System Mapping

A Guide to Visualizing Complex Systems

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From Place to Experience

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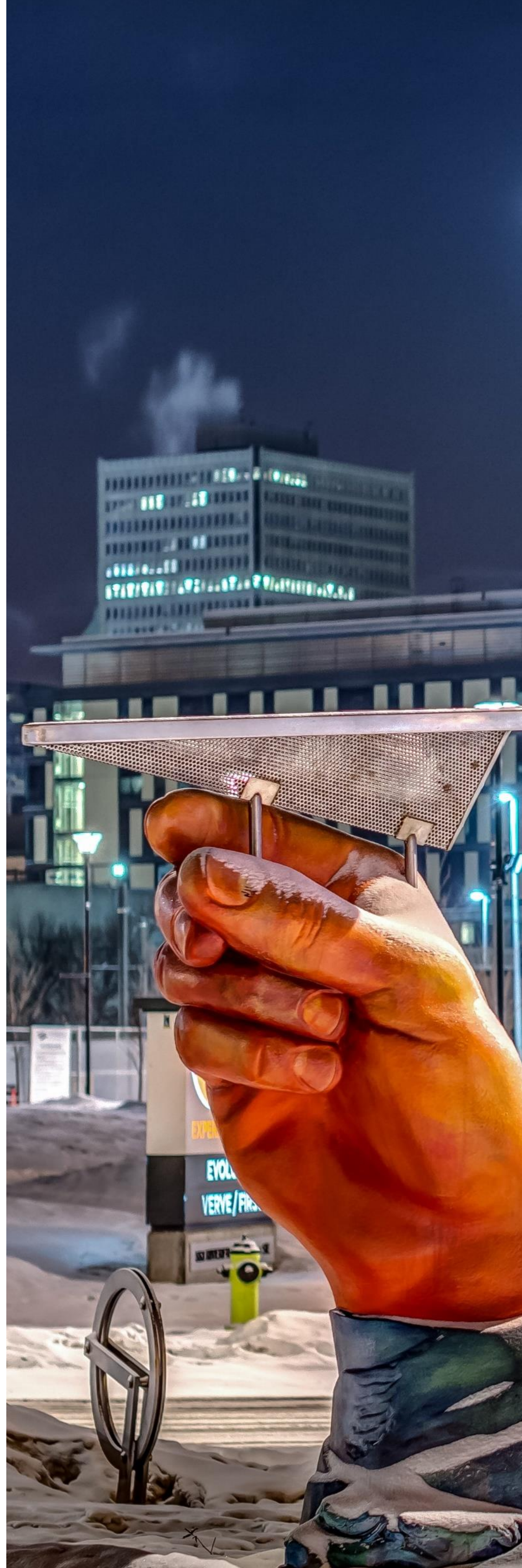


THE WORLD AS A COMPLEX SYSTEM

The world has always been complicated. But today, the world is not just complicated, it's complex. A complicated world is relatively stable and predictable. This predictability allowed us to make simple assumptions of causation - If I do *A*, then *B* happens.

However, a complex world is defined by volatility and uncertainty. This volatility demands we move beyond simply linear causation and adopt a system view, recognizing any outcome could be caused by an exponential number of interconnected variables. The result is decision-making that demands a new approach to problem solving – system thinking.

A system is a series of variables that interact to create new and sometimes unexpected outcomes. System thinking analyzes how the variables in a system interact to influence its overall behaviour and outcomes. System thinking is simple in principle that most people find difficult to adopt in practice. This is because system thinking reframes the principle of causation. We are taught a way of thinking about causation from childhood, which is reinforced to become unconscious. This is because for most decisions we choose simplicity, intuition and speed over slow deliberation. As a result, we prefer to break big problems into a series of smaller and more manageable problems. This pursuit of simplification and speed contributes to a desire to isolate a specific cause that led to the defined effect.[1]

For example, let us consider a case study. In a test, student A received an A+ and student B received an F. In a search for simplicity, it may be easy to just assume that student A is more intelligent than student B. In some cases, this assumption may hold true; however, it is just as likely that this assumption is incorrect. Accepting an incorrect assumption is to be vulnerable to enormous consequences. If we step back and adopt a system view, we will see the problem far more holistically and see that the variance in grades is likely far more complex and multifaceted. Questions we could ask include:

- Is it related to a difference in study habits?
- Is it because student B volunteers 10 hours a week in their community?
- Is it because student A is from a family that can afford a tutor?
- Is it because student B isn't really concerned about their grades?
- Is it because student B has a learning disability that affects their ability to memorize raw facts?

In this example, there are an exponential number of potential inter-related variables that contributed to this test result, so simply attributing it as being rooted in intelligence, is not only likely incorrect, but it also contributes to poor decision-making and unintended consequences. The term *unintended consequence* is simply an excuse for those who do not have a system-level view.

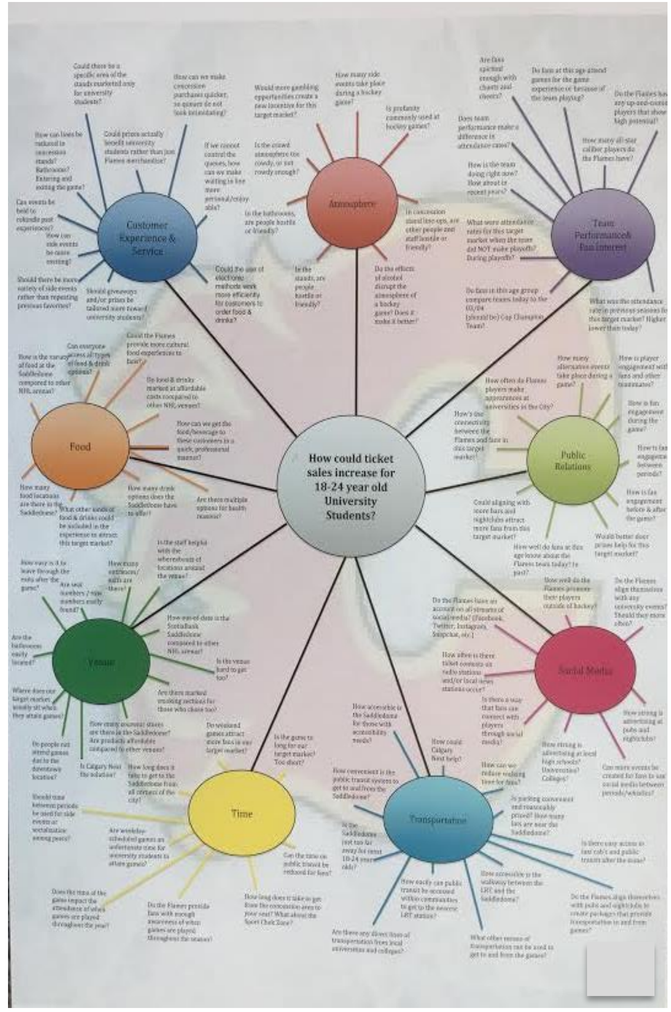
What system thinking demands is a greater focus on identifying problems, not answers. As Albert Einstein is quoted to have said, "If I were given one hour to save the planet, I would spend 59 minutes defining the problem and one minute solving it." Finally, theorist Peter Senge argued: "Business and human endeavors are systems…we tend to focus on snapshots of isolated parts of the system. And wonder why our deepest problems never get solved".[2]

"a complex world is defined by volatility and uncertainty. This volatility demands we move beyond simply linear causation and adopt a system view."

FROM SYSTEM THINKING TO SYSTEM MAPPING

System thinking emerged as a means to explore and map the interconnections of variables and explain divergent or unexpected outcomes. System thinking demands we consider the whole system and the internal and external forces shaping the system. One challenge of system thinking is the number of variables and inter-relationships that can become overwhelming and almost impossible for people to constructively debate as purely mental models. This is because our working memory limits us to processing a limited number of variables at one time.[3] To overcome this deficiency, system mapping was developed as a tool to visualize the interconnections between variables in a system. A system map is simply a diagram incorporating the variables and relationships between them in a defined system. As per the Figure-1, system maps can adopt many different visual formats.

> **How to Make Toast**
>
> For an effective example of the power of system thinking as a collaborative tool, see Tom Wujec's Ted Talk *'Got a wicked problem? First, tell me how you make toast'*.



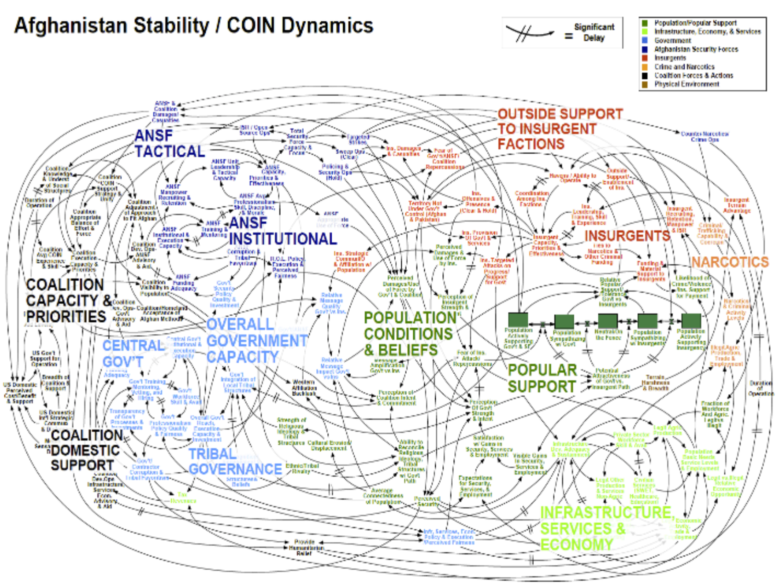


Figure-1: Sample system maps

> ***"System mapping…value is as a platform for generating debate and insights from a diverse range of perspectives on cause, effect, patterns and problem identification."***

As a strategic decision-making tool, its value is as a platform for generating debate and insights from a diverse range of perspectives on cause, effect, patterns and problem identification. Moreover, system mapping forces each of us from our discreet silos and embedded bias. In sum, system mapping contributes to strategic decision-making in six different ways:

1. **Problem Identification:** Provides a systems approach to problem identification and definition.
2. **Opportunities and Risk:** Provides a systems approach to identifying current or emerging opportunities and risks.
3. **Assumption/Hypotheses:** Provides a systems approach to articulating core assumptions or hypotheses.
4. **Impact:** Provides a systems approach to forecast cascading impacts of future decisions or scenarios.
5. **Strategy:** Provides a systems approach to develop an integrated strategy anchored to a defined goal.
6. **Collaboration and Decision Making:** Provides an effective storytelling platform to stimulate collaboration and decision-making.

HOW TO MAP A SYSTEM

Step 1: Define your system anchor

A system anchor is a concise articulation of the challenge or problem someone is trying to solve. For this reason, a system anchor is highly contextual and may take many forms. The ideal system anchor is precise and measurable. Precision provides a person with the ability to put a boundary around the problem.

For illustrative purposes, we will use the six steps to develop a system map exploring the variables contributing to an 18-24 year old Calgarian's decision to stay in Calgary. Figure-2 reflects this anchor.

Figure-2: System anchor

Step 2: Inventory development

A social system is composed of discrete variables ranging from people to organizations to competitive or environmental variables. A critical step in the process is identifying potential variables in the system. Variables may exist at macro, meso or micro-levels within the same system.[4] The CRESTED and SWOT tools are two examples that can be used to generate an inventory of potential variables for a system map. The weakness of these tools is that they provide limited insight into the interconnections between variables. Additional information for these two tools can be found in the appendix.

CRESTED: A CRESTED analysis extracts the competitive, regulatory, economic, socio-cultural, technological, ecological and demographic variables influencing a defined situation. [5]

SWOT: A SWOT analysis identifies the Strengths, Weaknesses, Opportunities and Threats both internal and external to an organization.[6]

During the development of a variable inventory, clusters will naturally start to form around major themes. Figure-3 is a simple illustration of seven clusters that emerged in the system map associated with an 18-24 year old Calgarian's decision to stay in Calgary.

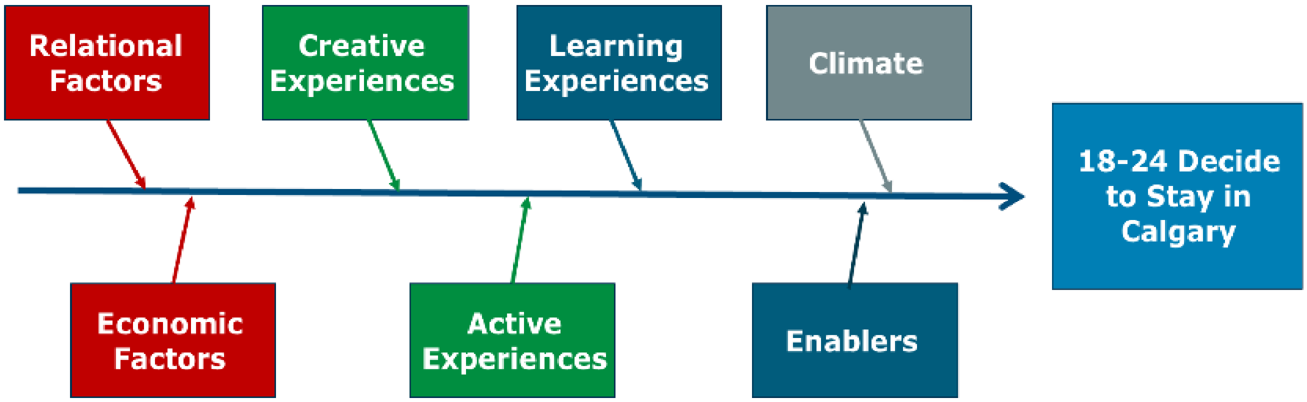


Figure-3: Theme clusters

Step 3: System hypotheses

Once an inventory of variables has been created, the next step is hypothesizing the interconnections between them and their potential implications to the system. This is called synthesis. The interconnections may be one-way, two-way (also known as a feedback loops) or they may be multi-directional (contributing to multiple interconnections). Questions to consider during this process include:

- What are the relationships between trends (e.g., technology, economic, competitive) and stakeholders?
- What are the formal and informal relationships between stakeholders and how do they influence the system?
- How do the motivations or drivers of stakeholders influence the system?
- What are the variables (e.g., media) that influence stakeholder attitudes?
- How do stakeholder attitudes influence behaviour?
- What is the relationship between behaviours and your anchor?

During this step, you may also identify connections with other systems, or subsystems within the system. Finally, it is important to remember that most of the interconnections will likely only be hypotheses as you may not have sufficient evidence to support conclusions.

Figure-4 is a sample illustration of the relational cluster that emerged in the system map associated with an 18-24 year old Calgarian's decision to stay in Calgary.

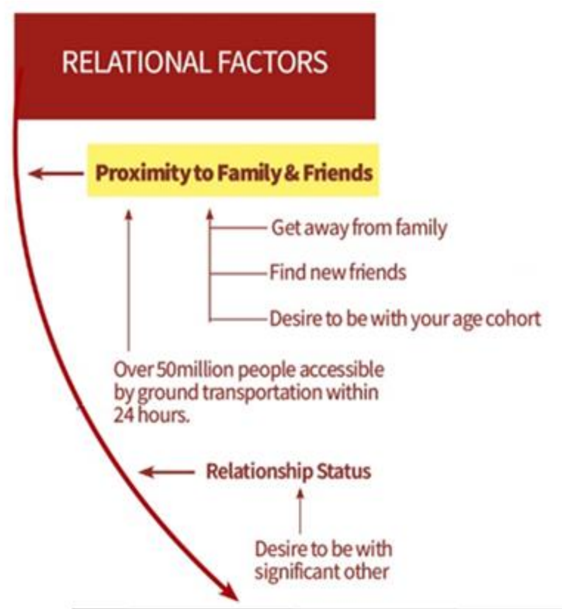


Figure-4: Sample interconnections

Step 4: Identify high-leverage points

The challenge with system mapping is the exponential number of potential variables in any system. It is rare to have the capacity to test every hypothesis in a system map. Rather, as your system map evolves, certain factors will emerge as "high-leverage" points. These are parts of the system that often have multiple and/or cascading implications on the overall system. Identifying high-leverage points allows individuals to shift from merely reacting to focusing on interventions in areas that will lead to transformative change.[7] The iceberg model in Figure-5, is a visualization for the importance of viewing a system as layered, ranging from simple observable variables (above the water line) to increasingly high-leverage patterns and structures that lie below the surface and contribute to systemic impact.[8] As you evaluate your system looking for high-leverage points, consider these questions:

> ***"Identifying high-leverage points allows individuals to shift from merely reacting to focusing interventions in areas that will lead to transformative change."***

1. Are there clusters of variables that appear to have system impacts (positive or negative)?
2. Are there variables that appear to have a unique "gravitational pull" in the system?
3. Are there variables or trends in the system that appear to repeat themselves and have cascading influence?
4. Are there elements in the system that rarely appear or are not obvious but have a disproportionate amount of influence?

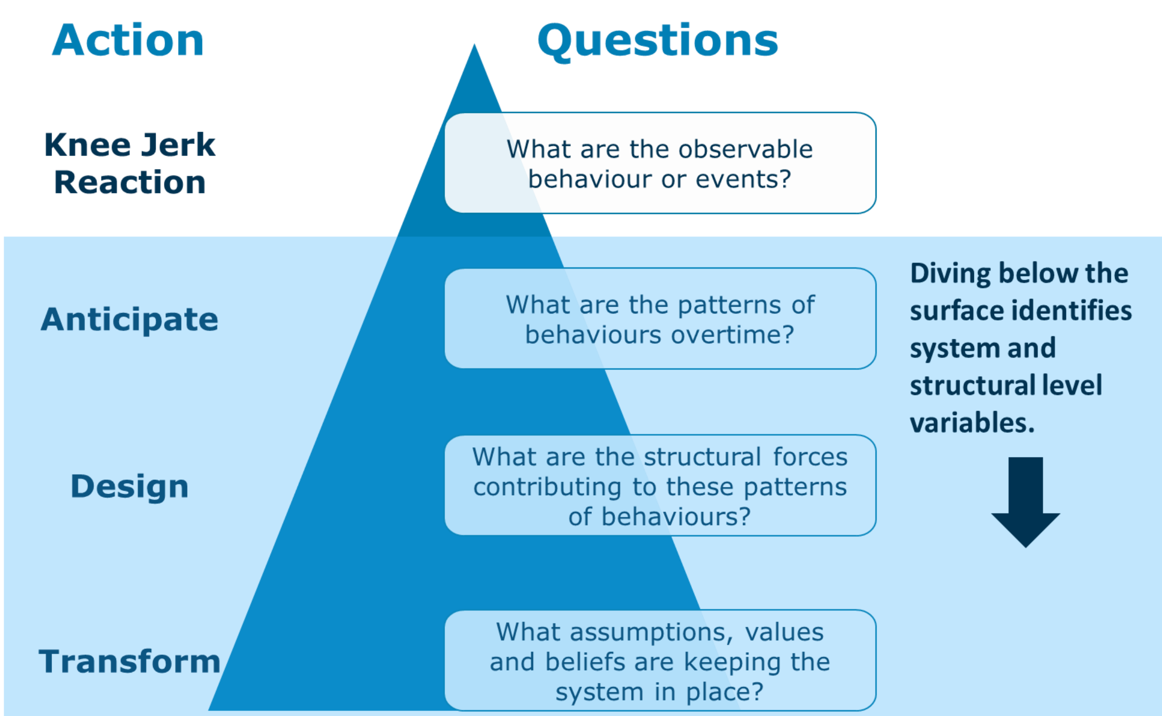


Figure-5: Identifying high-leverage variables through the iceberg model

This process will enable you to prioritize the hypotheses associated with high-leverage points. In addition, this process will contribute to identifying high-leverage stakeholders. These may be organizations or individuals who appear to have significant influence on the system. These stakeholders will also be contextual and could include employees, customers, competitors, funders, regulators, or suppliers.

Finally, a reminder that a system map serves multiple purposes, including as a tool to facilitate collaboration and as a storytelling platform. Therefore, your final system map does not necessarily need to include all of the variables in your inventory as it may dilute the effectiveness as a communication tool. As system maps are highly contextual, there is no "right" answer to how many variables should be included. This will depend on both the nature of the system and your audience. If you are concerned about the negative impact of reducing variables, one option is to develop subsystem maps to balance the need for detail and the need for clear communication.

> ***"System maps are highly contextual, there is no "right" answer to how many variables should be included. This will depend on both the nature of the system and your audience."***

Step 5: Test the priority high-leverage hypotheses

In the next step, you will test the validity of high-leverage hypotheses with triangulated evidence.[9] This evidence may include primary or secondary sources. At this stage you will also begin to identify approaches used to quantify or measure the high-leverage variables in the model. Based on the outcome of your hypotheses testing, your system map or the priority of your high-leverage variables may evolve.

Step 6: Extract strategic insights

Based on step 5, define the strategic insights that emerge from your system map and their implications. These strategic insights become foundational to prioritizing the allocation of resources to achieve the defined anchor.

One outcome of a system map may be to identify a need for a journey map. A journey map is a detailed system map at the level of an individual. For more information on journey mapping, refer to *A City as a Journey: Your Guide to Citizen Journey Mapping*.

Step 7: Iterate & Reflect

Systems are dynamic and constantly evolving. Therefore, it is essential for you to continually return to your map and re-evaluate changes and implications of new learnings.

Refer to Figure-6 on the following page for a sample of a full system map associated with an 18-24 year old Calgarian's decision to stay in Calgary.

What to Learn More?

Below are samples of additional resources if you would like to dig deeper into system thinking.

Johnson, A,. Papi-Thorton, D., & Stauch, J. (2019). *A Student Guide to System Mapping*. Mount Royal University. Available from https://www.mtroyal.ca/nonprofit/InstituteforCommunityProsperity/_pdfs/ssdata_icp_mts_2020.pdf

Policy Horizons Canada. Module 4: System Mapping. Government of Canada. Available from https://horizons.gc.ca/en/our-work/learning-materials/foresight-training- manual-module-4-system-mapping/

TED Talk by Eric Berlow on *Simplifying complexity*: available from http://www.ted.com/talks/eric_berlow_how_complexity_leads_to_simplicity?language=en or the article

Meadows, D. (N.D.) *Leverage Points: Places to Intervene in a System* available at: http://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/

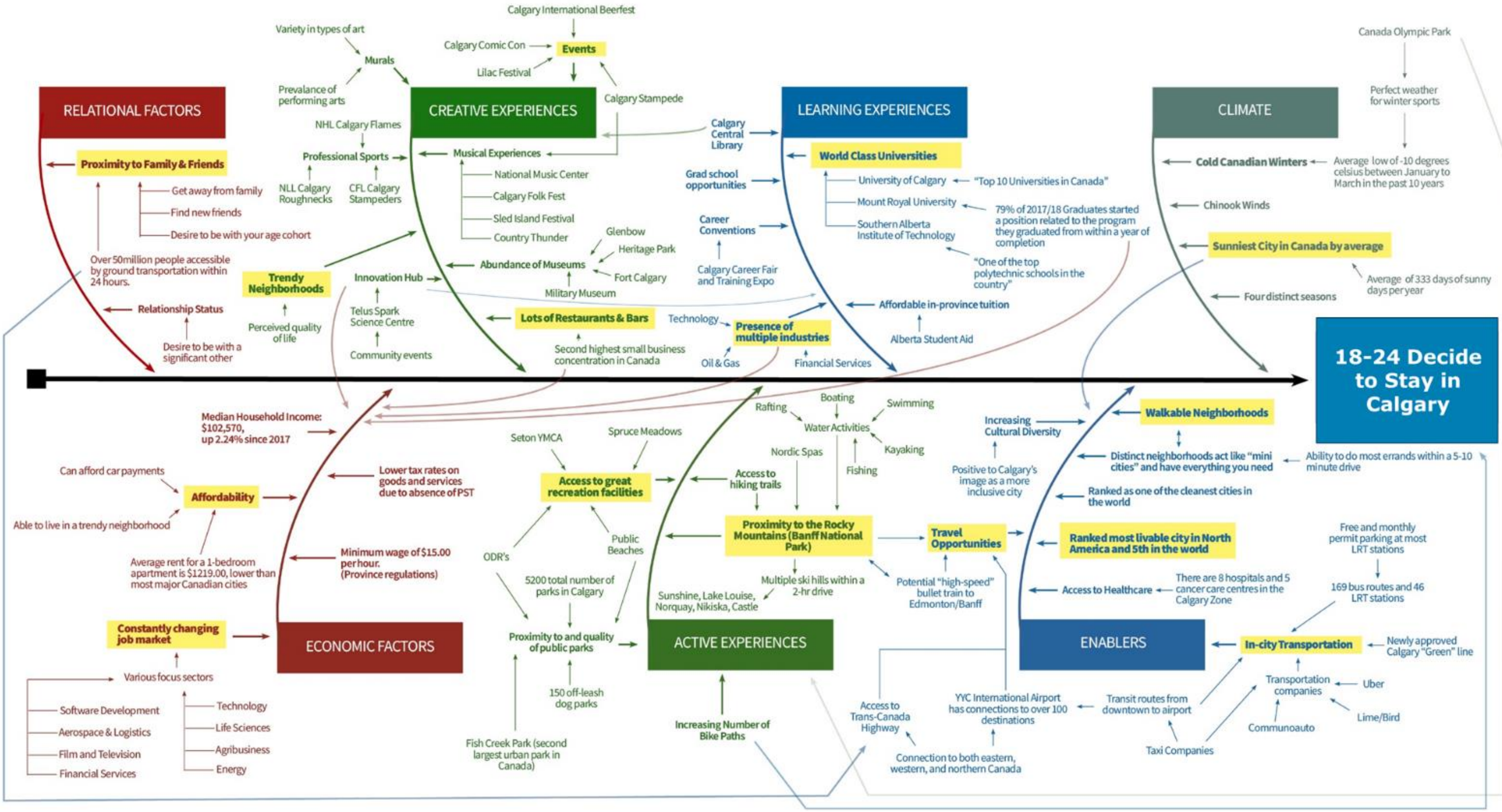


Figure-6: Sample full system map

APPENDIX – TOOLS FOR GENERATING SYSTEM MAP VARIABLES

Tool 1: SWOT

Strengths	Weaknesses
• What an organization does well • Areas of competitive differentiation • Resources available to an organization	• What an organization does poorly • Areas of competitive disadvantage • Resource limitations
Opportunities	**Threats**
• Underserved markets • Emerging markets for a product or service • Trends that may generate market opportunities	• New competitors • Changing market needs • Changing regulatory or political conditions • Changing customer needs • Trends that may generate a competitive threat

Tool 2: CRESTED Analysis

Competitive	Regulatory	Economic	Socio-Cultural
• Competitive dynamics • Product and services • Channel dynamics • Pricing dynamics	• Other legal dynamics that may influence contextual dynamics • Government policy • Trade policy • Political dynamics • Labour dynamics	• Economic growth • Inflation • Disposable income • Unemployment rate	• Lifestyle trends • Cultural dynamics • Ethnicity
Technological	**Ecological**	**Demographic**	
• Emerging technologies • Research & development	• Climate • Weather • Non-government organization pressure	• Age • Gender • Income • Family structure • Population growth	

REFERENCES

[1] System thinking has a long history in academia. For further information:

Johnson, A,. Papi-Thorton, D., & Stauch, J. (2019). *A Student Guide to System Mapping*. Mount Royal University. Available from https://www.mtroyal.ca/nonprofit/InstituteforCommunityProsperity/_pdfs/ssdata_icp_mts_2020.pdf

Sargut, G., & McGrath, R. G. (2011). Learning to live with complexity. *Harvard Business Review*, 89(9), 68-76.

Kaplan, R. S., Kaplan, R. E., Norton, D. P., Davenport, T. H., & Norton, D. P. (2004). *Strategy maps: Converting intangible assets into tangible outcomes*. Harvard Business Press.

Policy Horizons Canada. Module 4: System Mapping. Government of Canada. Available from https://horizons.gc.ca/en/our-work/learning-materials/foresight-training-manual-module-4-system-mapping/

TED Talk by Eric Berlow on *Simplifying complexity*: available from http://www.ted.com/talks/eric_berlow_how_complexity_leads_to_simplicity?language=en or the article

[2] Senge, P. M. (2006). *The fifth discipline: The art and practice of the learning organization.* Currency.

[3] Policy Horizons Canada. Module 4: System Mapping. Government of Canada. Available from https://horizons.gc.ca/en/our-work/learning-materials/foresight-training-manual-module-4-system-mapping/

[4] The recognition of levels or a nested system is also referred to as Panarchy. Please refer to Allen, C. R., Angeler, D. G., Garmestani, A. S., Gunderson, L. H., & Holling, C. S. (2014). Panarchy: theory and application. *Ecosystems*, 17(4), 578-589 available at, https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1126&context=ncfwrustaff

[5] Refer to: Ho, J. K. K. (2014). Formulation of a systemic PEST analysis for strategic analysis. *European Academic Research*, *2*(5), 6478-6492.

[6] Refer to Helms, M. M., & Nixon, J. (2010). Exploring SWOT analysis–where are we now?. *Journal of Strategy and Management*.

[7] For additional information on how to identify "high-leverage" points in the system, refer to: Meadows, D. (N.D.) *Leverage Points: Places to Intervene in a System* available at: http://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/

[8] Johnson, A,. Papi-Thorton, D., & Stauch, J. (2019). *A Student Guide to System Mapping*. Mount Royal University. Available from https://www.mtroyal.ca/nonprofit/InstituteforCommunityProsperity/_pdfs/ssdata_icp_mts_2020.pdf Adapted from Goodman, M. The Iceberg Model. Hopkinton, MA: Innovation Associates Organizational Learning, 2002; and Sweeny, L. and Meadows, D. The Systems Thinking Playbook. White River Junction, VT: Chelsea Green Publishing, 2010

[9] Triangulation leverages a minimum of three unique data sources on a single topic. Triangulation enhances validity and mitigates risk of conclusion.