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# Conceptualising Health Systems for Economic Evaluation: A Review and Framework for Health System Models

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# Abstract

Multi-disease Health System Models (HSMs) represent a new frontier in economic evaluation, enabling decision analysis for sector-wide resource allocation in the context of interacting health needs, system capacity and financial constraints. To support the development of conceptually grounded HSMs, we conducted a meta-narrative review of conceptual frameworks from the economic evaluation and health system assessment literature to understand how health systems and their relationships with different types of outcomes have previously been represented. Four main approaches were identified: health systems as a *set of functions*, as *production constraints* on overall healthcare, as intervention-specific constraints along the *care pathway*, and as *complex adaptive systems*. We assess the strengths and limitations of each in informing the structure, scope, and causal logic of HSMs.

Drawing from our experience developing the *Thanzi La Onse model* of Malawi's health system, we propose a new conceptual framework for HSMs, grounded in theory of change principles and informed by prior literature on health system assessment. The framework is designed to support the full lifecycle of HSMs, from model design and intervention representation to the transparent communication of assumptions and results. By clarifying causal pathways, enabling the representation of diverse interventions, and facilitating stakeholder engagement and policy translation, the framework provides a bridge between high-level conceptual thinking and the operational needs of policy-relevant modelling. This work seeks to advance how health sector policies and investments are conceptualised in economic evaluation and to guide the continued development of health system modelling approaches.

**Keywords:** Health System Models, Economic Evaluation, Theory of Change, Health System Strengthening, Conceptual Framework

# 1. Introduction

Every policy and investment decision in health systems involves trade-offs. Economic evaluation offers a systematic way to weigh the costs and benefits of different options to inform these decisions. The field of economic evaluation has historically centred on assessing the cost-effectiveness of discrete, health condition-specific interventions, with limited attention to the systems through which they are delivered. However, achieving universal health coverage requires not only effective technologies but also strong and responsive health systems<sup>1</sup>. Over time, three insights have become widely recognised: first, the central role of health systems in shaping population health outcomes<sup>1</sup>; second, that economic evaluations of even targeted, technology-based interventions need to account for the system or context in which they are delivered<sup>2</sup>; and third that such targeted interventions can produce system-wide effects - both intended and unintended - which need to be considered in evaluations<sup>3</sup>.

Historically, health systems were treated as "black boxes" - too complex to model in detail, and therefore bypassed in favour of narrowly evaluating direct inputs like drugs or diagnostics<sup>1</sup>. This approach has clear value, especially in contexts where new proprietary technologies dominate decision-making and where evaluations often assume a delivery system able to absorb them as intended. Yet in practice, health systems in all settings face constraints (service bottlenecks, workforce shortages, or pressures on infrastructure) that shape the real-world impact of even simple technologies<sup>2</sup>. These challenges are particularly pronounced in low- and lower-middle income settings, where system constraints can be more acute and where the case for broader system-level investment is especially strong. For this reason, there is wide recognition in the literature for the need for evaluation methodologies to adopt a wider perspective<sup>2,4,5</sup>.

Despite this recognition, the application of economic evaluation to system-level interventions and the application of systems-thinking in economic evaluation of interventions remains sparse. Recent systematic reviews have found a lack of studies estimating the value for money of broad health system strengthening (HSS) investments, including the returns to cross-cutting or system-wide interventions<sup>6</sup> and the potential economies of scope from joint production of services<sup>7</sup>. Even multi-country cost-effectiveness models, while adjusting for demographic, epidemiological, and cost heterogeneity, often ignore differences in demand- and supply-side constraints across health systems<sup>2</sup>. Where evaluations of system-level policies do exist, they typically rely on short-term surrogate outcomes rather than long-term health outcomes<sup>4</sup>, making them difficult to compare against other options. Health system challenges are also frequently treated as external "implementation barriers", addressed through implementation science, rather than as core elements of the causal pathway to be explicitly incorporated into economic evaluation<sup>8</sup>. These gaps reflect deeper methodological challenges: system-level interventions act through indirect and multifaceted pathways, involving dynamic interactions across multiple health system components<sup>9</sup>.

Multi-disease Health system models (hereafter referred to as HSMs) have the potential to address this challenge. As a complement to existing economic evaluation methods, these

dynamic models allow for decision analysis that reflects real-world constraints, such as workforce shortages or supply chain bottlenecks, and the interactions between them. Chang et al. (2017) define HSMs as dynamic mathematical models “designed to describe, predict, and quantitatively capture the functioning of health systems”<sup>10</sup>. Borghi & Chalabi (2017) discuss the potential of system dynamics models (SDMs) and agent-based models (ABMs) to capture non-linear relationships within health systems and to serve as experimental frameworks for optimising system performance prior to implementation to inform the design of subsequent empirical evaluations”<sup>11</sup>.

Crucial to building HSMs is an understanding of how to conceptualise the health system itself. Across the policy and economic evaluation literature, a wide range of frameworks have been proposed - some, like the WHO Building Blocks<sup>12</sup>, offer guidance on what system components to consider; others, particularly from complexity science<sup>13</sup>, emphasise the multifarious types of interactions between system elements. In the economic evaluation literature<sup>14</sup>, frameworks often rely on simplifying assumptions that abstract the system into production functions to link health system capacity and efficiency with health outcomes. Each of these reflects a different underlying theory of the system, shaped by disciplinary tradition and intended use.

In this paper, we conduct a meta-narrative review<sup>15</sup> of conceptual frameworks that have been used to represent health systems in the context of policy and economic evaluation. Through an interpretive synthesis, we group these frameworks into four types of system conceptualisation and critically assess their advantages and omissions for informing the structure and assumptions of HSMs. While our primary concern is with economic evaluation, we also included frameworks developed for health system assessment and evaluation, which are also used to inform priority setting and system reform<sup>16</sup>.

Building on this synthesis and our experience developing the Thanzi La Onse (TLO) model<sup>17,18</sup> (a HSM of Malawi’s healthcare system), we propose a new conceptual framework for HSMs grounded in theory of change principles<sup>19</sup>. While existing frameworks offer valuable insights into system components, constraints, and dynamics, none provides a generalisable and operational template to guide the development of HSMs across their full lifecycle (defining model scope, mapping causal pathways, structuring inter-component relationships, and supporting stakeholder engagement and policy translation). Our framework is developed with the explicit goal of bridging this gap, offering a conceptual foundation tailored to the design, implementation, and communication of HSMs for policy and economic evaluation.

## 2. Existing Conceptualisations of Health Systems in Economic Evaluation and Health System Assessment

### 2.1 Method

We adopted a *meta-narrative review approach*, as defined by Greenhalgh et al. (2005)<sup>15</sup>, to identify relevant conceptual frameworks for health systems in economic evaluation and health system assessments. This approach was well suited to the aims of our study, allowing

us to draw on the cross-disciplinary expertise of the team and to maintain flexibility in the scope and focus of the review, which evolved through the process of discovery.

Our objective was to identify how different bodies of literature conceptualised the health system as a structure through which interventions propagate health-related outcomes, and guide the definition of objectives, evaluation methods, and indicators. We began with a *territory-mapping exercise*<sup>15</sup> across the disciplines of health economics, epidemiology, operations research, implementation science and impact evaluation, followed by an iterative effort to identify organising principles to group candidate papers. The initial review was validated and expanded through a mid-way presentation to the UK Health Economists' Study Group (HESG)<sup>20</sup>, which yielded additional references.

From this exploratory phase, we identified four recurring meta-narratives in the literature that shape how health systems are conceptualised: (1) as a set of functions, (2) as a *production constraint on overall healthcare*, (3) as intervention-specific constraints along the *patient care pathway*, and (4) as *complex adaptive systems*. This typology formed the basis for the second phase of targeted snowballing to identify further frameworks aligned with each narrative.

To sharpen the focus of our review, we defined inclusion and exclusion criteria (see Table 1) to identify conceptual frameworks that offer structural or causal representations of the health system, relevant for the *comparative evaluation or prioritisation of interventions or investments* in the health sector. Rather than aiming for an exhaustive review, we prioritised frameworks that added conceptual value to the overall narrative, i.e. those that advanced or refined existing frameworks.

## 2.2 Result

Table 2 provides a summary of the identified frameworks, categorised by meta-narrative. The types of conceptualisation identified are not mutually exclusive and were developed to draw out the primary features that distinguish how each framework conceptualises the health system, particularly in terms of its level of abstraction, orientation toward supply-side constraints versus the care-seeking and treatment pathway, and relevance to specific evaluation methods or modelling approaches.

The first group (**Function-Based Frameworks**) conceptualises the health system in terms of its constituent functions, but without anchoring the framework to a specific evaluation methodology. These frameworks were developed to encourage systems thinking when considering health sector interventions. These originated as lists of health system components or policy levers and have evolved to include increasing levels of structure, including hierarchical relationships between system functions. Walt & Gilson (1994)<sup>21</sup> offered a high level framework (called the *Policy Triangle*) drawing attention to the often-overlooked roles of *context*, *process*, and *actors* in shaping the outcomes of the *content* of policy. The influential WHO Building Blocks Framework (2007)<sup>22</sup> described the health system as consisting of six building blocks – i. *service delivery*, ii. *health workforce*, iii. *information*, iv. *medical products, vaccines and technologies*, v. *financing*, and vi. *leadership and governance*. While not originally intended to guide evaluation or prioritisation, the framework became widely used for funding decisions and prioritisation<sup>23</sup> and provided the basis for later

extensions more directly concerned with evaluation<sup>23,24</sup>. Subsequent extensions distinguished global health initiatives from national systems<sup>23</sup>, social determinants and societal partnerships (eg. with civil society groups) from health service delivery platforms<sup>24</sup>, and further differentiated the health system's architecture (platforms, services, workforce, population) from the policy levers that shape it (such as financing and organisation)<sup>25</sup>. The last among these, the Control Knobs framework<sup>25</sup>, identified discrete, actionable areas of system structure that can be adjusted through government policy to influence health system performance (the '*five control knobs* for health sector reform') - *financing, payment, organisation, regulation, behaviour*. It recognised the *interdependence* of levers (changes to one knob may influence others), the *multidimensional* nature of reform (requiring the use of multiple knobs in combination), and the different ways to change the knobs depending on the level of control and involvement of the government in the health system, such as through policy changes (*steering role*) versus direct action (*rowing role*). A more recent evolution of this tradition is the Health System Performance Assessment (HSPA) Framework by Papanicolas et al. (2023)<sup>16</sup>. It retains the function-based approach but introduces much greater granularity by breaking down system functions - distinct areas of system activity that can be measured, monitored, and linked to specific actors within the system. This hierarchical logic model was developed to enhance the utility of the broader building blocks framework for performance monitoring, accountability, and policy evaluation.

The second group (**Constrained production frameworks**) conceptualises the health system as an input-constrained production system, where system performance is defined through aggregate parameters such as production *efficiency* or platform *capacity*. These frameworks are designed to be compatible with mathematical programming approaches to optimise resource allocation, and aim to represent the trade-offs between *vertical investments* into expanding the scope and scale of health services and *horizontal investments* into the platforms for service delivery ("logistically related service delivery channels" which "mark the point of contact between service users and healthcare providers"<sup>14</sup>). For example, Morton et al. (2016) treat health system investments as levers to improve the production efficiency of service delivery platforms<sup>26</sup>. Van Baal et al. (2018) model input-specific capacity constraints, showing how these alter the feasible decision space and introduce multiple opportunity costs depending on the constrained resource. This leads to the need for adjusted (multiple) shadow prices presented as 'cost-effectiveness thresholds' when system bottlenecks are present<sup>27</sup>. Hauck et al. (2019) add a third dimension - investments in the creation of new platforms - required for certain interventions (e.g., an advanced cold chain). Kirwin et al. (2022) further generalise this approach using integer rather than linear programming and incorporate intertemporal optimisation, resource indivisibilities, and spillovers between interventions<sup>28</sup>. All four frameworks abstract away much of the system's internal complexity to simplify the causal relationship between system constraint and healthcare production or outcomes.

The third group (**Pathway-Constrained Frameworks**) centres the patient or health-seeker within the health system and views the system as imposing a series of constraints along the *disease/illness/care pathway*<sup>1</sup>. These frameworks trace how individual access to care is shaped by demand-side, supply-side, and quality-related barriers, and how interventions propagate through each stage of the care trajectory. For instance, Vassall et al. (2016)

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<sup>1</sup> As opposed to the supply-side perspective adopted under the second type

conceptualise health system resources and contextual features as constraints that operate at multiple points in care delivery, arguing that even technology-focused trials or decision analytic models should account for how services interact with, and are shaped by, system-level constraints<sup>2</sup>. De Silva et al. (2014) offer a complementary perspective from program evaluation, advocating for the use of an explicit theory of change (ToC) to map how interventions move through stages of resource mobilisation (including physical resources such as health workers), identification or diagnosis, treatment, and long-term outcomes, to ultimately achieve population-level impact<sup>29</sup>. Both contributions support the view that modelling or evaluating health interventions requires tracing how the system enables or hinders each step in a patient's care trajectory<sup>2,29</sup>. Ochalek et al. (2018) extend this approach by defining intervention-specific ceilings on feasible coverage, based on an abstracted understanding of demand and supply-side bottlenecks in the system<sup>9</sup>. These constraints are not applied uniformly across the system, but tailored to each service, capturing expert opinion on what is deliverable given the full range of constraints in the system. This feasible coverage constraint can be 'relaxed' through allocating resources towards HSS. Similar to the characterisation proposed by Ochalek et al. (2018), the adapted version of the 1978 Tanahashi model<sup>30</sup> in UNICEF's Equitable Impact Sensitive Tool (EQUIST)<sup>31</sup> represents the health system in terms of *demand, supply, and quality-side determinants* of feasible effective coverage. Each of these dimensions is quantified through several parameters, of which the following are examples for antenatal care (ANC) service delivery: the percentage of ANC cases for whom essential medical commodities are available (*supply*), the initial care-seeking followed by the conversion rate from first to recommended visits (*demand*), and the proportion of women receiving timely ANC visits in accordance with clinical guidelines (*quality*). The tool enables users to input assumptions about how targeted investments will address specific bottlenecks across these dimensions and estimate the resulting changes in *effective coverage* for selected interventions. These approaches aim to reflect how system constraints are experienced at the level of specific interventions rather than through system-wide aggregates.

The fourth group (**Complex Adaptive System Frameworks**) conceptualises the health system as a complex adaptive system made up of interdependent components whose interactions are non-linear, context-dependent, emergent, and dynamic. These frameworks challenge the adequacy of the traditional linear 'input-output-outcome impact chain approach'<sup>32</sup> in capturing the multidirectional and evolving system dynamics triggered by interventions. McDonnell et al. (2004) propose a system dynamics model that maps a large *causal loop* between health system components, health outcomes and broader economic variables, including a series of *nested dynamic models* to represent population dynamics, economic growth and government expenditure, human resource for health, health outcomes and infrastructure<sup>33</sup>. Their model seeks to simulate how changes in one part of the system can trigger cascading effects across others over time.

Other contributions in this group adopt a theoretical lens and clarify important aspects of systems thinking to capture within HSMs. Paina & Peters (2012) highlight the need to use *complexity science concepts* such as *path dependence, feedback, scale-free networks, emergent behaviour, and phase transitions* to understand the unpredictable and adaptive nature of a health system<sup>34</sup>. Atun et al. (2010) build on this systems perspective to examine how new technologies and policies are integrated into existing health systems. They conceptualise adoption as a *context-sensitive* and *actor-dependent* process, shaped by

system readiness, institutional incentives, and the *nature of the problem* being addressed. Their framework highlights how system architecture and contextual features jointly determine the success or failure of intervention assimilation<sup>35</sup>. Verguet et al. (2019) draw from the WHO building blocks<sup>22</sup> and the control knobs framework<sup>25</sup> to propose an evaluative framework that anchors health system models within an Input–Output structure, where policy levers (e.g., financing, regulation) function as inputs and processes, while health system objectives (e.g., health gains, financial protection) represent outputs<sup>36</sup>. Their focus is on using system dynamics to link these components through available evidence. In contrast to the aforementioned studies in this group, De Savigny et al. (2009) are focused on the use of empirical impact evaluation and emphasise that evaluating large-scale, system-level interventions requires moving beyond the “input–black box–output” paradigm and incorporating a more nuanced understanding of flows, control points, feedback loops, and contextual factors<sup>32</sup>. They advocate for evaluations to include four components: process evaluation (to assess implementation adequacy), context evaluation (to judge transferability), effect evaluation (to understand effects across subsystems), and economic evaluation (to assess value for money). In addition, they recommend the three evaluation designs to capture the complex effects of interventions - probability designs, plausibility designs, and adequacy designs. Together, these contributions offer a more layered conceptualisation of the health system than linear models and recognises it as dynamic, adaptive, and embedded within institutional and political realities of the context.

These four frameworks have helped expand how health systems are conceptualised across different strands of the literature. Yet none provides a sufficient foundation for the design of Health System Models intended to mechanistically represent how inputs are translated into health outcomes. *Function-Based Frameworks* are useful for structuring system components and, in the case of the HSPA framework, even offer a theory of change. However, they are primarily geared towards performance measurement, indicator tracking, and situational analysis, rather than HSM construction. *Constrained Production Frameworks* provide a mathematically solvable way to model horizontal and vertical investment trade-offs under resource constraints, but rely on highly abstracted assumptions about platform efficiency or capacity that are not adequate to capture the mechanistic detail that can be modeled within HSMs. *Pathway-Constrained Frameworks* offer more granular representations of how interventions interact with supply and demand-side bottlenecks, but are typically intervention-specific making them insufficient for representing the full architecture and interactions of the health system. Finally, *Complex Adaptive System Frameworks* advance important theoretical insights for system-level evaluation and simulation, but do not offer a generalisable, theory-based template for representing the structure and causal logic of the health system.

What remains missing is a unifying framework that defines system components, structures them into a causal pathway (based on theory), and allows interventions to be represented in terms of how they affect, and are constrained by, the system and that is explicitly designed to guide the construction of Health System Models. In the next section, we seek to fill this gap by proposing a new conceptual framework for the design and use of HSMs.

### 3. New Conceptual Framework for Health System Models

In this section, we present a generalised framework to guide the design of Health System Models (HSMs) for policy and economic evaluation. The framework is intended to provide a comprehensive, generalisable, and accessible foundation to support the full lifecycle of an HSM, from initial model design, stakeholder engagement, and intervention representation, to the transparent communication of assumptions and results.

It draws on existing conceptualisations of health systems and literature on the interrelationships between system components, as well as our own experience developing the Thanzi La Onse (TLO) model<sup>17</sup>, which to our knowledge is the first multi-disease HSM of a national health system that integrates demographic and epidemiological dynamics with a detailed representation of input constraints and care-seeking behaviour.

#### 3.1 Method of development of the framework

The starting point for the overall architecture of our framework was the Health System Performance Assessment (HSPA) framework proposed by Papanicolas et al. (2022)<sup>16</sup>, which provided a generalisable breakdown of health system functions alongside a high-level theory of change. We augmented this foundation in two key ways. First, we conducted a targeted review of the literature to identify sub-functions as well as types of interventions or policies within each of the high-level functions in a manner compatible with HSM design. Second, we examined existing literature to clarify the causal relationships and interdependencies between functions, with the goal of capturing the key mechanisms through which changes in one part of the system propagate through others.

To set boundaries on the components captured by our framework, we adopt the definition of a health system offered by WHO (2010) - “the aggregate of all public and private organisations, institutions, and resources mandated to improve, maintain or restore health. This includes both personal and population services, as well as activities to influence the policies and actions of other sectors to address the political, social, environmental, and economic determinants of health”<sup>37</sup>.

#### 3.2 Description of the Framework

**Figure 1** presents our conceptual framework for the design and use of Health System Models in economic evaluation (hereafter referred to as the *HSM Framework*), developed to accommodate the complexity and heterogeneity of interventions designed to improve health and health-related outcomes. We synthesize, reorganise and extend prior contributions listed above by offering a theory-driven structure that can inform both model construction and the interpretation of economic evaluations. Our framework is organised as a nested architecture across four **Analytical Domains**: the Health System, the Wider Context, Intermediate Outcomes, and Final Outcomes. Each block contains core **Functions**, which are further disaggregated into specific **Sub-functions** that represent operational units of modelling or analysis. Linked to these are lists of **Actionable Levers**, which we define as

modifiable characteristics or mechanisms that policymakers can act upon, through interventions, reforms, or investments, with the expectation of influencing health system functions and outcomes.

The framework is designed not only to classify system functions, but also to support analysis of how interventions propagate changes through the system. Functions are connected via potential **pathways of impact**, representing a causal cascade from structural or contextual determinants to final outcomes. These pathways are grounded in published literature and global guidance, including WHO frameworks on health systems strengthening and performance assessment, as described above.

The **Health System** consists of organisations, institutions, and resources, the main purpose of which is to improve, maintain and restore health. The **Wider Context** consists of structural and systemic factors outside the immediate control of the health system, but which shape health outcomes and system performance. The health system and wider context together determine the supply (*Service Delivery*) and demand (*Healthcare Seeking*) for care (**Intermediate Outcomes**), which together with the *determinants* of foundational health of individuals in the population, determine total population health and other relevant outcomes (**Final Outcomes**). In the subsections that follow, we describe the functions, sub-functions and actionable levers in further detail.

## Health System

### Health Financing

**Health Financing** is positioned as an enabler of health system operations. This includes the three widely recognised health financing (sub-)functions of **revenue raising, pooling and purchasing**. The fourth sub-function - **Governance of health financing** - refers to the overarching choices, rules, and normative decisions that shape how the core financing functions are designed and implemented. It includes *coverage policies*, which determine who is entitled to what services and under what conditions, and *public financial management (PFM)* systems, which govern how public funds are allocated, disbursed, and accounted for<sup>16</sup>.

Actionable levers under health financing include - i. *sufficiency* of resources to meet population health needs, ii. *stability* of these resources through improving predictability and resilience to shocks, iii. *efficiency* in the *allocation* of resources (who is entitled to what services and at what cost, and how much is spent on overheads), iv. *autonomy and incentive structures* among purchasers and providers to encourage alignment with system goals<sup>38</sup>, v. *accountability* to ensure that resource flows and spending decisions are subject to oversight and scrutiny, contributing to trust and stewardship in the system.

### Health Sector Governance

Health Sector Governance refers to the overarching institutional arrangements, decision-making processes, and norms that shape how authority is exercised, accountability is ensured, and policies are formulated and implemented across the health system. Distinct from the governance of financing, this function captures the cross-cutting systems for

coordination, regulation, and oversight that enable or constrain effective health sector functioning as a whole.

Among sub-functions, **Policy and vision** refers to the state's ability to articulate a shared direction for the health system through formal strategies, plans, or guidelines to guide investments and activities of health sector actors. This is closely tied to **stakeholder voice**, which reflects the extent to which diverse groups - such as civil society and professional associations - are engaged in shaping health system priorities, determining the legitimacy and responsiveness of these priorities and strategies<sup>39</sup>. **Information and intelligence** refer to the institutional capacity and culture needed to generate, interpret, and apply evidence to monitor and improve system performance. This sub-function acts as an enabler for other governance sub-functions by improving their responsiveness to the situation and results<sup>40</sup>. Finally, **legislation and regulation** provide the legal foundation for governance by establishing "rules to govern the behaviour of actors"<sup>41</sup>.

Actionable levers under health sector governance include - i) *Political commitment*, reflecting the will and capacity of leadership to prioritise population health<sup>42</sup> and ensure continuity of support across political cycles; ii) *Participatory mechanisms* for stakeholder engagement and deliberation in agenda-setting and accountability processes, ensuring inclusive governance<sup>39</sup>; iii) *Institutional accountability systems*, including transparency laws, oversight bodies, and anti-corruption mechanisms, which ensure that public decision-making processes are responsive and legitimate<sup>16</sup>; iv) *Information and research systems*, including both the physical infrastructure and institutional capability to use evidence in policymaking and implementation<sup>43</sup>.

## Health System Inputs

Health System Inputs refer to the tangible resources required to deliver health services, including **medical commodities, human resources, physical infrastructure, and medical equipment or movable capital items** (such as ambulances)<sup>12</sup>. These inputs represent the production factors of the health system and determine its operational capacity to convert health financing and governance decisions into service delivery.

Actionable levers to influence this operational capacity include changing the level of *availability* of inputs, their *distribution* and relative *mix/composition*, and *training and maintenance status*. For example, operational capacity may be increased through an expansion of the number of health workers, through providing them with better medical equipment for diagnosis/treatment, or through training them in the use of new technology.

## Wider Context

### General Political Context

For the health sector to function effectively, the general political and social context beyond the immediate domain of the health sector must be strong and functional. These include **governance** arrangements and practices, **macroeconomic and fiscal policies, social policies** (affecting factors such as labour, social welfare, land and housing distribution) and

**public policies** (in other relevant areas such as education, medical care, water and sanitation), and the **civil society** (which includes the culture and societal values which influence people's engagement and actions)<sup>44</sup>. This capacity and these policies in complementary sectors affect the policy implementation capability and efficiency of the health sector. The effects of governance are indirect and mediated through interactions with all the other system functions.

Its full scope includes the capacity of governments to coordinate across sectors, engage stakeholders, influence social determinants that shape health outcomes, as well as the capacity of civil society to effectively engage with the wider system and exert influence both through direct action and through holding governments accountable.

The levers of this component are identical to those under Health Sector Governance.

### Social Determinants of Health (SDH)

Social Determinants of Health (SDH) refer to the socioeconomic conditions in which people are born, grow, live, work, and age, which shape exposure to health risks, access to care, and ultimately health outcomes<sup>45</sup>. These determinants operate outside the health system but exert a profound influence on the foundational health, health risks and health-seeking behaviour of the population.

The SDH framework provided by Solar & Irwin (2010)<sup>44</sup> distinguishes between **structural determinants**, which are the structural mechanisms which establish individuals' social positions, and **intermediary determinants**, which are downstream factors through which these positions influence health. Structural determinants include *income, education, occupation*, and other *sociodemographic characteristics* (gender, race or ethnicity), which operationalise the socioeconomic position of individuals. These may have different levels of importance in different settings. These stratifiers shape intermediary determinants - *material circumstances* (e.g., housing quality, food security, working conditions), *behavioural and biological factors* (e.g., smoking, diet, genetics), and *psychosocial circumstances* (e.g., stress, social support). The components of structural and intermediary determinants themselves constitute the actionable levers under the SDH function.

### Intermediate outcomes

#### Service Delivery

Service Delivery is the principal interface between the health system and the population, encompassing the provision of **public health, primary care, and specialist care** (which encompasses secondary and tertiary care)<sup>16</sup>, and represents the supply-side of healthcare delivery. This conceptualisation of service delivery deviates from the WHO building blocks conceptualisation in which service delivery is one of the six building blocks of the health system and is more in line with the disease/illness/care pathway<sup>2,29</sup> characterisation. This function focuses not on the *choice* of which services are funded (which is addressed under the Health Financing component), but rather on *how* these services are operationalised - through platforms<sup>14</sup> for healthcare delivery. It is the mechanism determining the translation of

health system inputs into health care, taking account of financing, governance and the wider context.

Actionable levers include<sup>12</sup> -

- *Accessibility*: Ensuring that services, commodities, and where appropriate, self-care options are available at the suitable level of care to ensure access.
- *Continuity of care*: Facilitating coordinated service provision across health conditions, life stages, and levels of care
- *Quality of care*: Encompassing the *effectiveness* (e.g. timely and appropriate diagnosis and treatment), *safety*, and *responsiveness* (or patient-centredness) of services delivered<sup>46</sup>.
- *Coordination*: Referring to the strength and functionality of referral systems, communication, and collaboration between service providers - “across types of provider, types of care, levels of service delivery, and for both routine and emergency preparedness”<sup>12</sup>.
- *Efficiency*: Ensuring that services are delivered with optimal use of available resources. This includes minimising waste, gatekeeping to deliver care at an appropriate level of care and task sharing/shifting from the point of view of resource use efficiency<sup>47</sup>, integrating services where appropriate<sup>38</sup>, and prioritising patients<sup>48</sup> effectively in the face of input constraints.
- *Accountability*: Service providers are held accountable to users and payers for performance and outcomes. Mechanisms may include performance monitoring, public reporting, or user feedback systems.

## Healthcare seeking

Like service delivery, healthcare seeking behaviour is also treated as an intermediate outcome but in contrast captures the demand-side of healthcare delivery. It reflects the population’s engagement with available health services, encompassing both the **initial decision to seek care** and **continued participation** in a care pathway over time<sup>49</sup>. This function is shaped by individual perceptions and social influences that govern health behaviours and the utilisation of services.

Early behavioural theories such as the *Health Belief Model (HBM)* highlighted the role of perceived susceptibility, severity (of illness), benefits, barriers, and self-efficacy in shaping decisions to seek care<sup>50</sup>. More recently, the *COM-B* (Capability, Opportunity, Motivation - Behaviour) model, has become widely used and provides a broader lens that links individual behaviour to modifiable system and contextual factors<sup>51</sup>. Based on this model, entry points to influence healthcare seeking behaviour include -

- *Capability*: The knowledge, skills, and confidence needed to recognise symptoms, navigate services, and follow treatment plans. This includes *physical capability* and *psychological capability*.
- *Opportunity*: The external conditions that enable or hinder care-seeking, such as the accessibility and responsiveness of services, affordability at the point of use, and the presence of supportive outreach or community mobilisation. This includes *physical opportunity* afforded by the environment and *social opportunity* afforded by the cultural milieu that dictates the way people think.

- *Motivation*: The internal processes that energise and sustain health-seeking behaviour, including trust in providers and perceived value of care. This includes *reflective processes* (involving logic, evaluation of consequences, and weighing of evidence) and *automatic processes* (involving emotions and impulses that arise from associative learning and/or innate dispositions).

These determinants are shaped by broader contextual factors, including social determinants of health, peer and community experiences with the health system, and the wider financing and governance environment. Through health education and promotion (operationalised via the public health sub-function of service delivery), behavioural nudges, responsive and respectful care, and mechanisms that strengthen provider accountability, the levers outlined in COM-B can be influenced to support timely and appropriate utilisation of healthcare services<sup>44,50</sup>.

From a modelling perspective, empirically parameterising these demand-side levers within HSMs can be challenging. Quantifying capability, opportunity, and motivation is non-trivial, as data on these is difficult to obtain and highly context-specific<sup>52,53</sup>. Indeed, demand-side dynamics are weakly captured components in health system models, with literature emphasising the initial access event, and much less retention in care over time, or behavioural responses to system capacity such as drug stock-outs, temporary facility closures, or negative care experiences.

## Final Outcome

### Health and Other Outcomes

Health and Other Outcomes represent the final goals of a health system, which it ultimately achieves through the organisation and delivery of care. In many health system models, **health gains**, such as reductions in morbidity and mortality, are prioritised as primary outcomes. However, other goals such as **equity**<sup>12</sup>, **social and financial risk protection**<sup>12</sup>, **customer satisfaction and confidence in the system**<sup>25,54</sup>, **macroeconomic consequences**<sup>55</sup>, and **system resilience and sustainability**<sup>22</sup> are also relevant, especially in the context of publicly funded systems. These outcomes serve as evaluative endpoints within HSMs to inform priority-setting and resource allocation. Accurately quantifying these outcomes, and the trade-offs among them (such as between efficiency and equity), is essential for determining the value and desirability of competing policy options.

### 3.3 Application to the TLO Model

Having proposed a conceptual framework for structuring HSMs, we demonstrate its application by mapping it onto a recently developed model. We illustrate how the framework can clarify both the modelling boundaries, i.e. what is represented mechanistically, and the assumptions underlying a specific analysis.

The Thanzi La Onse (TLO) model is an individual-based simulation designed to represent interactions between individuals and the health system, incorporating demographic, behavioural, and epidemiological processes, as well as the organisation of health services. It captures a wide spectrum of health conditions, including communicable diseases,

non-communicable diseases, and maternal and newborn health. Full details of the model structure and calibration procedures are described elsewhere<sup>17,18</sup>. The model was developed to support Malawi's Ministry of Health and health sector stakeholders in prioritising investment decisions to improve performance on health sector objectives.

The framework allows us to systematically identify which functions and impact pathways are explicitly mechanistically represented within the TLO model and those which are treated as exogenous or fixed, in the latest version of the model<sup>18</sup>. As shown in **Figure 2**, the model simulates key processes within the domains of health system inputs, healthcare seeking, service delivery, and health outcomes, while other system functions (e.g. governance and financing) are reflected only through static assumptions.

**Figure 3** applies the framework to visualise the evaluation of a system-wide Health System Strengthening (HSS) strategy, as presented in Mangal et al. (2025)<sup>56</sup>, which compares a range of vertical and horizontal investment packages in terms of health impact and cost-effectiveness. The horizontal strategy (called the *HSS Expansion Package*) targets improvements in the availability of medical commodities, expansion of the health workforce, and service prioritisation. The framework played a central role in guiding this evaluation by helping stakeholders and analysts identify which health system functions were to be directly targeted (commodities, workforce, service prioritisation), which were assumed to remain unchanged, and which would be indirectly affected through interdependencies. In doing so, the framework provided a common reference point for discussions with stakeholders, supported the design of the interventions to be simulated, and ensured shared understanding of the modelling scope and assumptions.

Figure 3 also illustrates how the framework makes explicit the pathways through which modelled investments propagate across the health system, influencing service delivery, healthcare seeking behaviour, and ultimately health outcomes (deaths and disability-adjusted life years averted). At the same time, it provides a structured way to document modelling assumptions, including those concerning infrastructure, provider productivity, and social determinants of health, so that these are transparent and open to scrutiny. This transparency enhances both the interpretability and the credibility of model-based economic evaluations, particularly when assessing complex, cross-cutting interventions such as those examined in Mangal et al. (2025). Equally, the framework can be valuable for communicating the outcomes of more focused, single-component interventions (for example, changes to service prioritisation<sup>48</sup>) by making explicit how even narrow interventions rest on assumptions about their interaction with the wider health system.

## 4. Conclusion

This paper reviewed existing frameworks used to conceptualise health systems in the context of economic evaluation and synthesised their contributions through a meta-narrative approach. We identified four broad types of system conceptualisation and assessed their relevance for informing the structure and application of Health System Models (HSMs). Building on this synthesis and our experience developing the Thanzi La Onse (TLO) model, we proposed a new conceptual framework tailored to the needs of HSMs, designed to support evaluations of health interventions from a systems perspective.

Our framework serves three functions. First, it acts as a blueprint, helping analysts decide which system components to model in detail and which to include more abstractly, identifying areas where empirical evidence and expert elicitation are needed, and clarifying model boundaries. Second, it facilitates the representation of a broad range of interventions - from macro-level financing reforms to micro-level quality improvements - and facilitates tracing their pathways of impact individually or jointly. Third, it improves communication and interpretability by providing a structured lens through which assumptions and mechanisms can be clearly conveyed to diverse audiences, including policymakers, funders, and other stakeholders.

While the framework does not prescribe a specific modelling approach, it provides a common structure that can support a wide range of users. For technical audiences such as health economists, modellers, and policy analysts, it helps to guide model design choices, prioritise data collection, document assumptions, and engage stakeholders in model design and validation. For policy advisors, ministries of health and global health institutions, it offers a transparent way to design interventions, plan evaluations, interpret model outputs in terms of system functions and interdependencies, and facilitate inter-sectoral discussions on how investments in one part of the system may influence others. The framework's comparative advantage lies in bridging high-level theories of change with the operational requirements of simulation-based evaluations, something previous frameworks have not fully achieved. The application to the Thanzi La Onse (TLO) model illustrates this advantage, demonstrating how the framework enables explicit description of mechanistic assumptions and clear identification of system functions and pathways that fall outside the model's scope.

To support adaptation and reuse, an editable version of the framework is available at <https://bit.ly/HSM-framework>. This allows other users to extend, annotate, or tailor the framework to their own modelling contexts or policy questions.

We acknowledge the limitations of our study. As a meta-narrative rather than systematic review, relevant literature may have been missed. We do not offer guidance on which functions or sub-functions must be included in HSMs; this depends on the intervention, decision context, and available data. More generally, HSM design requires balancing abstraction and detail: each sub-function could, in principle, be represented by its own dynamic model (for example, a detailed simulation of drug inventory management<sup>57</sup>), but such detail is not always feasible or necessary. Functions such as governance and health financing may be especially challenging to parameterise and may be incorporated in HSMs at a higher level of abstraction, with less granularity than components such as health system inputs or social determinants of health. We also do not provide methodological guidance on the use of HSMs for evaluation, for example on how to synthesise evidence and capture uncertainty, which present unique challenges for complex HSMs. Additionally, defining the boundary of the health system remains a judgement call. In developing the framework, we treat broader contextual forces, such as climate change, technological innovation, conflict, global politics, as exogenous to the health system. Their sources of impact lie outside the scope of the framework, but their effects on the health system - for example, disruptions to supply chains, changes in disease burden, or shifts in service delivery capacity - are highly relevant for HSMs and can be incorporated through their influence on modelled functions and outcomes. Finally, our focus has been on HSMs with a national scope; extending the

framework to models with a global or cross-country scope, as discussed by Borghi et al. (2022)<sup>13</sup>, requires further consideration that lies beyond the remit of this paper.

With a growing focus on system-level interventions<sup>4,56</sup>, the use of HSMs for economic evaluation is likely to increase. We hope that this work contributes to more transparent, relevant, and rigorous use of health system models in guiding real-world policy and investment decisions.

**Table 1: Inclusion and Exclusion Criteria for Meta-Narrative Review**

<b>Criterion</b>	<b>Inclusion</b>	<b>Exclusion</b>
<b>Scope</b>	Frameworks that address the health system as a whole or multiple interlinked system components	Frameworks that focus on single component (e.g., drugs supply chain only) or single disease (eg. <i>HIV investment framework</i> <sup>58</sup> )
<b>Purpose</b>	Frameworks developed to guide comparative evaluation of health policy or investment options, with health or health-related outcomes as the final goals assessed	Frameworks intended purely for situation analysis (eg. <i>WHO Service Availability and Readiness Assessment (SARA)</i> <sup>59</sup> ) rather than forward planning
<b>Structure</b>	Frameworks that offer a structured depiction of components, causal pathways, or functional relationships between system parts	Frameworks that offer checklists for ‘health system benchmarking’ without causal pathways or functional linkages (eg. <i>WHO SARA</i> ).
<b>Conceptual Contribution</b>	Frameworks that introduce new conceptual elements or extend existing models in terms of system structure, relationships, or evaluation method.	Frameworks that closely mirror already-included models without substantive additions (e.g., <i>Health System Analysis for Better Health System Strengthening</i> <sup>60</sup> ) or are practical applications of existing frameworks (e.g. Mohan et al. (2023) <sup>61</sup> )

**Table 2: Summary of existing conceptualisations for the consideration of health systems for economic and health system assessment**

No.	Framework	Core Conceptualisation of the Health System	Relevant Evaluation Method	Key Strength or Contribution
<b>1. Inventory list</b>				
<b>1</b>	<b>Walt &amp; Gilson (1994)<sup>21</sup></b>	Health systems are shaped not only by technical inputs but by political and organisational factors. The framework introduces the <b>Policy Triangle</b> (Content, Context, Process) as key dimensions influencing health system change, along with their interaction with the actors who implement reform.	Conceptual only	Sought to move policy analysis beyond a purely technical focus by highlighting the importance of <b>process, context, and actors</b> in shaping policy outcomes of health system reform.
<b>2</b>	<b>World Health Organisation (2007)<sup>22</sup></b>	Health system as six interrelated components (service delivery, health workforce, information, medical products and technologies, financing, and leadership and governance)	Conceptual only	Provided a structured language for system components; Served as the foundational structure for later frameworks that link system components to evaluation and prioritisation efforts
<b>3</b>	<b>Roberts et al. (2008)<sup>25</sup></b>	Mechanisms for health sector reform grouped into five control knobs representing the most important factors that determine a health system's outcomes - financing, payment, organisation, regulation, behaviour	Conceptual only	Offers a consequence-oriented framing of policy levers; highlights interdependence between levers and integrates ethical and political considerations into system change.

4	<b>WHO Maximizing Positive Synergies Collaborative Group (2009)</b> <sup>23</sup>	WHO building blocks categorised into global health initiatives and domestic health systems	Conceptual only	Highlighted system-level effects of external funding and programs
5	<b>Sacks et al (2019)</b> <sup>24</sup>	WHO building blocks expanded to incorporate community-level health workers, community organisation, societal partnerships, and accountability (administrative and social).	Conceptual only	Adds granularity to the "building blocks" by including health workers at the community level, community organisation, and societal partnerships (e.g. civil society and research). Reframes the "information" block as part of a larger structure of "information, learning and accountability,"
6	<b>Papanicolas et al. (2023)</b>	Represents the health system as a set of interrelated functions that influence intermediate objectives (e.g., access, quality, efficiency) and final goals (e.g., health outcomes, equity, financial protection). Emphasizes <b>conceptual linkages</b> across functions and goals.	Performance monitoring framework; not linked to economic evaluation	Extends the WHO Building Blocks by adding granular subcomponents within each health system function and explicitly mapping how functions relate to intermediate and final outcomes.
<b>2. Aggregate production/coverage parameter</b>				
7	<b>Morton et al. (2016)</b> <sup>26</sup>	Health system as platform efficiency modifier; HSS as productivity-enhancing input	Constrained optimisation (Linear)	Allowed modelling horizontal investments using simplified assumptions

8	<b>Van Baal et al. (2018)</b> <sup>27</sup>	Health system as a set of input constraints shaping intervention feasibility and Incremental Cost-Effectiveness Ratio (ICER) interpretation	Constrained optimisation (Linear)	Illustrates how system constraints modify the cost-effectiveness of interventions in practice
9	<b>Hauck et al. (2019)</b> <sup>14</sup>	Health system platforms as targets of three horizontal investment types - efficiency-enhancing, capacity-expanding, and platform-generating.	Constrained optimisation (Linear)	Broadened concept of horizontal investment; captured interdependence across vertical interventions (services)
10	<b>Kirwin et al. (2022)</b> <sup>28</sup>	Health system as a multi-period, imperfectly divisible resource environment with spillovers	Constrained optimisation (Integer programming)	Added realism to modelling HSS trade-offs, including dynamic and intertemporal elements
<b>3. Disease/illness/care pathway</b>				
11	<b>De Silva et al. (2014)</b> <sup>29</sup>	Theory of change framework for program evaluation across care pathway from inputs to final impact	Impact evaluation; Randomised Control Trials (RCTs)	Emphasized stakeholder-led logic modelling to improve transparency in causal mechanisms considered
12	<b>Vassall et al. (2016)</b> <sup>2</sup>	Health system as a series of constraints along the disease/illness/care pathway	Implementation research; decision analytic models	Made the case for modelling real-world constraints in technology evaluation
13	<b>Ochalek et al. (2018)</b> <sup>9</sup>	Health system as demand and supply constraints defining effective (maximum feasible) coverage of interventions	League tables; constrained optimisation	Enabled modelling of service-specific bottlenecks without assuming optimal allocation

14	<b>EQUIST (UNICEF, 2016)<sup>31</sup></b>	Health system bottlenecks modelled as linear cascade of constraints on supply of resources, demand, and quality resulting in an overall maximum effective coverage of services	Bottleneck analysis combined with the use of Lives Saved Tool (LiST) to translate service coverage levels to health outcomes	Introduced data-driven prioritization for HSS strategies
<b>4. Complex adaptive systems</b>				
15	<b>McDonnell et al. (2004)<sup>33</sup></b>	System as a causal loop including health, economic, and infrastructure components	System dynamics modelling (SDM)	Linked health system to broader macroeconomic outcomes
16	<b>De Savigny &amp; Adam (2009)<sup>32</sup></b>	Emphasizes feedback loops and operational feasibility over linear input-output chains	Plausibility and adequacy designs	Introduced contextual realism in evaluation; enabled unintended consequence mapping
17	<b>Atun et al (2010)<sup>35</sup></b>	The health system is treated as a <b>complex adaptive system</b> with dynamic, non-linear interactions between system elements, the broader context, and an “adoption system” of actors and institutions (professional groups, opinion leaders, social networks, systems and structures) which determine the speed and scale of adoption of innovations.	Conceptual only	Provides a framework to analyse how new health interventions (technologies or reforms) are diffused or adopted by existing system functions. Emphasises the importance of considering the socio-political context, problem perceptions, adoption systems, institutional behaviours, rather than focusing solely on structural components of the health system.

18	<b>Paina &amp; Peters (2012)</b> <sup>34</sup>	Health system as a web of complex, adaptive interactions among actors and institutions	SDM / ABM / Complex systems modelling	Highlighted need to model <i>emergent behaviour</i> and <i>feedback</i> in health system scale-up <sup>35</sup>
19	<b>Verguet et al (2019)</b> <sup>36</sup>	Combines WHO building blocks with control knobs to represent the health system as an interactive architecture of platforms, workforce, services, and population, through which the impact of policy options can be propagated.	SDM / ABM / Complex systems modelling	Provides a clear distinction between health system architecture/context and policy levers, and emphasises the integration of political analysis into system models, framing politics as both a constraint and a potential driver of reform.

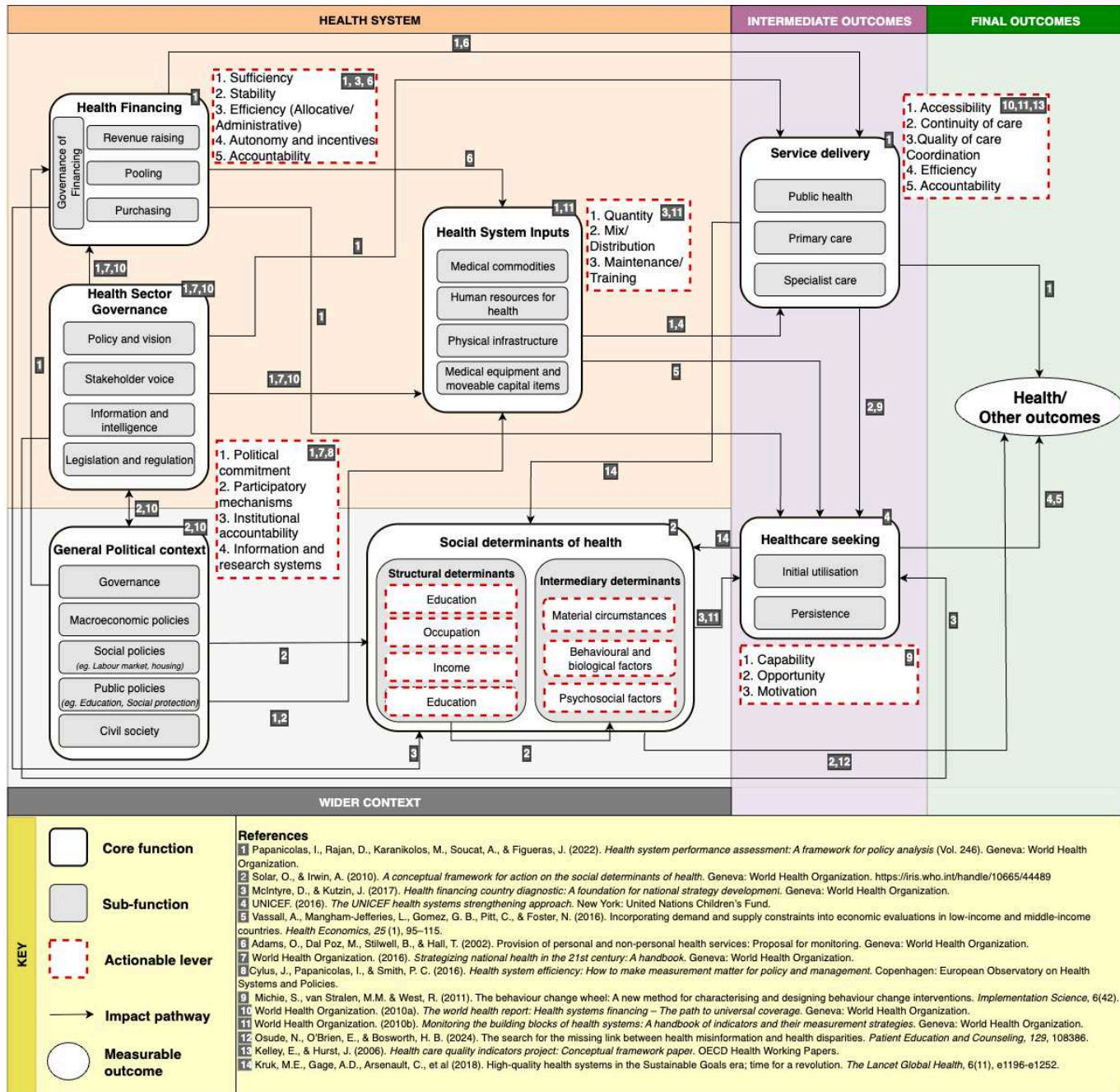
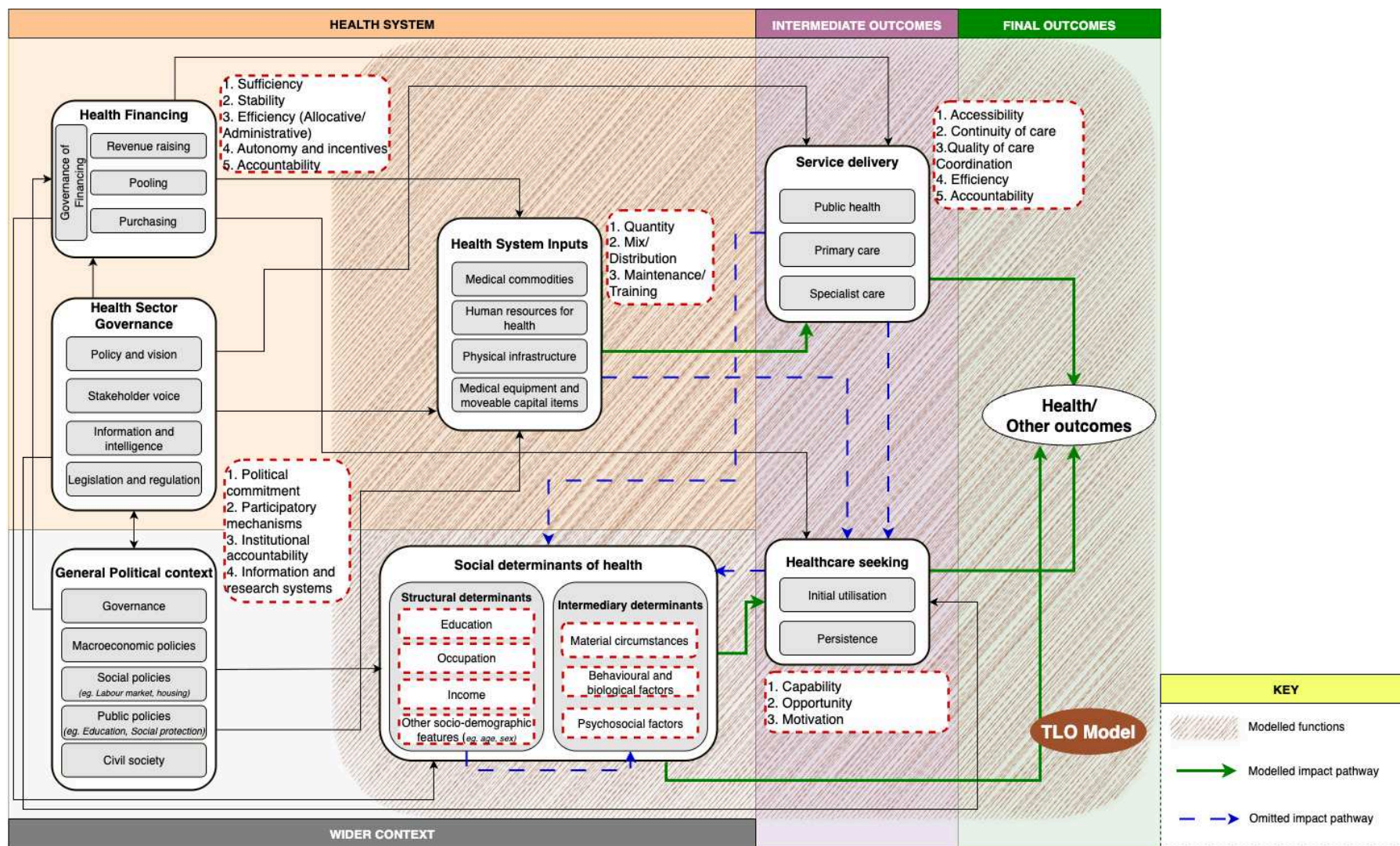
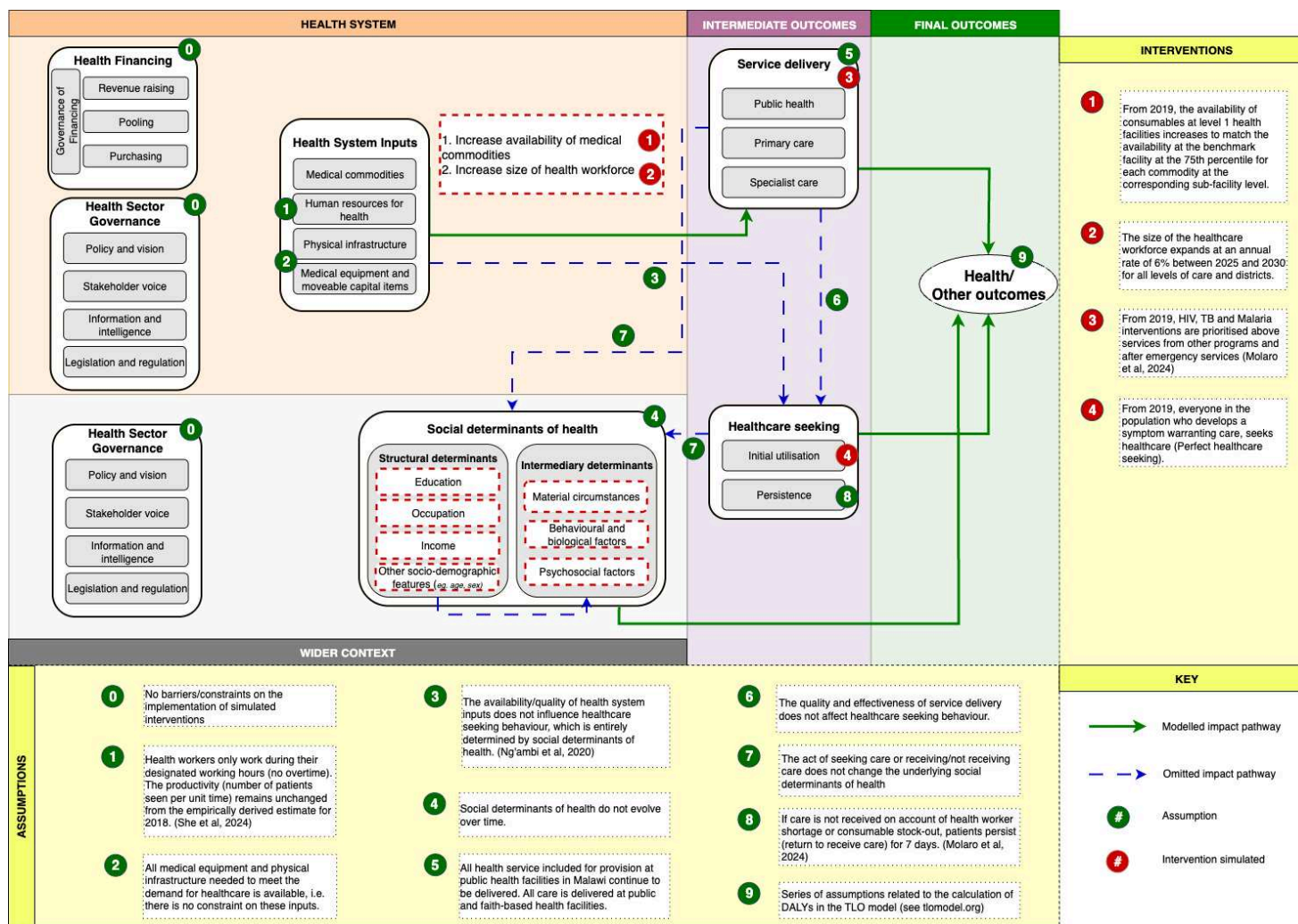


Figure 1: Conceptual Framework for Health System Model (HSM Framework)



**Figure 2: Boundaries of the Thanzi La Onse Model within the HSM Framework.** The shaded area represents the components which are explicitly modelled within the current version of the TLO model<sup>18</sup>



**Figure 3: Representation of a complex health system intervention package using the HSM framework.** This is a representation of the *HSS Expansion package* strategy simulated using the TLO model in Mangal et al (2025)<sup>56</sup>

## References

1. Frenk, J. The Global Health System: Strengthening National Health Systems as the Next Step for Global Progress. *PLOS Med.* **7**, e1000089 (2010).
2. Vassall, A., Mangham-Jefferies, L., Gomez, G. B., Pitt, C. & Foster, N. Incorporating Demand and Supply Constraints into Economic Evaluations in Low-Income and Middle-Income Countries. *Health Econ.* **25**, 95–115 (2016).
3. Mangal, T. D. *et al.* Assessing the effect of health system resources on HIV and tuberculosis programmes in Malawi: a modelling study. *Lancet Glob. Health* **12**, e1638–e1648 (2024).
4. Walker, S. *et al.* Program Evaluation of Population- and System-Level Policies: Evidence for Decision Making. <https://doi.org/10.1177/0272989X211016427> (2021)  
doi:10.1177/0272989X211016427.
5. Jamison, D. T. *et al.* Global health 2035: a world converging within a generation. *The Lancet* **382**, 1898–1955 (2013).
6. Hendrix, N. *et al.* Economic evaluations of health system strengthening activities in low-income and middle-income country settings: a methodological systematic review. *BMJ Glob. Health* **7**, (2022).
7. Cleary, S. Economic evaluation and health systems strengthening: a review of the literature. *Health Policy Plan.* **35**, 1413–1423 (2021).
8. World Health Organization. *Implementation Research for the Control of Infectious Diseases of Poverty: Strengthening the Evidence Base for the Access and Delivery of New and Improved Tools, Strategies and Interventions.* (World Health Organization, Geneva, 2011).
9. Ochalek *et al.* Supporting the development of a health benefits package in Malawi. *BMJ Glob. Health Practice*, (2018).
10. Chang, A. Y., Ogbuoji, O., Atun, R. & Verguet, S. Dynamic modeling approaches to characterize the functioning of health systems: A systematic review of the literature. *Soc.*

- Sci. Med.* **194**, 160–167 (2017).
11. Borghi, J. & Chalabi, Z. Square peg in a round hole: re-thinking our approach to evaluating health system strengthening in low-income and middle-income countries. *BMJ Glob. Health* **2**, e000406–e000406 (2017).
  12. World Health Organization. *Monitoring the Building Blocks of Health Systems : A Handbook of Indicators and Their Measurement Strategies*. 92 (World Health Organization, 2010).
  13. Borghi, J. *et al.* Viewing the global health system as a complex adaptive system – implications for research and practice. *F1000Research* **11**, 1147 (2022).
  14. Hauck, K. *et al.* How can we evaluate the cost-effectiveness of health system strengthening? A typology and illustrations. *Soc. Sci. Med.* (2019) doi:10.1016/j.socscimed.2018.10.030.
  15. Greenhalgh, T. *et al.* Storylines of research in diffusion of innovation: a meta-narrative approach to systematic review. *Soc. Sci. Med.* **61**, 417–430 (2005).
  16. Papanicolas, I., Rajan, D., Karanikolos, M., Soucat, A. & Figueras, J. *Health System Performance Assessment: A Framework for Policy Analysis*. 246 (2022).
  17. Hallett, T. B. *et al.* Estimates of resource use in the public-sector health-care system and the effect of strengthening health-care services in Malawi during 2015–19: a modelling study (Thanzi La Onse). *Lancet Glob. Health* **13**, e28–e37 (2025).
  18. Hallett, T. *et al.* The Thanzi La Onse Model. Zenodo <https://doi.org/10.5281/zenodo.15357253> (2025).
  19. Breuer, E., Lee, L., De Silva, M. & Lund, C. Using theory of change to design and evaluate public health interventions: a systematic review. *Implement. Sci.* **11**, 63 (2016).
  20. Sakshi Mohan, Mark Sculpher, Paul Revill, & The Thanzi La Onse Modelling Team. Health system modelling for health sector-wide resource allocation: A framework and novel application using the Thanzi la Onse model. in *Health Economists' Study Group* (Oxford, 2023).
  21. Walt, G. & Gilson, L. Reforming the health sector in developing countries: the central role

- of policy analysis. *Health Policy Plan.* **9**, 353–370 (1994).
22. World Health Organization (WHO). *Everybody's Business: Strengthening Health Systems to Improve Health Outcomes (WHO's Framework for Action)*. (2007).
  23. World Health Organization Maximizing Positive Synergies Collaborative Group. An assessment of interactions between global health initiatives and country health systems. *The Lancet* **373**, 2137–2169 (2009).
  24. Sacks, E. *et al.* Beyond the building blocks: integrating community roles into health systems frameworks to achieve health for all. *BMJ Glob. Health* **3**, e001384–e001384 (2019).
  25. Roberts, M., Hsiao, W., Berman, P. & Reich, M. *Getting Health Reform Right: A Guide to Improving Performance and Equity*. 344 (Oxford University Press, 2008).  
doi:10.1093/ACPROF:OSO/9780195371505.001.0001.
  26. Morton, A., Thomas, R. & Smith, P. C. Decision rules for allocation of finances to health systems strengthening. *J. Health Econ.* **49**, 97–108 (2016).
  27. van Baal, P., Morton, A. & Severens, J. L. Health care input constraints and cost effectiveness analysis decision rules. *Soc. Sci. Med.* **1982** **200**, 59–59 (2018).
  28. Kirwin, E., Meacock, R., Round, J. & Sutton, M. The diagonal approach: A theoretic framework for the economic evaluation of vertical and horizontal interventions in healthcare. *Soc. Sci. Med.* **301**, 114900 (2022).
  29. De Silva, M. J. *et al.* Theory of Change: A theory-driven approach to enhance the Medical Research Council's framework for complex interventions. *Trials* **15**, 1–13 (2014).
  30. Tanahashi, T. Health service coverage and its evaluation. *Bull. World Health Organ.* **56**, 295–303 (1978).
  31. Chopra, M., Lakshmi N Balaji, Harry Campbell, & Igor Rudan. Global health economics: The Equitable Impact Sensitive Tool (EQUIST) – development, validation, implementation and evaluation of impact (2011 to 2022). *J. Glob. Health* (2023)  
doi:10.7189/jogh.13.04183.
  32. de Savigny, D. & Adam (Eds), T. *Systems Thinking for Health Systems Strengthening*.

[https://apps.who.int/iris/bitstream/handle/10665/44204/9789241563895\\_eng.pdf;jsessionid=7D77626757A58263C3A7F70062C255B1?sequence=1](https://apps.who.int/iris/bitstream/handle/10665/44204/9789241563895_eng.pdf;jsessionid=7D77626757A58263C3A7F70062C255B1?sequence=1) (2009)  
doi:10.4037/CCN2022225.

33. Mcdonnell, G., Wales, S., Heffernan, M. & Faulkner, A. Using System Dynamics to analyse Health System Performance within the WHO Framework. *White Pap. Evans Peck* (2004).
34. Paina, L. & Peters, D. H. Understanding pathways for scaling up health services through the lens of complex adaptive systems. *Health Policy Plan.* **27**, 365–373 (2012).
35. Atun, R., de Jongh, T., Secci, F., Ohiri, K. & Adeyi, O. Integration of targeted health interventions into health systems: a conceptual framework for analysis. *Health Policy Plan.* **25**, 104–111 (2010).
36. Verguet, S. *et al.* Health system modelling research: towards a whole-health-system perspective for identifying good value for money investments in health system strengthening. *BMJ Glob. Health* **4**, e001311–e001311 (2019).
37. Dheepa Rajan. Chapter 3: Situation analysis of the health sector. in *Strategizing national health in the 21st century: a handbook* (World Health Organization, Geneva).
38. Adams, O. *et al.* *Provision of Personal and Non-Personal Health Services: Proposal for Monitoring.* (2002).
39. Katja Rohrer & Dheepa Rajan. Chapter 2: Population consultation on needs and expectations. in *Strategizing national health in the 21st century: a handbook* (World Health Organization, Geneva).
40. de Cos, P. H. & Moral-Benito, E. Determinants of health-system efficiency: evidence from OECD countries. *Int. J. Health Care Finance Econ.* **14**, 69–93 (2014).
41. World Health Organization. *The world health report: health systems financing: the path to universal coverage.* (World Health Organization, 2010).
42. Frank Terwindt & Dheepa Rajan. Chapter 5. Strategic planning: transforming priorities into plans. in *Strategizing national health in the 21st century: a handbook* (World Health Organization, Geneva).

43. *Health System Efficiency: How to Make Measurement Matter for Policy and Management*. (European Observatory on Health Systems and Policies, Copenhagen (Denmark), 2016).
44. Solar, O. & Irwin, A. *A Conceptual Framework for Action on the Social Determinants of Health*. <https://iris.who.int/handle/10665/44489> (2010).
45. WHO Commission on Social Determinants of Health. *Closing the Gap in a Generation: Health Equity through Action on the Social Determinants of Health*. (2008).
46. Kelley, E. & Hurst, J. Health Care Quality Indicators Project: Conceptual Framework Paper. *OECD Health Work. Pap.* (2006) doi:10.1787/440134737301.
47. World Health Organization. *The World Health Report 2008 : Primary Health Care Now More than Ever*. 119 <https://iris.who.int/handle/10665/43949> (2008).
48. Molaro, M. *et al.* A new approach to Health Benefits Package design: an application of the Thanzi La Onse model in Malawi. *PLOS Comput. Biol.* **20**, e1012462 (2024).
49. UNICEF. *The UNICEF Health Systems Strengthening Approach*. (2016).
50. Rosenstock, I. M., Strecher, V. J. & Becker, M. H. Social learning theory and the Health Belief Model. *Health Educ. Q.* **15**, 175–183 (1988).
51. Michie, S., van Stralen, M. M. & West, R. The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implement. Sci.* **6**, 42 (2011).
52. Funk, S. *et al.* Nine challenges in incorporating the dynamics of behaviour in infectious diseases models. *Epidemics* **10**, 21–25 (2015).
53. Osi, A. & Ghaffarzadegan, N. Parameter estimation in behavioral epidemic models with endogenous societal risk-response. *PLOS Comput. Biol.* **20**, e1011992 (2024).
54. Kruk, M. E. *et al.* High-quality health systems in the Sustainable Development Goals era: time for a revolution. *Lancet Glob. Health* **6**, e1196–e1252 (2018).
55. Ventelou, B. *et al.* The Macroeconomic Consequences of Renouncing to Universal Access to Antiretroviral Treatment for HIV in Africa: A Micro-Simulation Model. *PLoS ONE* **7**, (2012).

56. Mangal, T. D. *et al.* System-Wide Investments Enhance HIV, TB and Malaria Control in Malawi and Deliver Greater Health Impact. 2025.04.29.25326667 Preprint at <https://doi.org/10.1101/2025.04.29.25326667> (2025).
57. Ngai-Hang Z. Leung, Ana Chen, Prashant Yadav, & Jérémie Gallien. The Impact of Inventory Management on Stock-Outs of Essential Drugs in Sub-Saharan Africa: Secondary Analysis of a Field Experiment in Zambia. *PLOS ONE* **11**, e0156026 (2016).
58. Schwartländer, B. *et al.* Towards an improved investment approach for an effective response to HIV/AIDS. *The Lancet* **377**, 2031–2041 (2011).
59. Service availability and readiness assessment (SARA).  
[https://www.who.int/data/data-collection-tools/service-availability-and-readiness-assessment-\(sara\)](https://www.who.int/data/data-collection-tools/service-availability-and-readiness-assessment-(sara)).
60. Peter Berman & Ricardo Bitran. *Health System Analysis for Better Health System Strengthening*.  
<https://documents1.worldbank.org/curated/en/472131468331150352/pdf/659270WP0Health00Box365730B00PUBLIC0.pdf> (2011).
61. Mohan, S. *et al.* Supporting the revision of the health benefits package in Uganda: A constrained optimisation approach. *Health Econ.* **32**, 1244–1255 (2023).