

### **Activity 1.1.1: Defining Complex Adaptive Systems**

In your groups develop a definition of complex adaptive systems for health systems focusing on the building blocks, any additional dimensions as well as complexity and interconnectedness.

**You can use this paper to help you define it;**

1. Paina, L. and Peters, D.H., 2012. Understanding pathways for scaling up health services through the lens of complex adaptive systems. *Health policy and planning*, 27(5), pp.365-373.

Upload your definition before Tutorial 1 and be prepared to discuss your definition.

<b>Definition of complex adaptive systems</b>	<b>References</b>	<b>Contributor</b>
According to Paina and Peter (2012), a complex adaptive system (CAS) in health systems refers to the interconnected and evolving interactions among diverse actors, institutions, and processes that adapt, self-organise, and produce outcomes that cannot be fully predicted by analysing parts in isolation. CAS highlights that financing is more than simply mobilising and transferring resources, it is a dynamic process shaped by feedback loops, incentives, historical choices, and contextual pressures.	Paina, L. and Peters, D.H., 2012. Understanding pathways for scaling up health services through the lens of complex adaptive systems. <i>Health Policy and Planning</i> , 27(5), pp.365–373. <a href="https://doi.org/10.1093/heapol/czr054">https://doi.org/10.1093/heapol/czr054</a>	Group 2
In South Africa, complex adaptive systems for health systems focusing on the health financing building block can be seen in the	Sturmberg, J.P. and Bircher, J., 2019. Better and fulfilling	

<p>interplay between government allocations, medical aid schemes, donor contributions, and out-of-pocket payments, which continuously reorganise in response to shocks or policy changes. For example, the COVID-19 pandemic led to emergency reallocation of funds in South Africa, disrupting existing priorities while simultaneously creating new financing mechanisms for testing, treatment, and vaccination. Additionally, withdrawal of donor funding by Donald Trump disrupted HIV programmes: local providers, NGOs, and government had to reorganise resources in response.</p> <p>Therefore, CAS in health systems using the health financing lens is characterised by non-linearity, self-organisation, path dependency, and resilience (Paina and Peters, 2012; Sturmberg and Bircher, 2019), requiring flexible, learning-oriented reforms rather than rigid, one-size-fits-all approaches.</p>	<p>healthcare at lower costs: The need to manage health systems as complex adaptive systems. <i>Journal of Evaluation in Clinical Practice</i>, 25(5), pp.620–628.</p> <p><a href="https://doi.org/10.1111/jep.13139">https://doi.org/10.1111/jep.13139</a></p>	
<p>A Complex Adaptive System (CAS) is made up of autonomous agents whose actions are not always predictable, with each agent's behaviour influencing the environment for others, resulting in interconnected and evolving dynamics (Plsek, 2001). Health systems, including their financing structures, can be understood as CAS because they involve multiple stakeholders, institutions and subsystems whose interactions produce emergent and often nonlinear outcomes (Paina &amp; Peters, 2012). Health financing, as a</p>	<p>Paina, L. and Peters, D.H. (2012). Understanding pathways for scaling up health services through the lens of complex adaptive systems. <i>Health policy and planning</i>, 27(5), pp.365-373. Available at:<a href="https://doi.org/10.1093/heapol/czr054">https://doi.org/10.1093/heapol/czr054</a></p>	<p>Group 3 (Mpho, Buhle, Retshepile, Puleng, Jabu and Makoena)</p>

<p>core building block of health systems, plays a critical role in advancing universal health coverage by supporting effective service delivery and ensuring financial risk protection (World Health Organisation, n.d.). Within this context, health financing reflects CAS principles through the dynamic processes of revenue generation, fund pooling and purchasing of services, which are shaped by feedback mechanisms and shifting priorities. These interactions yield outcomes such as resilience or maladaptation, highlighting the system's capacity for self-organisation and adaptation to changing circumstances. Consequently, effective health financing requires context-sensitive and adaptive approaches that integrate ongoing learning, transparent use of data, and recognition of its co-evolution with other components of the health system.</p>	<p>Pilsek P., (2001). <i>Redesigning Health Care with Insights from the Science of Complex Adaptive Systems</i>. National Center for Biotechnology Information. Available at: <a href="https://www.ncbi.nlm.nih.gov/books/NBK222267/">https://www.ncbi.nlm.nih.gov/books/NBK222267/</a></p> <p>World Health Organization, (n.d.). <i>Health financing</i>. Available at: <a href="https://www.who.int/health-topics/health-financing#tab=tab_1">https://www.who.int/health-topics/health-financing#tab=tab_1</a></p>	
<p>A complex adaptive system in the context of health refers to a dynamic network of interrelated components, such as actors, institutions, and processes, that interact and adjust continuously in response to internal shifts and external influences. When focusing on the health financing building block, this perspective highlights how the mobilisation, pooling, and allocation of resources are not linear processes, but part of a broader, interconnected system. Health financing interacts with other components of the health</p>	<p>Nimako, K., &amp; Kruk, M. E. (2021). <i>Seizing the moment to rethink health systems</i>. The Lancet Global Health, 9(12), e1758-e1762.</p> <p>Baltussen, R., et al. (2016). <i>Priority setting for universal health coverage: we need evidence-informed deliberative</i></p>	<p>Group 4 ((Muntu Tladi, Ethan Terblanche, Mbali Zondo, Zhiyi Chen, Blessing Chabi, Phuma Rapetsoa)</p>

system such as service delivery, governance, and the health workforce. For example, changes in financial policies, like the introduction of performance-based financing or a shift in budget allocations, can produce wide-ranging and sometimes unexpected outcomes due to the system's non-linear nature and the presence of feedback loops. These interactions may alter provider behaviour, affect access to care, or shift incentives for users and policymakers. A core feature of complex adaptive systems is emergence, where outcomes arise that could not be predicted by looking at individual components alone. This is particularly relevant for South Africa as it implements health reforms like the National Health Insurance (NHI), where financial decisions need to be understood within a system that is continuously learning and adapting. Recognising health financing as part of a complex adaptive system encourages policy designs that are flexible, inclusive of stakeholder input, and sensitive to unintended consequences. Such an approach is crucial for building resilient and equitable health systems. This understanding is supported by scholars like Nimako and Kruk (2021), who argue for systems thinking in health reforms, and Baltussen et al. (2016), who stress the importance of deliberative and context-aware processes in health priority setting. Viewing financing this way shifts the focus from isolated interventions to understanding how financial decisions ripple through and shape the whole system.

*processes, not just more evidence on cost-effectiveness.* International Journal of Health Policy and Management, 5(11), 615–618.

The pursuit of equitable and sustainable health financing in developing countries has often been challenged by the application of overly simplistic, linear models of change. These traditional approaches, which look at

1. Paina, L. & Peters, D.H. (2012). Understanding pathways for scaling up health services through the lens of

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health systems as predictable machinery/systems that will respond uniformly to standardized inputs like funding or insurance schemes, have frequently failed to account for the dynamic and unpredictable nature of real-world implementation/realities. A more robust and realistic framework emerges when we reconceptualize the health financing building block not as a mechanical construct, but as a Complex Adaptive System (CAS). Drawing on the work of Paina and Peters (2012), a CAS in this context can be defined as a dynamic network of multiple interacting agents patients, providers, public and private payers, policymakers, and donors whose individual decisions and adaptations in response to incentives and constraints collectively give rise to the system's emergent, non-linear, and often unpredictable behaviour. This perspective fundamentally shifts our understanding of scale from mere expansion to an organic process of strengthening a system's inherent capacity to adapt and grow.

Viewing health financing through a CAS lens shows why one size fits all approaches fails. The phenomenon of path dependence illustrates how a system's history locks it into a unique trajectory; the success of a social health insurance model in one nation is not easily replicable in another due to deeply ingrained political processes, existing institutions, and cultural norms. Furthermore, feedback loops are critical to understanding financial dynamics. Positive feedback can create vicious cycles, such as where informal payments, driven by inadequate formal salaries, become entrenched, further undermining public trust and formal revenue collection (Gilson et al., 2011). Conversely, negative feedback might modulate the explosive growth of a new insurance scheme. Perhaps most strikingly, emergent behaviour explains outcomes that no single actor intended, such as the spontaneous formation of provider cartels to control prices or

complex adaptive systems. \*Health Policy and Planning\*, 27(5), 365–373.

2. Gilson, L., Hanson, K., Sheikh, K., Agyepong, I.A., Ssengooba, F. and Bennett, S., 2011. Building the field of health policy and systems research: social science matters. *PLoS medicine*, 8(8), p.e1001079.

3. Swanson, R.C., Atun, R., Best, A., Betigeri, A., de Campos, F., Chunharas, S., Collins, T., Currie, G., Jan, S., McCoy, D. and Omaswa, F., 2015. Strengthening health systems in low-income countries by enhancing organizational capacities and improving institutions. *Globalization and health*, 11(1), p.5.

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widespread strikes in response to changes in remuneration. These phenomena are not anomalies but inherent features of a complex system where local interactions generate unpredictable macro-level outcomes.

Consequently, managing health financing effectively requires a paradigm shift from top-down control to adaptive stewardship. Planning must embrace uncertainty, using tools like scenario-building and network analysis to identify leverage points and potential tipping points, rather than insisting on rigid, predetermined plans. Implementation must prioritize continuous learning and iterative adaptation, where policies are treated as hypotheses to be tested and refined based on real-time feedback and local context. As recent analyses reinforce, this involves fostering “resilient and adaptive health systems” that can learn from experience and absorb shocks (Swanson et al., 2015).

This approach does not abandon structure but recognizes that sustainable scale is achieved not by engineering a fixed outcome, but by carefully creating the conditions robust information feedback, aligned incentives, and trusted relationships from which effective and equitable financing can organically emerge. Ultimately, adopting the CAS lens is not merely an academic exercise; it is a practical necessity for developing health financing systems that are truly responsive, resilient, and capable of meeting the complex health challenges of the 21st century.

