drainage systems.

River Revitalisation

Rivers that run through cities offer economic development prospects as well as ways of reinvigorating social and cultural heritage.

At the outset, during the planning and design process, engagement with multiple stakeholders and the local community is crucial in establishing clear design goals and objectives. Revitalisation involves the enhancement of diverse environments - although the design should be tailored to suit specific locations – and opportunities to test new technology and techniques. Experience with river revitalization shows that water quality (especially odour) may be a significant influencer in the delivered design outcome.

Case study
Kallang River, Singapore

The naturalisation of the Kallang River and park surrounds involved transformation of the concrete drainage channel into a naturalised meandering river. An application of soil bioengineering techniques (a combination of vegetation, natural materials and civil engineering techniques) was used to stabilise the banks and prevent erosion, which resulted in an expansion of the effective maximum river channel width.

The profile of naturalised river and surrounding park area was transformed such that river flow is confined to a narrow stream during dry weather; and the park areas adjacent to the river become a flood plain and conveyance channel (i.e. natural retention facility) during heavy rainfall. The new riverbed reportedly can hold 40 percent more water now than prior to the redevelopment.

Retention Facilities

In designing storm retention facilities like retention lakes, controlled storage areas and retention parks, encouraging the successful co-use of land requires multiple engagement avenues - hence early community engagement in the design process is essential. For operation and maintenance, optimisation of flood management strategy and hydrological aspects may be required following construction so as to minimise maintenance through design and to allow standardisation of maintenance and management activities. Other items of importance concern risk management measures to ensure public safety and security around waterways and flood waters. Ecological compensation may be required as part of EIA approval conditions.

Case Study
Boronia Park, Sydney

Boronia Park is a high-use community space, located adjacent to a local library, basketball stadium and playgrounds. As a valued community space, upgrading works to the Boronia Park Retarding Basin started with community consultation during the planning and design process, having in mind that the basin was specifically intended to encourage public access and interaction. The new Boronia Park Retarding Basin design hence encourages public access, with designated areas specifically built for the community to enjoy. The basin upgrade includes an outdoor classroom, amphitheatre, trees and vegetation, a boardwalk, and recreational zones for locals to sit and enjoy the ambience as well as new features such as landscaping, rockworks and connecting pathways. The wetland at the base of the retarding basin was also designed to provide amenity to the community.

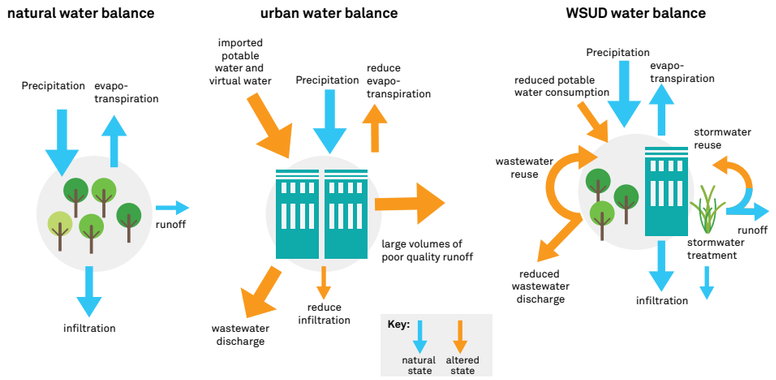
For safety and maintenance reasons, recreational spaces in the park are located just outside areas of potential inundation. The park design, however, is not fenced, and footpaths are purposely located in close proximity to the water edge to encourage people to interact with park elements such as the wetland areas.

Key features of the proposed works include:

- Upgrade of the storage capacity and flood protection performance of the retarding basin from a 15 percent risk of flooding to 2 percent likelihood
- Creation of a new path into the basin across a new 'meadow' and wetland garden
- Integration of stormwater quality treatment, in the form of a wetland, at the base of the retarding basin
- Creation of more useable areas in the park to walk, meet and relax – new north and west facing sloping lawns to maximise sunny areas to sit and rest
- Installation of new seating and feature trees
- Creation of a new multipurpose plaza space

Sustainable Drainage Systems (SuDS)

SuDS –which includes green roofs, rainwater harvesting, water reuse, porous pavement, bioswales and rain gardens - is part of Water Sensitive Urban Design (WSUD), the process of integrating water cycle management with the built environment through planning and urban design.



SuDS can be adopted to contribute to broader sustainability and greening space objectives. Pilot testing of SuDS designs is valuable in optimising the design and demonstrating compliance with standards although there are practical challenges with procurement of soils and plant species and meeting water quality standards. Researchers have found that a simple mixture of soil, sand and bark works extremely well at reducing toxins in storm water runoff. In terms of operation and management, establishment of bioretention facilities or similar SuDS measures will have different requirements over the life of the asset. Effective routine maintenance is essential to maintaining SuDS function.

Case Study
North West Cambridge, UK

North West Cambridge is Europe's largest rain water harvesting system, consisting of a series of swales that collect, convey and cleanse storm water falling on 3,500 homes in a green field site in Cambridge. The water is then stored in a new lake and reticulated back for non-potable reuse. This reduces potable water demand to under 80 litres per person per day and also helps reduce downstream flood risk. The project was designed to meet 1 in 100 flooding under the Code for Sustainable Homes Level requirements. Although some level of water recycling is required, what drives the project is the desire to become a sustainability exemplar using international best practices.

Connections and transitions were important in the SuDS strategy to ensure that runoff is captured and filtered using a treatment process of at least two SuDS features. All runoff therefore is directed towards the Western Edge, where it is slowed and treated during its journey. Runoff from properties is connected to the surface water sewer only after passing through initial SuDS measures, where possible. Connections made at the front of the property can be done via front sloping roofs to avoid passing pipework beneath the house. Connections from the back are installed if properties back onto communal courtyards or green spaces. Features to keep water above the surface and help reduce pressure on the subterranean environment include:

- Brown, Green and Blue roofs
- Permeable paving in courtyards
- Disconnection from the down pipe

Surface water drainage networks offer other benefits such as a pleasant environment, cycling routes and biodiversity.

The New Path Forward

Blue green infrastructure presents new ways to address flood risk in the urban environment, offering a multitude of other benefits with it. These include:

- Linking urban water infrastructure (blue) to urban vegetation (green)
- Reversing urban creep
- Greater climate change resilience
- House, street, community and city-wide applications

- Reduced flood and drought risk
- Efficient use of water (recycling)
- Lower temperatures in summer (reduced heat island effect)
- Lower pollution levels
- Better biodiversity
- Increased amenity and health
- Generation of local jobs

However, capturing these benefits, which are very local, is still difficult, making putting forward business cases for funding beyond flood risk management problematic. New legislation will be required if more sustainable drainage solutions are to be established in new developments. Retrofitting urban areas offers local benefits but local authorities and communities will need to be proactive in seeking opportunities.

Costs of blue green infrastructure such as bioswales and rainwater collection systems are in fact not much more than typical good quality landscape features. The design and materials used to construct these elements are the same as for typical landscape planters, except with more specific requirements for certain items (e.g., soils, drainage, planting stock). On the whole, they are generally seen as cheaper to construct and maintain, particularly as they are on the surface. As these are landscape solutions, costs are sometimes doubled up, mainly for the drainage systems which will entail a higher landscape specification. However the landscape solutions should reduce the demand for and amount of grey infrastructure needed. Much also depends on the parameters i.e. the volume of attenuation, the water quality improvement targeted and the pollution in the source water. Maintenance costs are comparable to typical good quality landscape.

It is also important to think of cost in terms of total value. Often for new builds it is cheaper to use natural processes. However, they can take up more land - the rule of thumb being 2-5% of impermeable areas – and if not planned properly, are as always more costly if retrofitting is needed. The benefits often trickle to the water company rather than the developer – so it is also a question of "who pays?".

The establishment period for blue green infrastructure is in the range of a few weeks to months. In terms of how quickly they take to establish, most of the benefit is actually derived through the soil structure, so as soon as they are constructed they will provide attenuation and some water quality improvements. Planted solutions provided added benefits from the microbes living in the root structure. These would take as long as a normal landscape to establish.

This short paper was prepared for the Second Asia Pacific Forum on Urban Resilience and Adaptation (2nd March 2016) The author would like to acknowledge with thanks the following for their contribution to this short paper: Michael Henderson, David Gallacher and Katrie Lowe.

5 Nature's Genius

by Rachel MW Hahs

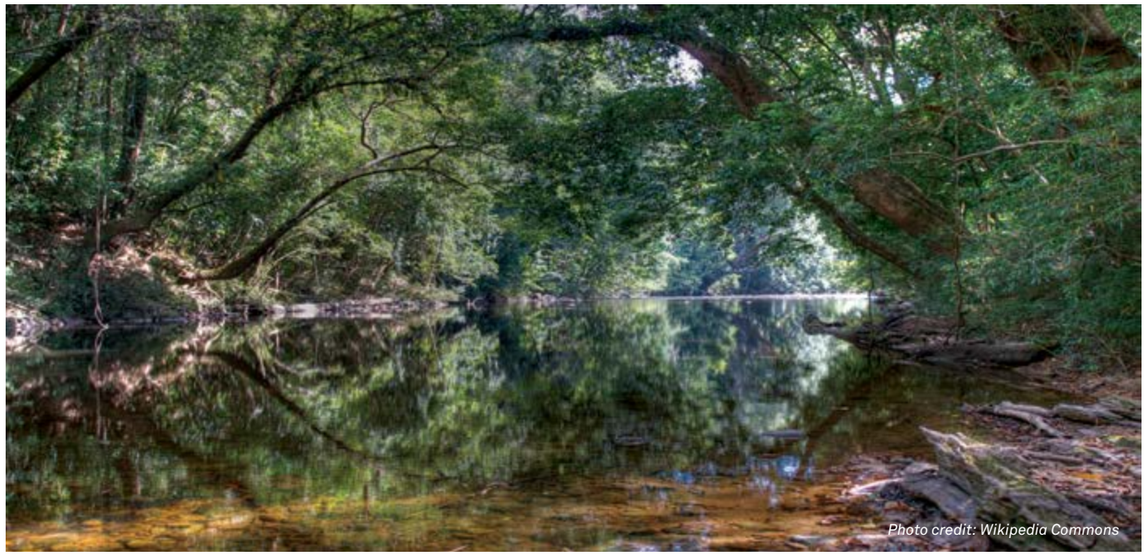


Photo credit: Wikipedia Commons

Prior to development, Kuala Lumpur was a lowland rainforest supporting the same species richness such as that currently found in Taman Negara in the east coast of Peninsular Malaysia. Today, Kuala Lumpur teems with completely different diversity and richness - those associated with human systems. However, fundamental to both systems is the need to effectively respond to the challenges of living here, in this place.

In Kuala Lumpur and other cities in Southeast Asia, environmental challenges are rooted in two primary operating conditions - constant warm temperatures and abundant rainfall. However, comparison of lowland tropical rainforest and Kuala Lumpur ecosystems tell two very different stories of success in dealing with challenges posed by these operating conditions.

Challenge	Lowland Tropical Rainforest	Kuala Lumpur
Carbon	Significant carbon sequestration	High carbon emissions
Energy	Capture and storage of local, renewable energy	Reliance upon imported non-renewable fossil fuels
Resources	Rapid local cycling of resources that fuels abundant growth; zero waste	Deforestation resulting in increasing soil erosion and a reduction in natural resources; Low reuse and recycling rates resulting in landfill capacity limitations
Water	Capture, storage, evaporation and filtering of water; flood management	High surface runoff from exposed soils and impervious surfaces into pipes and channelized waterways that are often polluted with waste and sediment
Biodiversity	System architecture that supports incredible species diversity	System architecture devoted to humans resulting in decreasing species diversity

As seen in the table above and repeatedly throughout the stories of our modern cities, our approach to solving for these challenges in human systems often differs significantly from the strategies employed by native ecosystems. Our species' future is dependent upon the successful continuation of these fundamental ecosystem functions, but the evidence indicates our human systems are failing us. Fortunately, city leaders and built environment experts are attempting to disrupt the stories of cities toward regenerative, resilient outcomes. The big question is, how?

The Forest Way

The lowland forests of Malaysia are some of the most productive ecosystems on earth. As the forests breathe in carbon dioxide to convert sunlight to sugars, they store an overabundance of carbon in forest vegetation which fuels rich biodiversity. As the forests breathe out, they release water vapor that helps to create their own weather patterns. Fallen vegetation, captured by massive buttressed tree roots and tiny fungal networks in the upper layers of the soil, is broken down rapidly in the constantly warm humid environment. These resources are stored in forms easily (and quickly) taken up again by living plants. In this way, the vast wealth of this complex ecosystem is held in the biomass, not in the shallow soil. Thus, the abundance of vegetation and the biodiversity it fuels are the living embodiment of a generous system in Malaysia. In biomimicry, we recognize this as genius.

The Biomimicry Solution

Biomimicry is the multi-disciplinary innovation practice of learning from and emulating solutions found in nature to solve human design challenges. Species have evolved over millennia to survive in their local environment. Those that didn't adapt and evolve have gone extinct. Thus, the species and systems we find today can provide examples of proven long-term solutions - they are inherently sustainable and resilient. By applying the lessons learned - the design principles - to our own designs, we can begin to create solutions that are better adapted to life on this planet.

In biomimicry we also look at the deepest patterns found across all species that define the rulebook for sustainable and resilient living on Earth, such as using life-friendly chemistry, being material and energy efficient, and adapting to changing conditions. We use these deep patterns both as an additional innovation tool during brainstorming and as an evaluation tool throughout the design process. Use of these deep patterns helps to engage a design team in systems thinking to understand and improve upon the broader impact of a design.

Cities are Ecosystems

When using biomimicry to find solutions to address built environment design challenges in a specific place, our research looks into the local context. Plants and animals in a desert look and function in fundamentally different ways than those in lowland forests. Conducting a deep dive into why and how local species deal with local operating conditions in place, including identifying deep patterns found across species in a geography, can provide invaluable insight into innovative and locally-attuned solutions that improve our management of the resources and risks associated with a challenge. We call this knowledge embodied in local species and systems "Genius of Place."

Fundamental to the idea of biomimicry as it applies to the built environment is the recognition that cities are inextricably linked to the ecosystems that support them - they both impact and are impacted by native ecosystems. Both native and human systems have overlapping energy and resource inputs and outputs, and rely upon as well as impact activities that occur beyond their borders. They are also constantly responding to dynamic conditions that come from both within and outside the systems. Our cities are biological systems - ecosystems - that are bound by the same rules as all other life systems.

Before every city was built, a native ecosystem was in place for millennia, if not longer (in Malaysia they estimate the forests are 130 million years old!), performing myriad services for its inhabitants. If our cities fail to meet the same net system metrics achieved by the native ecosystems they replace, the water, energy and resource cycles that sustain an abundance of life, including our own, are disrupted and begin to degrade, often rapidly. The degradation results in challenges that plague our cities - polluted water, higher temperatures, changes in weather patterns that affect rainfall, and large volumes of waste.

Rethinking Infrastructure to Achieve Ecosystem Functions

So how do we improve functionality of our built environment? How do we begin to rethink our approach to solving for the energy, food, transportation, and water infrastructure challenges plaguing our cities? Since our cities will not return to lowland forests, how can we re-engineer them to function like native ecosystems such that we improve the sustainability and resiliency of our cities? What will we learn from lowland forests about carbon cycling, energy use, soil management, water management and creating opportunities for biodiversity in Kuala Lumpur?

Fortunately we do not need to begin from scratch when looking for novel solutions - we can learn from innovative, proven sustainable and resilient solutions that are literally on the doorstep of our cities if we make the conscious decision to step outside, learn and emulate.

Photo credit: Wikipedia Commons

Biomimicry in Action

A popular example of biomimicry in infrastructure is Tokyo's Shinkansen Bullet Train, the front of which was redesigned to mimic the shape of a kingfisher's beak to eliminate a sonic boom generated upon exiting a tunnel. The redesign also happened to reduce electrical consumption of the train by around 15%.

When looking to biomimicry in systems, architects are rethinking how buildings can mimic the upper canopy's impact on slowing down precipitation and evaporation rates to contribute to sustaining local water cycles. Other examples include the application of swarm intelligence to design logistics software to determine the most efficient delivery routes, prevent collisions and improve traffic signal timing, and use of the algorithms of slime mold in choosing the best paths from point A to point B to design our highway systems.

About the author

Rachel Hahs is a Certified Biomimicry Professional and Envision Sustainability Professional, and holds a Master of Science in Biomimicry from Arizona State University.

As a biomimicry thought leader, she develops and facilitates biomimicry-based sustainable innovation workshops and design charrettes and conducts original biomimicry research on the topic of disruptive innovation. She is an experienced public speaker and recently started a blog called Think Biomimicry (www.thinkbiomimicry.com).

6

INNOVATIVE VIEWPOINTS

"A CULTURE OF CHANGE"

YBhg. Dato' Dr. Nadzri Bin Yahaya
Deputy Secretary General of the Natural Resources and Environment Ministry, Malaysia

Who are you and what is your background?

I am the Deputy Secretary General of the Natural Resources and Environment Ministry. I have been working for the Government for 33 years, previously for the Ministry of Finance, Ministry of Science, Technology and Environment, National Solid Waste Management Department and my recent post in KETTHA looking after Energy and Greentech. You could say that my career followed a 'snowball effect' as the environmental challenges I undertook seem to grow larger with each posting!

What is your concept of sustainability?

The definition of sustainability goes back to 1992, back to the original definitions of sustainable development, as it was known then. It was about what we leave for future generations and the triple bottom line. In other words, it was recognizing that resources are finite and that although economic growth is inevitable, we should still look after the state of the global environment as well as society. Hence the triple bottom line, economic, social and environmental factors, all of which must be balanced.

What are the main environmental issues facing us as Malaysians?

We have our challenges but actually there is a bright light in the future. Under the Environmental Performance Index 2016, Malaysia ranked 63 out of 180 countries. This is quite good. Malaysia has good policies in place for resources like water, land and energy. Our problem is not being able to execute them properly.

But our future lies in education. We have a high level of literacy in this country. The people are well aware of the latest development in science, technology and the environment. Sometimes this leads to controversy as people's awareness is high and they begin to question government. For instance take the recent case of water pollution in Semenyih which lead to the closure of the water treatment plant, people asked what are the pollutions, why it took so long to fix the problem and what government was doing about it. But on the whole, having a highly educated population means that we expect better environmental quality.

What is your notion of the end game?

That's an excellent question. I believe that in the future, people will not only be asking about pollution control but rather about the aesthetic value of life. People should be concerned about how to enjoy the quality of the environment. This starts with educating the mind. This is 'pendidikan' not 'pelajaran'. In other words, we inculcate the culture of the right behaviour at the start, and when you are older you can study science and other things. It is better to teach a five year old about respect and cleanliness than to teach him the Periodic table. This has to be culturally inbuilt.

In Japan, they teach such values at an early age. This way behaviour is very natural and not dictated by laws. Sadly in Malaysia we are still behind. But we cannot wait another 300 years to catch up, we must do this now. I believe we must do this with a balance of 'stick' and 'education'.

How can innovation help Malaysia's sustainable development?

In the 11th Malaysia Plan, innovation is cited as our key driver for economic growth. We must aspire to new or improved processes to yield additional sources of revenue. Technology spearheads all this. Let me give you some examples. For power generation, we still use coal. This causes global warming. So what would be the role of technology? We can either choose to use clean coal, or we can adopt technology such as ultra super critical for our power stations, or we can convert to solar or we can even innovate our buildings, where most of the energy is consumed. We can also convert the ash into road materials making wealth from waste. The Intergovernmental Panel on Climate Change (IPCC) is continuously looking into carbon capture and storage, as a new technique to combat greenhouse gas emissions, so there is a lot that technology can offer.

For infrastructure, we now have permeable concrete as new road materials that absorb water unlike the traditional material used in building roads. This means that in the event of flash floods, the roads are able to cope with water and we don't need deeper drainage systems. For housing, we should be using heat- absorbing materials to build houses so that the poor, who can't afford air-conditioning, can live more comfortably. In Kuala Lumpur, we have a Smart Tunnel that started off as a drainage channel but doubles up as a road thoroughfare. This is a remarkable piece of engineering. We also need to be mindful of our spending. We cannot spend on infrastructure and then find out that we have run out of money halfway to complete the job. We need to plan to execute properly not address problems partially, which is sometimes worse than not addressing them in the first place. Take for example the closure of a landfill, which was not wholly addressed due to insufficient fund. Although it looks green but we still have problems with leachate due to incomplete lining system and expensive maintenance of the leachate treatment plant. We must practice what we preach if we say we are going to solve the problem.

In regard to our natural resources, we do what we can to preserve our resources. In Sarawak, the State Government has stopped issuing new timber concessions to protect our forest cover. In Sabah, the state government only allows gas and hydropower instead of coal power plant. But while these are good initiatives, we must find ways to enhance earning of these states to compensate for any losses in revenue. Many states do not have steady income so they revert to exploiting their resources. How do we persuade them not to do so and how do we reward them accordingly? It is a question of environmental economics.

To better manage our environment and resources, one initiative that the government has taken up is a geospatial database to map the country which includes natural resources such as land, water, forest etc as well as infrastructures such as utilities. This means that we can see exactly how much area is affected. This helps us in inter-state issues. For instance Penang gets its water from Kedah and Selangor gets its water from Phang. We can see exactly what resources are being taken cross-boundary. This helps us as policy makers as we can make well-informed decisions.

Are we doing enough to meet sustainable growth needs?

Not enough. Many of our constraints are of our own making. There is a tension between the aspiration to high development and the need to protect the environment. Then the pressure on states to comply with the Federal policy and legislative requirement. The bottom line for all parties is finance needed for growth and the finance to sustain environmental protection. We have an Environmental Quality Act which is enacted under public health concerns and the Forestry Act to protect the forest which is state own.

How can education play a key part?

As I mentioned earlier, the Japanese approach is good. It introduces two things, a good behavioral culture and the knowledge behind what we do. Instilling a culture change is important in our young, knowledge can be acquired later in life. Change the mindset and then you can change the character.

How can we leave a legacy for our young?

(Laughs) Clean air, safe water and good earth. Legacy should not be the Petronas Twin Towers, it is about what we need to survive. Elements of life itself. Clean water and safe air and good earth.

Are businesses doing enough to contribute to our sustainability?

Companies are following the kaizen way. They are in stages, continuously reporting on their green plans and being held accountable. But they are not moving fast enough. They have changed though. In the past, companies came to Malaysia for cheap labour. Now they come because we offer good environmental standards.

On another note, when I headed Green Tech, we noticed many companies taking advantage of green opportunities. When government implemented its green procurement policies, companies are able to take advantage of this need for green products like stationary, cement and paint. This was a situation in which the private sector moved in tandem with the government aspiration of sustainable growth.

What can we learn from others? And what can we share?

We can learn soft skills like caring for the environment and for other people's needs. The other part is the hard side of technology that we need to manage the environment.

We should share knowledge of what we are good at. We have decades of practice in managing biodiversity and agriculture. We have experience in rubber and oil palm plantations. We should show others the practices we have developed over time. We must also stop working in silos and put environmental issues in mainstream practices so that we can automatically incorporate sustainability as part of how we work. That is how we will achieve sustainable development in the end.

"A REGENERATIVE FUTURE"

Shariha Khalid, founder and Managing Director of Scope Group in Kuala Lumpur

Please introduce yourself and your background

I am Shariha Khalid, founder and Managing Director of Scope Group in Kuala Lumpur and also a committee member of the Social Progress Network Malaysia.

What is 'sustainability' to you?

It means many different things. Although the term is commonly linked to environmental sustainability, to me it means more than that. It is about how you are living, how you make your work part of what you leave in this world and about looking at how you could fund your work and leave your mark. In the broader scope of things we should also look at financial sustainability and impact sustainability.

What are the main sustainability-related issues facing Malaysians?

If you look at the Sustainable Development Goals (SDGs), there are various angles that we need to consider such as social impact, financial impact and economic impact.

With regard to that, I think one of the main challenges that we face is actually around secure livelihoods. We think this is bigger than what is being represented in the public domain. A lot of people are struggling on a day-to-day basis to make ends meet and they are hidden from those who could offer help. Another area, which is also around basic human needs, concerns people who have slipped through the cracks in terms of receiving necessities such as food, electricity and water. Then there is a disease burden that we face, around tackling heart disease, diabetes, HIV/AIDS, drug addiction, mental health and other non-communicable diseases. We also have a burden around 'health' and 'care' - here I am referring to a very rapidly growing elderly population and the disabled. This doesn't even take into account the stateless and marginalized communities.

Essentially we have a big problem in these core areas. The things that we are doing are too superficial at this stage and we are not targeting on what really needs to be done.

How can innovation help Malaysia's sustainable development?

Innovation is about doing something new to solve existing problems. But we also need to think of problems that have not occurred. So we need to innovate for future problems, things that we believe Malaysia will likely face in the future. These could involve technological innovation, product innovation or service innovation, to do something differently to reach and impact the people we serve.

In our work, social innovation is at the core. Our principle as an organisation is around what we call 'PI2' which means partnership and innovation for impact. It is very much about leveraging innovations that are created by organisations out there and help them find partners so that they can scale up their impact.

Are we doing enough to meet sustainable growth needs?

Here's the irony – when we really look at the term 'sustainability', it is actually anti-growth. Growth is about taking, and sustainability on its own, is about maintaining the status quo. I don't think you could get sustainable growth. If you want to talk about sustainability, you should instead talk about 'regenerative growth'.

We need to remedy a lot of the damage by not taking from where we can't replace resources anymore. We need alternative pathways to grow the nation and our income and look at other measures that also give you the same indicators of progress. It is not just about wealth but about social progress.

We need a paradigm shift in how we see growth. And the regenerative piece is crucial as it becomes part and parcel of any strategy related to growth. When we are talking about growth it is about taking more than what we can replace. How we get growth then? How do we transform our business practices so that we are going beyond achieving 'zero' which is giving and taking back the same amount. We need to go above zero.

The first step to achieve this is actually moving towards being zero. It is proven to be something that you can do. Then we need to work with the government and with corporations towards becoming regenerative which is to restore and to give back. That's difficult. That's where we need to truly innovate. This involves changing the systems that we are running – in education, finance and governance, for example. We need ecosystem players if we want go that way. It's not impossible.

At the local citizen level you have citizen towns that are doing this where locals take action for their own communities. Imagine how powerful it would be if we could replicate that at the local government and national government levels. The same applies to corporations.

How can education play a key part?

I think education is good to raise awareness and also to connect people to pathways to action. But education and awareness on their own are not enough. What needs to happen is behavioral change. That can only happen when you design systems and platforms for such change to happen or that give rewards if you take action.

Another piece is there's a lot to be done in working with children and youths to nurture them as champions in awareness and show them how they could take action. That would be a message for adults to show that with little resource and experience we too can make a change.

If you need to run campaigns they need to include an element which allows people to do something. A simple idea is by allowing the audience to donate through an app. In short, you need to make it easy for people to take action. We are so inundated with information that we need to grab people's attention for them to act immediately.

What kind of a legacy do we want to leave for the younger generation, and how do we achieve that?

Ideally, we should be leaving a place with equitable opportunity. The reality is we're living in a world that is very contradictory. We have an abundance of intellectual resources, but we have very little in terms of social capital resources which relate to platforms or means for people who actually want to do something. I hope my legacy would be such a platform where people can discover, partner and take action together. I would be happy with that.

Are businesses doing enough to contribute to sustainability?

No. I will say that repeatedly but businesses have the resources to do what needs to be done. Why aren't they doing enough? It's because they haven't made the connection between the financial, social and environmental bottom lines. Businesses being businesses - if they can see the connection and the financial returns, they will surely invest more in becoming sustainable and being regenerative.

How do you see Malaysia in 10 & 20 years' time and beyond?

In 20 years, I hope the young people of today would have stepped into leadership positions. The 20-somethings now are really into making a change. So I am hopeful.

In 10 years we are going to see many more businesses that consider their footprints as part of their strategies. But the question is could we as a country achieve that kind of social progress with just businesses driving it?

What can we learn from others? And what can we share with them?

We can learn from countries that have prioritised sustainability and innovation. Just look at countries in Scandinavia for example, and even Austria, Switzerland and Canada – they are doing amazing stuff. At the most basic level, Bhutan is an example of how a country can do a lot with limited resources.

One of the things that we are doing well is that we have a desire to be better. We are very aspirational as a country so that is good as it shows that we understand that we cannot stagnate. We can share that 'Malaysia Boleh' spirit of wanting to go beyond 'average'. We can demonstrate that to other countries that are trying to get out of developing nation status. We are not there yet but our heart is in the right place.

7 *Special Feature on Waste*

Keeping Tabs on Waste

Green growth refers to growth that is resource-efficient, clean, and resilient. It is a commitment to pursue development in a more sustainable manner from the start, rather than the more conventional and costly model of 'grow first, clean up later'. A reinforced commitment to green growth will ensure that Malaysia's precious environment and natural endowment are conserved and protected for present and future generations. (11th Malaysia Plan)

Malaysia's waste management strategy is to manage waste holistically based on a life cycle approach (11th Malaysia Plan, 2015). The parties involved include the National Solid Waste Management Department, the Solid Waste Management and Public Cleansing Corporation, the Atomic Energy Licensing Board, Department of Agriculture, Department of Environment and Minerals and Geoscience Department and National Water Services Commission.

Aimed at achieving a goal of 22% household recycling rate by 2020, the Government has introduced the following initiatives:

- Waste separation at source for households to be implemented in selected states starting September 2015 and rolled out to other states subsequently during the 11th Plan.
- An investment in waste recycling and recovery to reduce dependency of industries on natural resources. Waste becomes a valuable resource – either converted to energy (e.g. bio mass and food waste for power generation) or used as an input for other products.

These initiatives should be private sector driven to ensure long-term financial viability of the projects so that industries see the value of waste as a source of energy or inputs for their processes. According to a waste survey conducted by the Department of National Solid Waste Management, the quantities of solid waste (excluding construction waste) generated in Malaysia comprise:

Sector	Metric tonnes per day (tpd)
Household	21,627
Commercial & Institutional	2,279
Industrial	9,224
Total	33,130

Roughly converted, each person in Malaysia generates 1.17 kg per day.
The following table shows the breakdown of waste by type:

	Tonnes per day	% composition
Food waste	11,141	33.6%
Garden waste	1,392	4.2%
Other organic waste	206	0.6%
Paper	5,437	16.4%
Plastics	6,985	21.1%
Glass	900	2.7%
Metals	1,399	4.2%
E-waste	33	0.1%
Batteries	25	0.1%
Hazardous waste	358	1.1%
Diapers	2,641	8.0%
Textiles	875	2.6%
Rubber	399	1.2%
Leather	139	0.4%
Wood	521	1.6%
Others	670	2.0%
Total	**33,130**	**100.0%**

Based on the waste survey, it is estimated that the overall recycling rate for Malaysia is 9.6%. The highest rates are for metals (47.6%), paper (34.4%), plastics (19.1%) and glass (19.7%). Hence, the amount of waste diverted currently from landfill is 3,174 tonnes per day based on 9.6% of the solid total waste generated. Considering the aim of achieving 22% solid waste recycling rate, the government needs to double the current amount to be absorbed back into society.

Special Feature on Waste

Can Cities Unlock the Resource Potential of Food Waste?

Food is a resource that we should treasure.

In the real world, this does not seem to be case.
According to the Food and Agriculture Organization, about one-third of all food produced worldwide, worth around US$1 trillion, gets lost or wasted in food production and consumption systems. Every year, consumers in industrialized countries waste almost as much food as the entire net food production of sub-Saharan Africa (222 million vs. 230 million tons). At the end of the food chain, food waste is defined as the food lost during retail activities and final consumption and relates more to behaviour. In Europe and North America, consumers throw away 95 -115 kg per year, while in industrialized Asia, the "throw away" amounts to 80 kg per capita per year.

How do we turn food waste into a resource? There are various means of doing this.

Composting 	- organic matter that has been decomposed and recycled as a fertilizer and soil amendment
Animal feed 	- the feeding of food scraps to animals is historically the most common way of dealing with household food waste. Animals turn a third of ingested food into meat or dairy products
Industrial 	- Used cooking oil is a common waste that can be turned into biodiesel
Energy 	- anaerobic digestion is the process by which organic matter such as animal or food waste is broken down in the absence of oxygen to produce biogas and biofertiliser

But to convert food waste into a resource, there are challenges to be overcome along the value chain. At the sorting stage, unfamiliarity among the public with how to handle food waste means extra manpower will be needed for sorting. During collection, temporary storage of food waste, if not properly carried out, can generate odour and hygiene problems. Although scale is favoured to make recycling cost-effective, additional administrative effort is often needed to collect for high-density and high-rise buildings. Transportation effort and costs further arise when bringing waste from collection points to treatment facilities. These can be as high as two-thirds of the total operational costs. Post-treatment and maintaining quality control of the product is important as incomplete decomposition or product that is contaminated cannot be used e.g. unfinished compost would not be suitable for gardening. Lastly, there must be sufficient market capacity to absorb large amounts of the final recycled product e.g. local needs from agricultural and landscaping use.

Many cities are looking at food waste recycling strategies within urban settings. San Francisco city has instated a "zero waste" target by 2020 and has made the sorting and composting of food waste mandatory. The city has a compost facility 89 kilometers east in Vacaville which supplies compost to the Napa and Sonoma wineries. In Sweden, Malmö city has also imposed mandatory sorting of household food waste whereby citizens recycle their food waste through waste grinders, vacuum systems or paper bags in garbage bins. The waste is anaerobically broken down to produce biogas to fuel city buses, garbage trucks, taxis and cars. The Adelaide city council in Australia provides Green Organics bins for residents for food scraps and peels, meat scraps and bones, teabags and coffee grounds, egg shells, dairy products, hair, shredded paper and tissues. The bins are a way of making recycling more localised and with the abundance of urban gardens, Adelaide has high food waste recycling achievements of up to 90%. Compost and mulch produced by this method is certified to Australian Standards AS4454 which is suitable for public, landscaping supply yards, landscapers and agricultural growers.

In Malaysia, the Kuala Lumpur Centre for Sustainable Innovation is working on the design and establishment of an innovative food waste recycling scheme in a 1,000 resident public housing complex located in Kepong, in the Greater Kuala Lumpur area. Food waste will be collected from individual owners' apartments, processed into compost on-site and used to nurture an urban farm for the residents. The innovation of the waste recycling scheme is that it eliminates transportation costs, which is usually the largest component of operating costs for this type of business. If successful, this scheme can be easily replicated across other communities in urban areas across Malaysia. In a survey of residents within the complex, findings showed that:

- Almost 70% cooked at home meaning that regular grocery shopping (85%) occurs once a week or more. In other word, there is regular supply of food materials coming into the complex.
- When asked why does food go to waste, almost 60% state that this due to spoilage, which is consistent with the local preference for fresh food.
- Roughly 45% of the households sort their food waste but just 55% are prepared to take this waste to the local collection point.
- Typical of urban dwellers in a high rise setting, more than 80% of those surveyed would not buy compost whether from food waste or other sources. This indicates the need for an urban garden as the outlet for the recycled food waste.

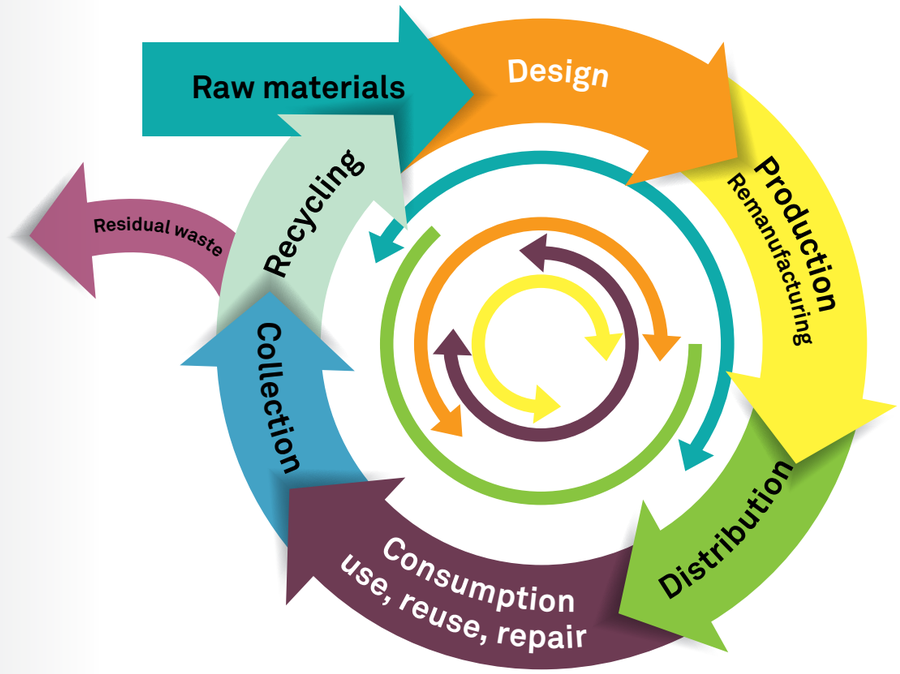
So what can we learn? There is a need to address behaviour change on food waste sorting and use of recycled products through public education. Mandatory sorting is needed (as demonstrated by San Francisco and Malmö). Specific collection arrangements for high-rise buildings should be implemented e.g. designated food waste collection bins should be provided; there is potential to incorporate pneumatic chute disposal systems in newly designed buildings. Some cities have instated waste charging mechanisms and at the same time offered economic incentives for households to sort food waste, for which they will be charged less. Food waste recycling operators must have viable business models, which mean that robust secondary markets for the finished products are vital.

This short paper was prepared for the CleanEnviro Summit Singapore 2016 .

The Circular Economy

The common definition of the circular economy is one where waste generated by one party can be converted into a useful resource for another party. This description of waste embraces not just solid materials but also other resources such as energy and water. By applying this principle, a closed loop is created, regenerating resources rather than the need to exploit new ones. The opposite of a circular economy is a linear economy.

A common example of the circular economy would be that of a tenant on an industrial complex using the waste by-products of another tenant as an input into his or her process. A slightly more complex example would be recycling bodies working either in-house or externally with producers and supply chains to take used products from users in exchange for new ones and reusing the used products either back into the original product stream or disassembling them for recycling elsewhere. Producers themselves can lead and own such initiatives by implementing 'take back' policies to encourage users to return used products to the manufacturing process.



The circular economy tends to exist internally within specific sectors. But the key to a true circular economy is to link up separate sectors so that spent resources from primary markets can be fed back into the same primary markets or into secondary markets. In shaping the circular economy, there are three main aspects to be considered: remanufactured goods; reconditioned goods; and secondary use goods.

Remanufactured goods refer to goods that enter the market as new but with re-used components such as glass and wiring. Reconditioned goods are those that retain the original body but with new internal components such as upgraded circuits and chips. Secondary use materials are materials from disintegrated assemblies that are recycled into low end applications like road surfaces, plastic fillers or wood chips.

Reuse or Recycle?

There is also a distinction between re-use and recycling. The former occurs when used products are converted into resources and put back into the original product, which will then be sold as a remanufactured or reconditioned good. If the used product is used as a resource for secondary use i.e. lower-value recycled products like road surfaces, plastic fillers or wood chips, it is considered to be a recycled product. This commonly comes from dissembled used items.

On a global level, a circular economy could help enable developing countries to industrialize. For developed countries the circular economy may increase wellbeing and reduce vulnerability to resource price shocks without placing unsustainable pressure on natural resources and breaching environmental limits. The Ellen MacArthur Foundation estimates that if the European Union manufacturing sector adopted circular economy business models, it could realize net materials cost savings worth up to US$630 billion per year by 2025.

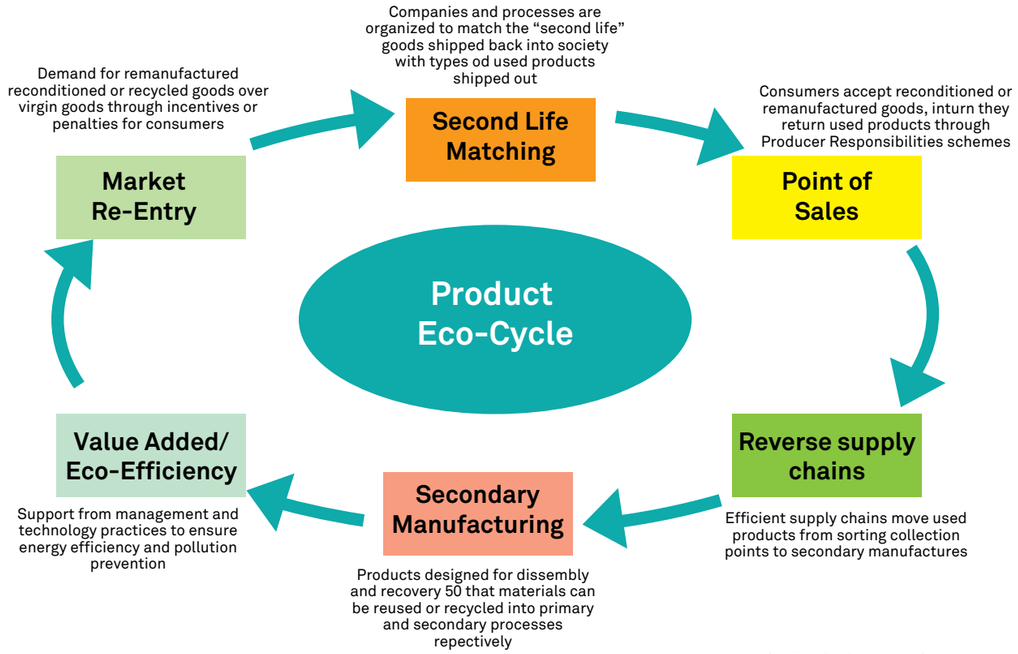
Can We Do It?

As in the case of many countries, the private sector provides the bulk of investment in innovation. Hence the policies set by governments are critical in accelerating the time it takes for breakthroughs in materials science and product design. Currently, companies are still reluctant to make the transition to circular economy practice due to a perceived lack of expected returns. The Ellen MacArthur Foundation has argued that the most profitable opportunities lie in products with a medium life span – longer than a single use but short enough for reuse and remanufacturing to be attractive. Barriers in applying the circular economy include:

- **Lock-in to resource-intensive infrastructure and development models** - the physical infrastructure of production, consumption and trade is highly geared to once-through manufacturing models.
- **Political obstacles to putting an appropriate price on resource use** - subsidies that encourage excessive use of resources will need to be removed and all 'externalities' incorporated into the price of resources and energy.
- **High up-front costs** – in the short term, there are significant up-front investment costs and risks for businesses – e.g. retooling machines, relocating whole factories, building new distribution and logistics arrangements and retraining staff.
- **Complex international supply chains** - supply chains have to be reorganized so that information and material flow can facilitate reuse and remanufacturing.
- **Lack of consumer enthusiasm** - consumers need to understand and value what the concept represents; a product certification or labeling system may be needed.
- **Challenges for company-to-company cooperation** - incorporating circular economy practices can require multiple companies to adjust their operations with potentially large transaction costs and delays in negotiating with partner companies.

The Product Eco-Cycle

To apply the circular economy to Malaysia, the Product Eco-cycle model is proposed. The model traces the path of products across the entire life cycle from raw materials to post consumer use.



The Product Eco-cycle

Compared to other models such as producer responsibility, producer take back and design for environment (DfE), the product eco-cycle is not intended to replace them but rather integrate the separate models into one holistic approach for specific products. The main difference is that collaborative partnerships between manufacturers, wholesalers and retailers are emphasized otherwise the individual elements of the product eco-cycle will not work in isolation of each other. Savings through economies of scale and the returns from recycling can thus be shared amongst all the players, as well as being further invested into the facilities and services necessary for the product eco-cycle.

In theory, it would be possible to apply the circular economy in a compact urban centre where collection and sorting systems operate and companies collaborate closely with one another. In practice, one particular example of the product eco-cycle is in photocopiers where there are dedicated resources to achieve this goal. As photocopiers are a specialized niche, there is no reason why other specialized niches like mobile phones and computers cannot adopt this approach.

Materials should be separated into biological and non-biological categories. Taking the latter first, non-biological products like metals are already in the circular economy as there is intrinsic value in the materials. But other materials like plastics, glass and paper are usually part of one-trip products which are discarded after use. A paradigm shift is needed to re-design products so that such materials can be retained in the original shape and form as the products and can be reused either through reconditioning or remanufacturing. The materials will have more value as the product is more attractive in intact form instead of being dismantled. One way to retain the value of a product is to 'rent' it out so that the consumer returns the product when no longer in use. Glass bottles are an example where the bottles can be reused many times if designed properly. Biological products, usually food, are difficult, if not impossible to re-use. The best uses for biological products are aerobic and anaerobic digestion. Using the by-products of the broken down items as nutrient for urban farming, in a sense, it closes the loop of lifecycle management. This provides opportunities for landscape designers and engineers to create 'green' urban infrastructure and space for growing crops.

Companies need to look beyond short-term objectives and make business investments in retooling machines, building new distribution and logistics arrangements as well as retraining staff. The starting point would be for products with a medium life span – longer than a single use but short enough for reuse and remanufacturing. In doing so, company-to-company cooperation must be established. Also governments must remove subsidies that encourage excessive use of resources, enforce sorting and separation to create the right material streams for the circular economy to work, licence the recycling industry to remove 'rogue' traders, provide land and resources for the private sector to set up the value chains needed for circular economy practices, educate the public on the need for managing resource and establish product certification or labeling systems so that consumers understand and value what the concept represents. For the consumer, the product eco-cycle represents a change in lifestyles, away from purchasing one-trip product to value-add reuse. This would encourage a reversion to old fashioned values of 'saving and conservation' which will make for a more sustainable economy in the long run.

The product eco-cycle model creates a number of business opportunities.

Product Eco-cycle stage	Business Opportunities
'Second Life'	Testing laboratories to verify that the performance of 'second life' products meet adequate performance standards. In particular, the role of standards testing laboratories is essential to ensure that second life products and materials are just as good as the original ones.
Point of sale	Enterprise Resource Planning (ERP) and systems experts to plan and forecast sales
Reverse supply chains	Logistics companies to sort, collect and return the post-consumer products back to manufacturers.
Secondary manufacturing	Process engineers and product designers to design machine tooling and products, respectively. Material technologists to identify better materials, which can be introduced into the manufacturing process.
The recycling sector	Consultants to introduce eco-efficiency and socially responsible as well as innovative practices.
For market re-entry	Marketing and branding companies to promote consumer demand for remanufactured and reconditioned goods.

The key to unlocking the potential of the circular economy lies its ability to link up separate parts of the value chain. Such a linkage allows spent resources from primary markets to feed back into the same primary production chains. The value chain should be a preference rather than turning to lower value secondary markets.

Conclusion

The Product Eco-cycle model is proposed as a way to apply the circular economy to Malaysia. The key to unlocking the potential of the circular economy lies its ability to link up separate parts of the value chain. Such a linkage allows spent resources from primary markets to feed back into the same primary production chains. The value chain should be a preference rather than turning to lower value secondary markets.

Companies need to look beyond short-term objectives and make business investments in retooling machines, building new distribution and logistics arrangements as well as retraining staff. The starting point should be for products with a medium life span – longer than a single use but short enough for reuse and remanufacturing. In doing so, company-to-company cooperation must be established.

Also governments must:

- Remove subsidies that encourage excessive use of resources.
- Enforce sorting and separation to create the right material streams for the circular economy to work.
- License the recycling industry to remove 'rogue' traders.
- Provide land and resources for the private sector to set up the value chains needed for circular economy practices.
- Educate the public on the need for managing resources.
- Establish product certification or labeling systems so that consumers understand and value what the concept represents.

For the consumer, the Product Eco-Cycle represents a reversal in lifestyle away from purchasing one-trip product to value-add reuse. This would encourage a reversion to old fashioned values of 'saving and conservation' which will make Malaysia a more sustainable economy in the long run.

8 LIVING LAB UPDATES

Segregating Waste

Waste segregation is slowly becoming a problem in many households in Malaysia. Many people seem to fail to see the importance of sorting household waste and this affects the efficiency of waste collection. Most also lack the tools sort their waste as only one waste bin is provided to each household by the municipal council. As part of KLCSI's plans for an innovative food recycling scheme in PPR Intan Baiduri, Kepong, we have proposed a plan to conduct a field test over a period of two weeks at the area. This field test is scheduled to be conducted in Block B of PPR Intan Baiduri which houses 320 residential units.

The prime focus of this field test is to demonstrate if the residents are capable of voluntarily sorting their own household waste when proper incentives are provided. KLCSI will also compute the waste data as well as the compost data at the end of this field test. KLCSI will collaborate with BASF to provide compostable bags for each residential unit in the project. These compostable bags are specifically designed to compost as they are made of materials that will break down into "humus" which provides nutrients to the soil. The proposition is to get the residents themselves to segregate their household waste (i.e. the wet food waste and the dry inorganic waste) and to place their food waste into compostable bags. Assigned cleaners will then collect the food waste left outside each household unit and send them to a designated collection point. The results of this field test would unveil the amount of food waste the residents produce in a day as well the amount of compost that can be generated from the accumulated food waste over a period of 2 weeks. Additionally KLCSI would be able to uncover the amount of tipping fee that can be saved annually and the amount of methane gas emissions from landfills that can be reduced if food waste is recycled and turned into compost.

The aerial view and site view of PPR Intan Baiduri

Elderly Day Care Community Centre

As Malaysia is fast approaching ageing nation status, there is an urgent need to push the conversation into actionable and practical solutions. As mentioned in our previous issue, the Elderly Day Care Community Centre model proposed by KLCSI is designed around the intergenerational community type of living concept. KLCSI believes that issues surrounding housing for the elderly should not be viewed in isolation and thus the proposition to place the younger and the older generation in one centre is to address this by allowing them to interact with each other and overcome some of the common challenges that the elderly face.
For one, this will help reduce isolation among the elderly as the younger community would be able to provide companionship. The centre also incorporates green features and facilities to will encourage active ageing. The use of green features in the design is significant to KLCSI as they showcase sustainable concepts such as energy efficiency, urban gardening, rainwater harvesting and sustainable building materials.

The winning design of the Aged Care Community Centre by KIRK.

KLCSI launched an innovative building design competition at the beginning of the year to seek innovative new ideas for the proposed centre. Four architecture firms took part in this competition. The design competition evaluation was held on 8 of August 2016. The panel of judges included Tan Sri Dr Ahmad Tajuddin Ali, Chairman of UEM Group Berhad, Dr. Thomas Tang, Managing Director of KLCSI and Dato' Mohamed Marzuk Basir. After careful deliberation, KIRK AUD Sdn Bhd was announced as the winner.

As a follow up to the design competition, KLCSI organized a design exhibition and networking event called "Helping Malaysia Age Gracefully" on 17 of August 2016. The objectives of this event were to showcase the winning architect's design and to get the various stakeholders together to allow them to exchange ideas. Further to this, KLCSI conducted a roundtable workshop on 22 of September 2016 focusing on 'Services for an Aged Day Care Centre'. The participants consisted of aged care service providers, architects, academicians and private operators. The views of the participants covered topics such as healthcare, social integration, learning and advisory services. KLCSI is currently looking for potential sites to build the Aged Care Centre.

Urban Mobility

Urban mobility is one of the toughest challenges that cities face today. KLCSI recognizes this challenge and as such is exploring a new "multi modal transportation solution". This solution aims to facilitate travelers' daily journey from home to major transportation hubs using cycling as an alternative mode of transport. The target groups for this new transportation modal are the daily commuters and cycling enthusiasts. KLCSI hopes to achieve this by providing bike stations at major transportation hubs such as the MRT/LRT/KTM Commuter and Monorail stations.

These bike stations will provide a safe place for cyclists to store their bicycles to ensure protection of bicycles against theft, vandalism and bad weather. These bike stations also aim to provide amenities such as restrooms, showers, changing rooms, day-use lockers, bike rentals and repairs, retail sales and bicycle accessories as well as electric bike charging systems. KLCSI anticipates that with the construction of bike stations across all major transport hubs in the Klang Valley, it will attract more recreational cyclists to join the commute-to-work community and provide space for social interaction as well as enhancing a positive cycling culture.

As mentioned in our last issue, KLCSI has also taken further steps to promote cycling as an activity in the island of Labuan, located off the coast of Sabah, West Malaysia. On behalf of the Labuan Corporation, KLCSI conducted 'Labuan Bike Share Outreach Workshop' on 14 October 2016 at UTC Labuan. The purpose of the event was to identify the challenges of cycling in Labuan and ways to promote more use of bicycles on this island.

KLCSI acknowledges that this effort is imperative in shaping the mobility ecosystems of today and the future. This concept is in line with one of KLCSI's vision which is to enhance urban mobility connectivity while also promoting a healthy and sustainable living to achieve a better quality of life.

9

NADI KOTA

Some of the memorable things that the team has been up to over the past few months.

October

KLCSI was in Labuan to conduct a stakeholder workshop on the Labuan Cycle Project which has been created to encourage the use of bicycles on the island. The island is flat, distances are short and the scenery is spectacular making this place perfect for cycling!

September

KLCSI took part in the launch of the Social Progress Network Malaysia initiative at Akademi Kenegaraan BTN on 9 September 2016. Social Progress Network Malaysia is a collaborative action network with members from government, business, academia and civil society, with the mission to see social progress sit alongside economic prosperity as a measure of a country's development. The launch was officiated by YBhg Tan Sri Dr Mohd Irwan Serigar Abdullah, Secretary General of Treasury, Ministry of Finance Malaysia, and involved key government and corporate officials, selected civil society representatives and members of the media. KLCSI is a founding member of Social Progress Network Malaysia

August

KLCSI signed a memorandum of understanding with LA21 Kuala Lumpur Chapter to be part of the 'Kebun Kejiranan' initiative in KL. This prestigious was event hosted by KL Mayor YBhg. Datuk Seri Hj. Mhd. Amin Nordin bin Abd. Aziz as well as numerous guests of honour. The MoU kickstarted KLCSI's food waste recycling and urban farming project at PPR Intan Baiduri which began in September 2016.

July

KLCSI went on BFM radio as part of a panel on the topic of Smart Cities. We shared the studio with Datuk Mohd Yusoff Sulaiman, CEO of the Malaysian Industry Government Group for High Technology (MIGHT). KLCSI spoke about how smart systems needed to be able to share data in order to be more citizen-centric and serve communities, in addition to meeting basic functionality requirements. Besides discussing how other cities fared in terms of smart performance, the panel also covered local issues such as traffic, walkability, waste and water.

KLCSI
KUALA LUMPUR CENTRE FOR SUSTAINABLE INNOVATION