APRIL 2020

WAYS OF THINKING: ENCOURAGING A SHIFT IN MINDSET

Reflecting Cities: Connecting for Sustainability – Planning in complex environments

ICLEI Local Governments for Sustainability

Robert Bosch Stiftung

This document showcases a variety of methods and approaches that support city officials in institutionalizing spaces for reflection. They include adopting new approaches to creating solutions such as systems thinking, people-centred planning and dialogic over didactic engagement.

A SYSTEM IS AN “INTERCONNECTED SET OF ELEMENTS THAT IS COHERENTLY ORGANISED IN A WAY THAT ACHIEVES SOMETHING – A FUNCTION OR PURPOSE”

(Meadows, 2009)

1 SYSTEMS THINKING

A system is an “interconnected set of elements that is coherently organised in a way that achieves something- a function or purpose” (Meadows, 2009). The interactions between elements in a system result in predictable and unpredictable behaviours and outcomes that are observable.

Natural and physical sciences (or modernist perspectives) have typically suggested that to understand something, one must take it apart to examine. For example, they suggest that we can understand how a watch works by taking it apart and seeing how the cogs, arms and face fit together. Everything can be understood as the ‘sum of its parts.’

Systems thinking helps to understand multiple layers of cause and effect by considering the type of interactions which reinforce system behaviours, outcomes or problems. This means that it is important to understand how systems behave and how they react in response to ongoing processes, interventions and system changes. Systems can then be nudged/manipulated in a variety of ways that result in different behavioural outcomes. Applying a systems thinking lens enables people to identify the elements that make up a system, to understand how they interact, influence and impact each other, and, therefore, to address any system failures, as opposed to treating mere symptoms. Systems thinking can also contribute to the anticipation of events, allowing for the development of proactive plans and actions, rather than simply reacting to system changes.

However, understanding system behaviours requires more than examining its constituent parts. Dissecting a watch offers limited insight into how its energy source, mechanisms and arms *interact* to result in a movement of the arms across the face. Further, this approach provides no insight into the concept of time, and how the watch owner interacts with it.

1.1 Key concepts for systems thinking

Understanding how systems behave is necessary for planning and decision-making in business, government and daily life. Much of the way we navigate the world is through embedded assumptions about cause, effect and feedback, each of which is explored below. Shifting from an intuitive or assumptive understanding of systems to a more purposeful approach can improve people's confidence in decision making and improve anticipatory or preventative actions, particularly as systems become larger or more complex, and show fewer predictable behaviours.

Systems thinking is a necessary approach to most urban challenges. Key concepts that define this body of thought are illustrated in **Figure 1** and described briefly below.

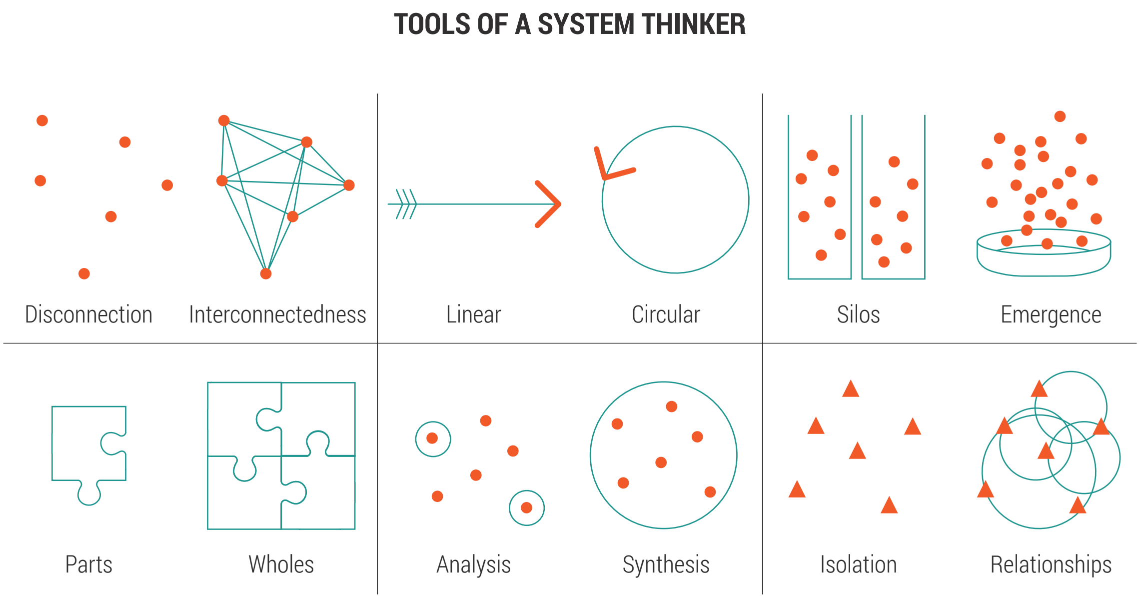


FIGURE 1: Tools of a systems thinker (Source: Adapted from Arcaroglu, 2017)

Interconnectedness refers to the interaction between elements of a system. When elements interact, there are expected and unexpected occurrences that determine how the system works, changes and influences other elements and the whole system. At its essence, systems thinking focuses not on parts, but on the whole, particularly with an examination of relationships between elements.

Uganda: Cities collectively applying systems thinking approaches to complex urban challenges

This may be understood using the example of a tree. A tree does not exist on its own, but as part of an ecosystem, relying on many other elements and systems that ensure its survival. These include above-ground factors such as atmospheric conditions, precipitation and the sun, and underground systems, such as micro-organisms that provide the tree with nutrients that ensure its growth. If the ground conditions change due to, for example, groundwater contamination, this affects the tree's growth, and ultimately, its survival.

As described here, relationships are typically based on cause and effect. Causality explains how one action results in another. Understanding the paths of causality is important in attempting to address problems or change systems, as any changes may result in new causal pathways. While it is possible to trace causes and effects a few steps, as systems become larger, the results of certain actions become less obvious or easy to trace. This means that actions taken with the best intentions can have unexpected consequences that can either exacerbate a problem or lead to different problems or outcomes.

Causal relationships in a system are typically not linear but circular, resulting in system feedback. For example, a tree is not only influenced by external elements but affects them too. Feedback loops take two forms, namely reinforcing and balancing: reinforcing loops occur when interactions between elements in a system reinforce more of the same behaviour and outcomes. Population growth is an example of this – as more people have children, there eventually are more people to have children, resulting in a reinforcing loop that increases the size of the population.

Balancing loops are important to maintain a dynamic equilibrium as they are goal-seeking and inhibit further increases or decreases in a given direction. They seek to bring systems to a desired state and keep them there. For example, deaths produce balancing behaviours in a population. The more deaths there are, the smaller the population becomes. However, the smaller the population is, the fewer deaths there are, suggesting the population can grow – as it does so, there are more deaths, and so on. "We can observe, understand and intervene in feedback loops once we understand their type and dynamics (Acaroglu, 2017).

> WE CAN OBSERVE, UNDERSTAND AND INTERVENE IN FEEDBACK LOOPS ONCE WE UNDERSTAND THEIR TYPE AND DYNAMICS
> Acaroglu, 2017

Emergence is the outcome of the relationships in a system. Systematic interactions or interactions between parts may result in, occasionally intangible phenomena called emergent properties. For example, an emergent outcome of the interaction between a bicycle and a person could be transportation. This emergent property cannot exist if the person and bicycle do not interact. Urban mobility can be seen as an emergent property of the relationships between people, bicycles, metro busses, taxis, motorbikes and other forms of transport, land-use planning and policy that regulates transport. As another example, communication emerges when two people converse, either in person, or through electronic communication devices, a telecommunications network, an energy grid and/or regulatory policies.

Systems exist at multiple scales and levels and systems within systems result in multiple layers of behaviours. This hierarchy, or nesting of systems, is observable in the example of a tree in, as it showcases many systems within systems – these could be cellular interactions that make up the process of photosynthesis or interactions between the tree's roots and mycorrhizal fungi which assist in drawing nitrogen closer. A tree may also play an important role in larger systems, reducing carbon dioxide in the atmosphere, providing shade or fruit, or combining with other trees in a forest to impact local climates and habitats.

Typically, analysis is used as a method to solve problems. However, this is a reductionist approach that leads to a focus on the components, rather than the entirety of a system (components, their interactions and the emergence of properties are part of a whole). Analysis reduces understanding to a part and therefore misses many causal interactions and emergent properties in its findings.

Synthesis, on the other hand, takes the opposite approach in seeking to understand a problem by the aspects that come together to produce the system's outcome. Such an approach examines system components and interactions without losing sight of the whole, placing particular focus on emergent behaviours and outcomes.

1.2 Complex systems

When examining systems, it is often tempting to call them complex if it is impossible or difficult to understand their behaviour. However, not all systems are complex – for example, the interaction between a person and their bicycle is simple, with several predictable behaviours. Add a tree into this system and it remains simple, with the outcome that the cyclist either avoids crashing into it, or doesn't.

Complex systems are difficult to define due to the intricate dependencies and interactions between their different elements. These are ever-changing, which further complicates them. However, Cilliers (1998), has identified some distinct properties that may define complex systems. In his view, complex systems:

- consist of a large number of elements at multiple levels
- are constantly in flux or states of change
- show diverse forms of interaction between elements
- are self-organising, showcasing interactions that are non-linear and asymmetric, usually occurring across different layers of influence
- have fairly short-range interactions between elements; however, what happens locally can have global impacts, and vice-versa
- show constant feedback in which information passing through loops is formed and transformed as it produces new outcomes
- are open systems, meaning the elements within the system have many relationships and interactions to other systems
- operate under conditions far from equilibrium
- have histories, understood as the collection of traces distributed throughout the system that provide insight into past events, how they affect the present and how future conditions can be influenced
- Are comprised of individual elements that are ignorant of the behaviour of the whole system in which they are embedded, may not always view the entire system and consider it to be a whole because they cannot see it

Regardless of whether a system is complex or not, it is important not to avoid decision-making or intervention because of a perception of complexity, uncertainty or difficulty.

1.3 Systems thinking tools

Having explored briefly the concepts and ideas that make up systems and systems thinking, and noting that the latter requires a certain level of comfort with 'uncertainty', this section describes several tools for doing (*undertaking*) systems thinking. These can improve confidence in recognising, understanding and influencing system behaviours.

1.3.1 The Iceberg Model

The Iceberg Model is a high-level approach to investigating systems. This tool is beneficial in attempting to understand the patterns of behaviour, supporting structures and mental models that shape a particular event so that interventions extend beyond being merely reactive to tackling the entire system instead. The model uses the analogy of an iceberg which only has the tip of its structure visible above a body of water, and most of its mass hidden. The greater mass of the hidden part greatly influences the iceberg's behaviour at the top. However, this top is generally the only part that is seen and interacted with and therefore the entire system or story is not engaged with. The Iceberg is made up of four aspects, which are shown in **Figure 2**.

THE ICEBERG MODEL

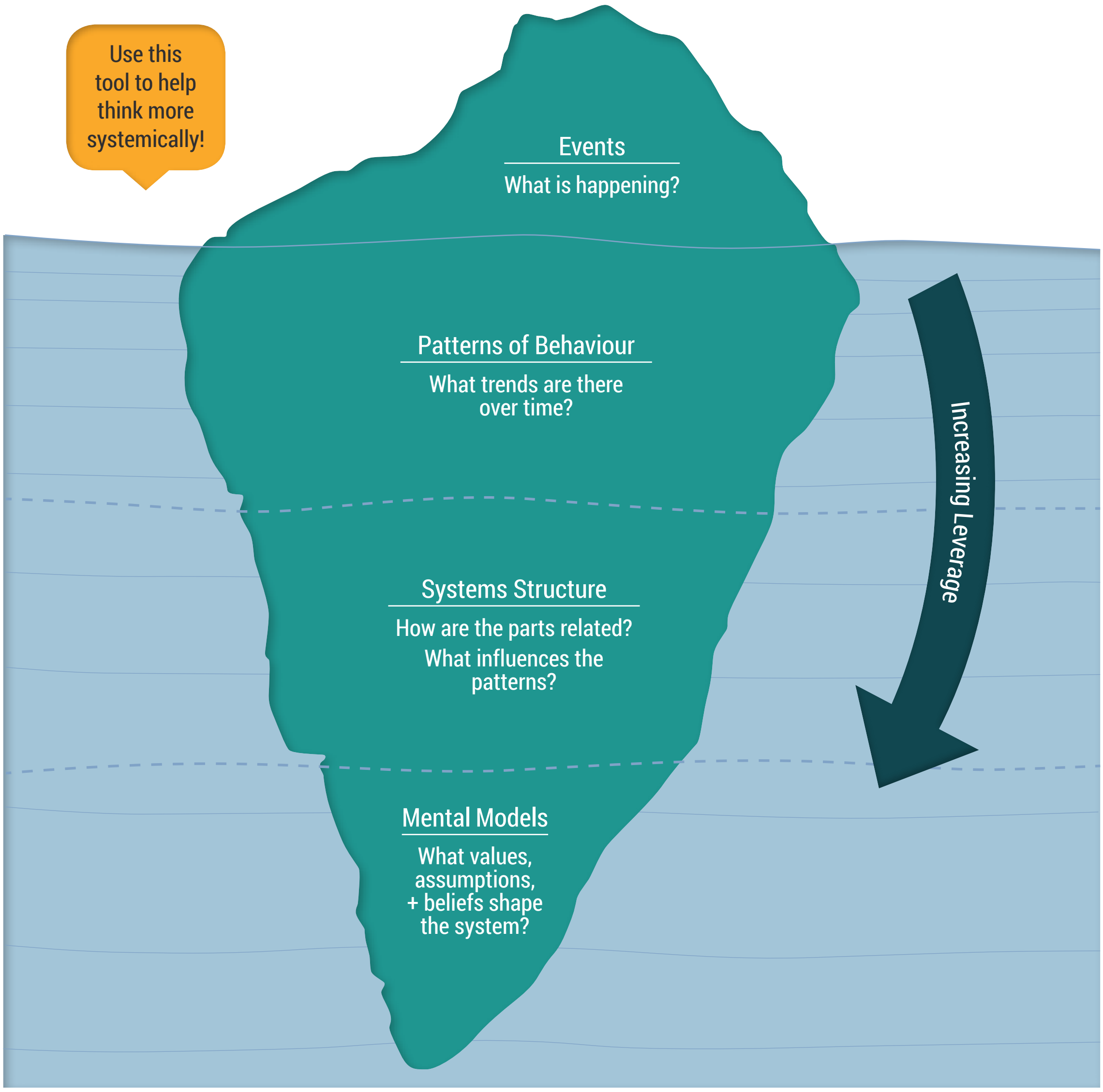
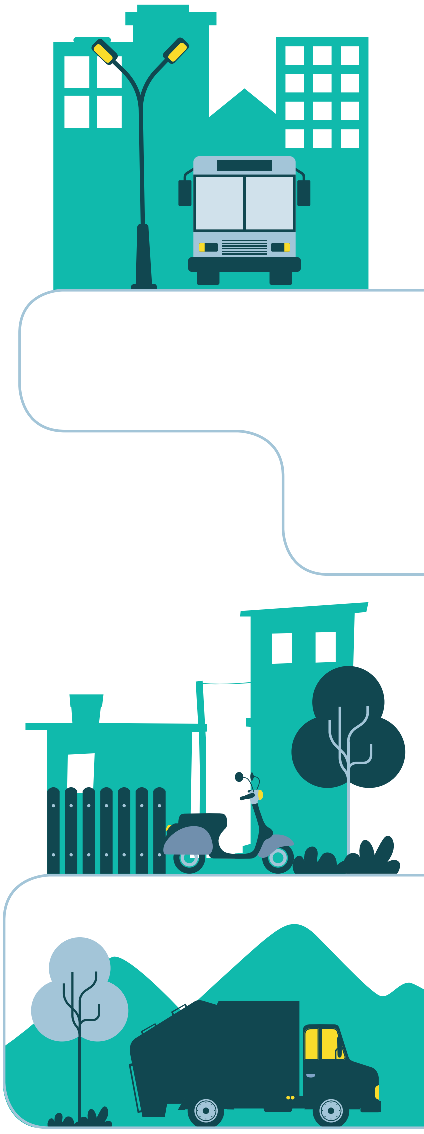


FIGURE 2: The Iceberg Model (Source: Adapted from Academy for Systems Change, 2019)

Events: Representing the visible part of the iceberg, these are occurrences that are either perceived or experienced. Attempts to address perceived problems may focus on addressing a symptom or a single aspect of a larger system. For example, we may notice that there is traffic on a road. If we rely solely on this information, we may send a traffic officer to manage an intersection and potentially improve the flow of traffic.

Patterns of behaviour: There may be a number of similar events that have occurred over a certain period. When it is possible to observe patterns/trends in these events, we can make associations that allow us to anticipate future events. For example, we may observe that most traffic accidents occur when it rains.



Systems structure: This aspect describes the relationship between events and system elements. Understanding a system's structure involves identifying the causal relationships that influence events and result in observable patterns. Returning to the example above, we may investigate why there is more traffic when it rains and discover that drivers are more cautious and drive more slowly due to a loss in visibility, or that parts of the road experience flooding due to poor drainage, requiring them to find alternative routes. In both examples, placing a traffic officer at the intersection may not affect the occurrence of congestion or reduce accidents.

Mental models: these are the often subconscious assumptions, attitudes, beliefs or values that shape how a system functions. A valuable step in a systems thinking process is to articulate the assumptions that inform how we interact, purposefully or intuitively, with a system. This is important in enabling us take actions with an improved understanding of the potential impacts.

The Iceberg Model is a useful tool for developing lasting solutions that target the whole system. It illustrates the relationship between what we notice (the event/s) and their cause as well as how people interact with the system as a whole.

Lilongwe, Malawi: Cities are characterised by various modes of transportation

1.3.2 Systems mapping

A systems map captures all of the immediate and extended components within a system's environment by making it possible to identify them. This invaluable tool is also used to capture the understanding of several people about a situation and organise their thoughts.

A systems map illustrates the following:

- *A system boundary,* which limits investigation into a chosen system context. Occasionally, it may be defined as phases in the life cycle of a system or the entire life cycle
- *Major components* (subsystems), which are typically a combination of actors and functions. These can be people, tools or processes that are vital to the functioning of a system and may vary along different stages of its life cycle
- *System environments,* which include specific variables that define, enable or control the functioning of certain aspects of the system. Examples of such are policies and regulations, and demand and supply, among others
- *The relationships* between main system components, usually after grouping related components and determining the nature of their interactions and the boundary of the entire system

Systems mapping tools are useful for defining and understanding the life cycle of a process, the different pull and push factors, or the inputs and outputs with a system boundary.

1.3.3 Social Network Analysis

Social Network Analysis (SNA) is a tool for understanding stakeholder networks. It identifies the actors therein as well as their characteristics, such as titles, race, language, age and role in the network or organisation. It is also used to examine the state of the relationships between the actors, such as whether they communicate, collaborate, depend on each other, supervise, share, empower, employ, trust or use each other. Finally, it builds a qualitative or quantitative understanding of the state, structure or function of a network, highlighting its strength, diversity, density, modularity or degree of fragmentation.

SNA is valuable as solving complex problems requires an understanding of the network of actors who seek to address them – the ways in which we interact with others (network) impact on our ability to manage complex policy problems. SNA draws out unexpected results for those mapping networks and challenges expectations. For example, a formal organisational organogram may differ from the reality of who holds real decision-making or brokering power, as illustrated in **Figure 3**. Finally, SNA offers both visual and mathematical analysis tools for use.

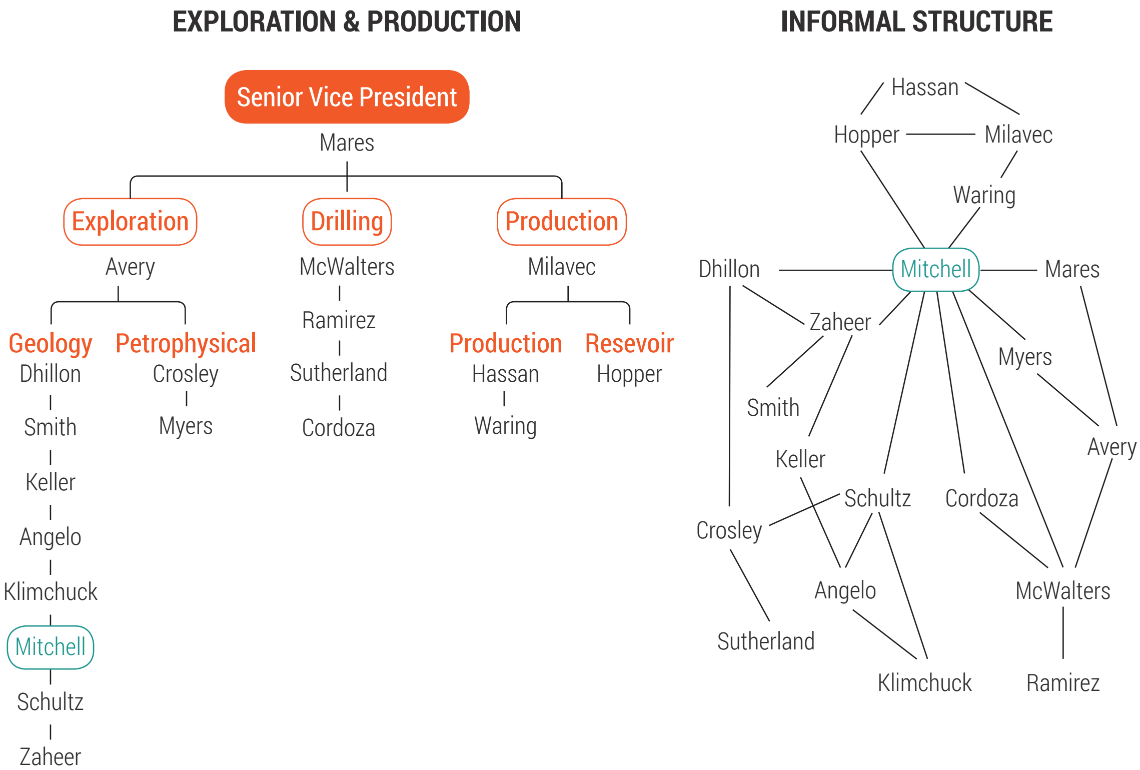


FIGURE 3: Example Organogram versus Social Network Map showing Mitchell as the person who holds the brokering power, despite being lowly placed on the organisational organogram
(Source: Adapted from Rob Cross: Organisational Network Fieldbook, 2010)

Another illustrative social network map is shown in **Figure 4**. The circles are called nodes, actors, vertices, individuals or organisations, and represent the people or ideas in the network; the colour and size represent the node's importance or an attribute that describes the actor. The lines are called edges, connections, ties, links or lines and represent the relationships between nodes; here too size can be used to show importance.

FIGURE 4: Illustrative Social Network Map

Lilongwe, Malawi: In order to tackle traffic management challenges, it is important to consider all elements in urban areas, including foot traffic, retail and recreation

1.3.4 A inity Diagram

An Affinity Diagram is an effective and powerful tool for generating, organising and communicating ideas about a complex problem when simple brainstorming, or agreement between contributors, is not possible. Creating an Affinity Diagram involves listing many ideas on separate notes before organising them into thematic groups. Ideas are arranged into themes through a two-step process of divergent and convergent thinking. The former style of thinking generates information and ideas about a problem or situation, while the latter organises, categorises and makes collective sense of them. This approach is illustrated in **Figure 5**.

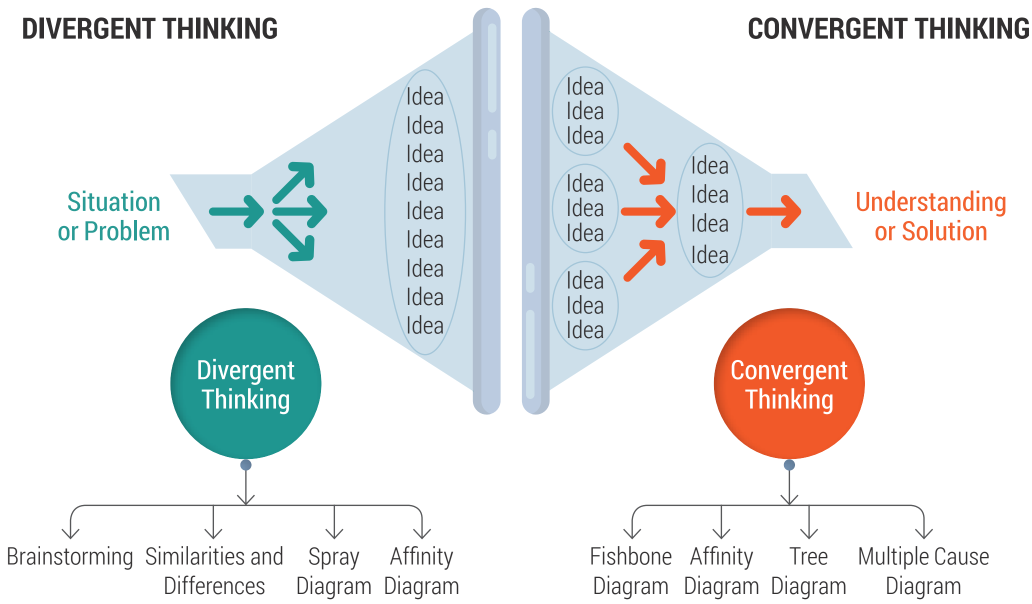


FIGURE 5: Convergent and divergent thinking with the aid of Affinity Diagrams (Source: Adapted from Burge, 2013)

Affinity Diagrams articulate and portray complex relationships using basic language and a simple process. The tool also allows for a participatory approach in which different members of a caucus can express their understanding of a situation in simple words, which can then be grouped and separated to propose a solution.

1.3.5 Ease-Bene it Matrix

Some solutions to problems may have a significant benefit but be difficult to implement, whereas others may offer fewer benefits but be easier to implement. An Ease-Benefit Matrix (which as an example is used to prioritise actions according to an organisation or individual's desired outcome and available resources). This simple decision-making tool illustrates trade-offs between various options and is used to compare the ease of actions and their potential benefit.

An Ease-Benefit Matrix uses circles or other shapes to represent options. Placing these shapes along two axes: 'Ease' and 'Benefit' allows them to be clustered. The matrix can be divided into quadrants which can be used to define or prioritise the options, as illustrated in in **Figure 6**. Ease-Benefit Matrixes are especially beneficial when evaluating situations in which several solutions can be adopted, helping to reduce a large number of options to the most impactful ones given available resources and timeframes.

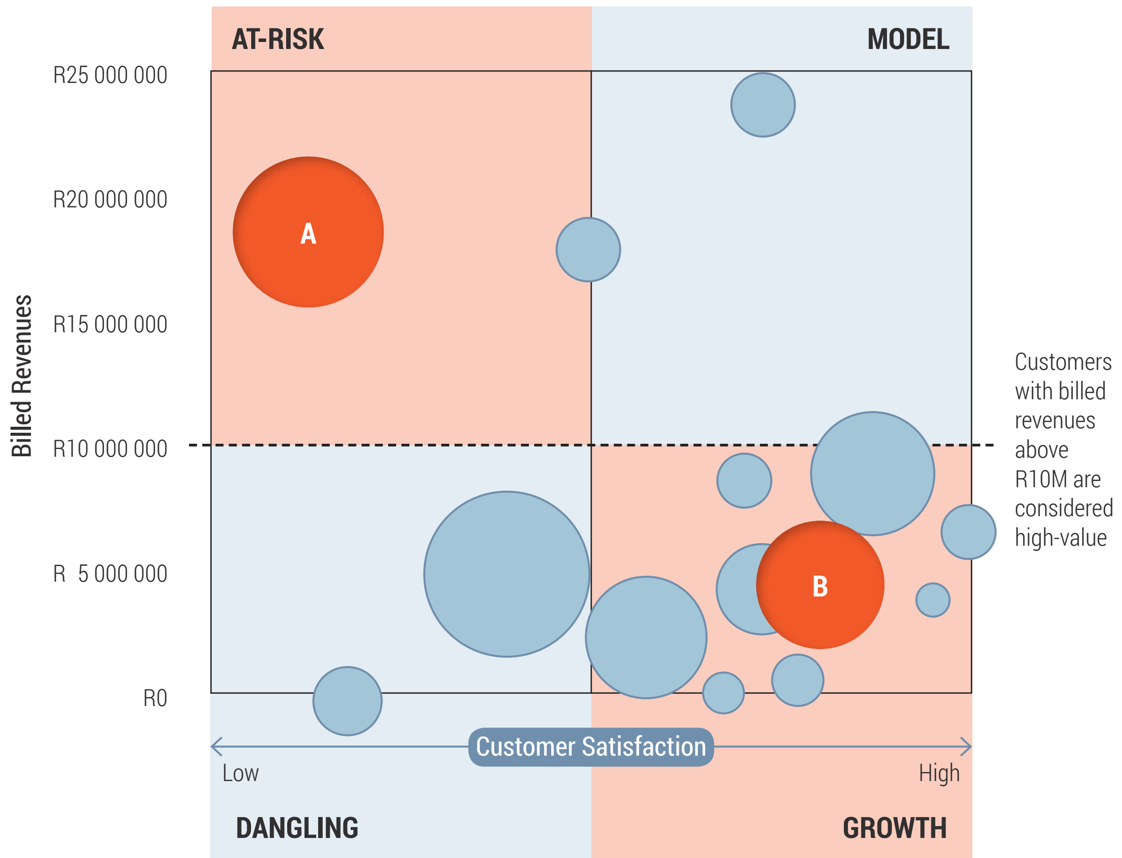
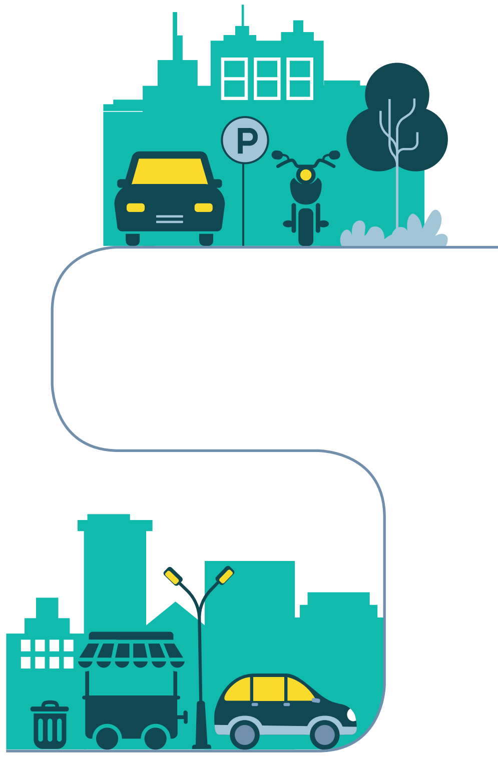


FIGURE 6: An Ease-Benefit Matrix for understanding customer experience (Source: Adapted from Schwager & Meyer, 2007)

1.3.6 Causal Loop Diagrams

Causal Loop Diagrams (CLDs) are used to map causal relationships between variables. They can be used for any theme or to map any interactions based on the assumptions (mental models) of the person or group using it. CLDs are useful provided the people using it have sufficient systems knowledge to make adequate causal links. CLDs are made up of the following aspects:

- Variables, which are elements or actions in a system
- Arrows, which connect the variables and can be either positive or negative (i.e. their 'polarity' – the effect of the first variable on the second.) A positive arrow means that the influenced variable moves in the same direction as the first (e.g. more 'private cars' lead to more 'traffic congestion'). A negative arrow means that the influenced variable moves in the opposite direction to the first variable (e.g. more 'convenient public transport' leads to less 'traffic congestion')
- Feedback occurs when a set of arrows returns to an initial variable. Depending on the polarity of the arrows, such feedback can either reinforce or balance the behaviour of the variables. For example, the following chain of variables shows balanced behaviour: 'enforcement of bylaws' leads to more 'relocation of street vendors', which leads to less 'illegal street vending' and fewer 'narrow roads', which lead to less 'traffic congestion' and 'more cars being able to access the city centre', leading to more 'illegal parking' and so on
- Delays are illustrated by two short lines across an arrow. As in the previous example, 'enforcement of bylaws' may only occur after a deferment caused by the observation of unmanaged traffic congestion, and may have a further delayed effect on 'discouraging the use of private cars.' These delays are important to consider when using CLDs for planning or decision support.



CLDs can be used to draw out the key assumptions of an individual or group and to visualise the relationships between variables and key feedback information. They are primarily used as a first qualitative model to illustrate the behaviours that can be expected from a system. Thus, they provide process learnings and can be used to make decisions.

2 SHIFT FROM 'SILOED' TO 'INTEGRATED' LAND USE PLANNING

2.1 Urban Planning tools

2.1.1 Land use planning

City planners designate 'mixed land use' areas in urban centres to provide for a variety of land uses including residential, commercial and industrial. This includes a provision for buildings or areas with mixed functions combined with various building types (dwelling types and densities) supported by sustainable forms of transport such as public transport, walking and cycling. Such areas have proven invaluable in providing a sustainable way of living for urban users/residents. Mixed land use developments enhance the economic vitality and perceived security of an area by increasing the number of pedestrians on the street and in public spaces, and if overlaid with sound transport plans, can save people travel time to access amenities. This in turn increases their personal productivity.

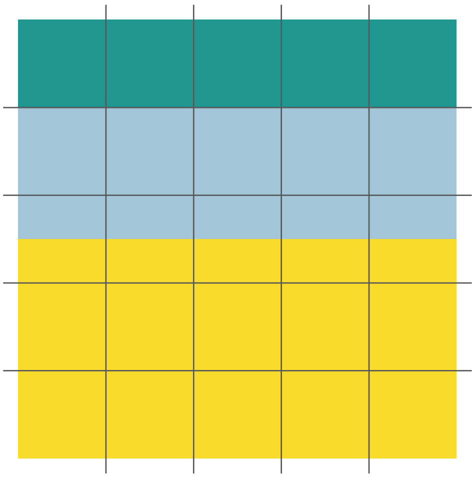
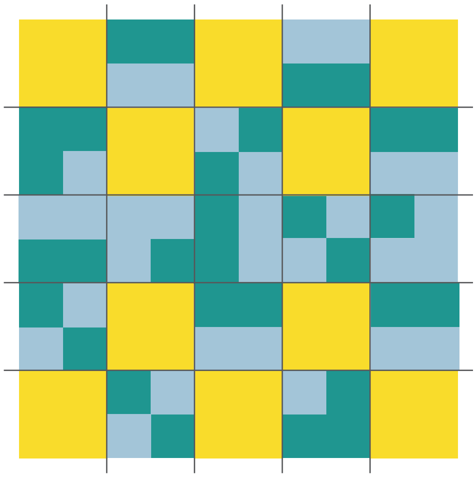
'SILOED' LAND-USE AREA	MIXED-USE 'INTEGRATED' LAND USE (Walkable distances are taken into consideration)
In the 'business as usual' scenario there is no integration of land uses. Most public amenities (schools, government institutions, shops etc) are not accessible by walking and users often have to travel long distances to get to them, often relying on private cars to do so. 	A best-case scenario is shown below. This makes provision for a sufficient land-use mix, taking into consideration walking distances and ensuring that trips to public amenities can be made on foot or by bicycle. These 'green' modes of transport are non-polluting and benefit the health of individual and the environment. 

FIGURE 7: 'Siloed' land-use area vs mixed-use 'integrated' land-use area

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