A Systems Thinking approach for responding to the COVID-19 pandemic

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Introduction

The human, social and economic costs of the COVID-19 pandemic are enormous. It is paramount that effective control strategies are implemented especially in resource-poor countries to initially mitigate and finally control this novel infection. Systems Thinking is considered a paradigm shift in human thinking. It first appeared in the business and management arena but has spread to all disciplines or 'systems', especially when the human factor is a pivotal element, e.g., in social systems. It was first publicized by a Nobel prize winner, Professor Peter Senge in his book, "The Fifth Discipline" (*1*).

The World Health Organization (WHO) has in a recent landmark publication, as well as among some international experts, strongly advocated the employment of a 'Systems Thinking' approach in formulating plans for resolving complex social and health issues (*2*); this includes the fight against COVID-19 (*3*). Systems thinking is an indispensable tool for quality improvement (*4*) and has shown promise in the fight against Human Immunodeficiency Virus infection and Hepatitis C (*5*).

Understanding the concept

A system is defined as an entity with interrelated and interdependent parts that are working together to achieve a common purpose; health care is considered a system. At its core is the concept of components interdependence at multiple levels. Any change in one part of the system affects the part and the whole system. Areas where system interventions produce higher impacts (using an equivalent input), are termed strong-leverage points.

The COVID-19 pandemic has so vividly brought this systems interconnectedness to the forefront of human thinking. As a health-care issue, the COVID-19 pandemic resulted in unprecedented impacts on all domains of life – economy, entertainment, transport, education etc. Additionally, it highlighted another critical domain in the Systems Thinking mindset – the domain of 'unintended consequences'. The latter will inevitably materialize as 'side-effects' to any intervention used to control the pandemic. Examples are the negative impacts of social distancing, curfew, market closures, etc. on people's livelihoods, mental health, domestic violence and other non-COVID-19 medical ailments (*6–9*).

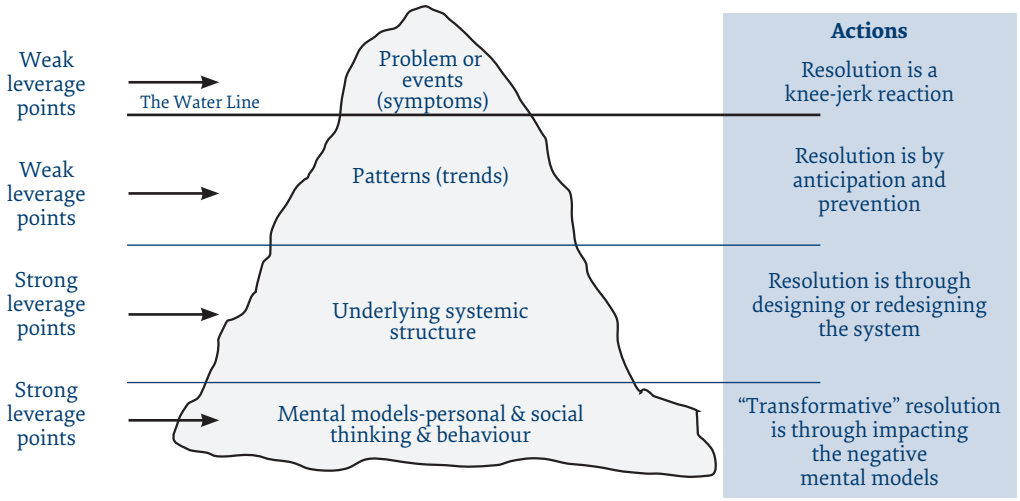
How to practice Systems Thinking?

Systems Thinking is a holistic approach to better understanding of how the system elements interact with each other over time, the root-causes of system defects, and the right approach for a highly effective problem-solving intervention (strong leverage areas). Systems thinking facilitates an in-depth understanding of system dynamics. Its tools enable its users to re-design their systems, thereby radically creating the results they truly desire thanks to a methodology for identifying the root causes and critically selecting and focusing on the right 'strong-leverage areas'. There are 5 pivotal steps in Systems Thinking: 1) root cause analysis, 2) selection of and focusing on strong-leverage areas, 3) system design or redesign coupled with 4) measures to nullify the impact of any unintended consequences resulting from these interventions and 5) continuous learning and improvement from the whole exercise.

One simple tool for identifying and categorizing the root causes, thus pinpointing the leverage areas, is the Iceberg Tool (*10*). The latter stratifies the issue or problem under consideration and its root causes into 4 elements: 1) the event (the problem); 2) the underlying pattern (why it happened); 3) the structures directly responsible for the pattern; and 4) The underlying cultural and mental models that maintain these structures and facilitate the persistence of the problem. Figure 1 portrays the Iceberg Tool and Figure 2 the Populated Tool for the problem of the COVID-19 pandemic in a resource-poor country. Systemic structures and mental models are considered the 'strong-leverage points' that system leaders should focus on when dealing with complex social problems and conflicts. The significance and importance of focusing on interventions in the mental model domain were the motivators for a joint New York University and UNICEF initiative to design a course for a "strategic global behavioural communication intervention" to deal with infectious diseases epidemics (*11*).

Another Systems Thinking tool for depicting these strong-leverage areas, thus facilitating their incorporation as building-blocks for 'a highly effective system', is

Figure 1 The Iceberg Tool: Below the water line, one can notice patterns of behaviour enforced by the structure of the system and sustained by mental models.



the Biomatrix Tool, which emanated from Biomatrix Systems Theory (*12*). Its seven components constitute the building blocks for any effective system. They are the pillars for any transformational project, whether it is a population-based or government intervention, organizational intervention, hospital, department or clinical unit intervention or establishment, etc. Unlike the classic description of a 'system' with only its 3 basic components (structure, process and outcome), the Biomatrix tool smartly incorporates 4 extra indispensable elements for comprehensive and successful system design or redesign. Thus, one may utilize it to build a comprehensive anti-COVID-19 system for fighting the pandemic.

Numerous interventions are recommended to prevent or slow the spread of COVID-19 infection (*13–16*). Table 1 depicts the seven elements, their definition and their relevant practical administrative components or actions for such a system. A major and deterministic 'leverage-point' for establishing this programme is purely administrative and falls squarely on government, professional and community leaders.

The evidence that a System Approach works

A recent Systematic Review (*17*), as well as experience from several countries that managed to mitigate COVID-19 infection employing elements in the System approach above, are worth referring to. Quarantine, especially if started early on and is combined with other system elements above, is very effective in reducing patient numbers and fatalities (*17*). South Korea applied a mitigation strategy thereby avoiding major social disruption actions, i.e., no true lockdown (*18*). Current daily figures for new infections hardly reach 50 to 100 cases.

Figure 2 The Iceberg Tool depicting the root causes of a failed response to a COVID-19 epidemic and the strong leverage points for effective action

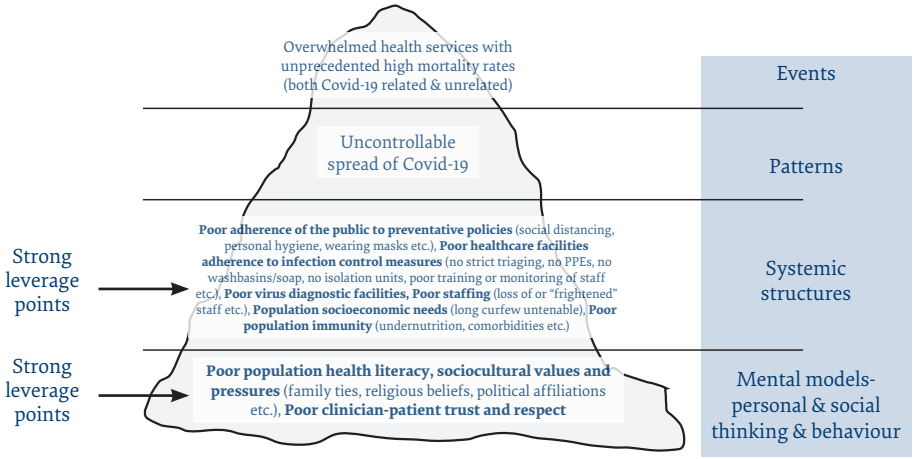


Table 1 A COVID-19 control package using a Systems Thinking Biomatrix Tool and administrative actions

Biomatrix Item	Description	Component or Action	Examples
Aims (Vision)	**The Outcome(s):** the results that the system wants to achieve. Aims create focus.	**A nation without Coronavirus!** (Positive public Communication)	
Ethos	**Organizational Culture:** its unique expectations, and values and is expressed in its self-image: "As you think, so you will become".	**We always win!** (Positive public Communication)	
Structure	**The Organogram:** the anatomy of a system.	• **Strategic Multidisciplinary**, Intergovernmental body with its comprehensive administrative and executive components. • **Strategic Roadmap** for the Health-care sector and the population as a whole. • **Monitoring and Assessment** unit with timely data capture, analysis and action supported by efficient information technology platforms.	Multidisciplinary Team from all ministries, nongovernmental organizations, social support societies, charitable organizations, professional unions, international agencies etc.
Process	**The Activities:** describes the activities of the system: the activities involved in the delivery of services (training) to the customers.	**Health care directed:** • Facility preparedness • Staff education and training • Confirmed and suspected patients' clinical management pathways • Staff support and incentives, etc. • Patient and family education	• Efficient screening of staff and patients • Effective diagnostic capabilities • Reducing in-hospital transmission (personal protective equipment (PPEs), handwashing, triaging, cohorting of patients and of staff, disposal of hazardous material, environmental cleanliness and hygiene, restricting non-urgent clinical services, virtual outpatient and inpatient patient encounters, etc.) • Screening of visitors and restricting hospitalized patients visits by relatives, friends, etc.
		• **Population Directed:** Education and empowerment, Personal hygiene practices e.g. hand washing, sneezing and coughing etiquette etc., Social Distancing, Wearing masks, Restriction of social gathering e.g. at work, schools, sporting events/social events, Robust contact tracing and isolation, Augmenting population innate immunity: e.g. education on healthy foods and herbs rich in immunopotentiators etc.	• Quarantine and isolation centers • Robust contact tracing, isolation and close monitoring during isolation etc.
Resources	**Material and Intellectual Assets:** refer to the resources of the organization, such as its capital equipment, financial resources, intellectual property, staff capabilities etc.	• System Leadership • Diagnostic and treatment facilities • Internists • Infection Control Specialists • Patient Educators • Epidemiologists • Infectious Diseases Specialists • Intensivists • Trainers and Educationalists • Statisticians • Financial Resources • Monitoring teams/IT Specialists • Social Psychologists • Audiovisual Resources • Covid-19 cyberspace resources, Website, Blogs in simple language etc. • Local Social and Religious support teams	

Table 1 A COVID-19 control package using a Systems Thinking Biomatrix Tool and administrative actions *(concluded)*

Biomatrix Item	Description	Component or Action	Examples
Environment	**Local & Surrounding Facilitators & Barriers:** (the latter need to be resolved at the outset).	• Social activists and local support networks in the community. • Incentive Program for all healthcare workers. • Insurance and financial support to healthcare workers who get infected. • Collaboration with Research Centers, Technology and Innovation Centers, Evidence-based Practice Centers, Quality Improvement Organizations, International bodies etc.	
Governance	**Regulation & Monitoring:** The function of governance in an organization is to set aims and to monitor and regulate the movement of the organization towards the attainment of these aims.	• Daily reporting from the monitoring unit and assessment of progress, successes and failures and timely interventions to improve performance and deal with unintended consequences.	

On the other hand, New Zealand and Jordon applied both mitigation and suppression measures with significant population-based lockdown strategies (*19–20*). Their current daily figures are less than 10 cases. All three countries employed thorough screening and diagnostic methods, contact tracing, isolation, and reporting of cases. These were coupled with robust organizational capabilities, electronic tracing, education, monitoring, positive public health communication, and involvement governed and monitored by high-level administrative structures (*18–20*). However, better outcomes in the latter two countries are primarily due to employment of all system elements. A recent review exploring the elements and measures in many countries supports this Systems Thinking approach (*21*).

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