Handbook - Architectural approaches to implementing digital health supply chain.

DRAFT FOR PUBLIC CONSULTATION

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Contents

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Abbreviations

CDC	Centre for Disease Control
CMST	Central Medical Stores Trust
DAK	Digital Adaptation Kit
DB	Database
DHSC	Digital Health Supply Chain
eLMIS	Electronic Logistics Management Information System
FHIR	Fast Healthcare Interoperability Resources®
FTE	Full-time equivalents
GFPVAN	Global Family Planning Visibility and Analytics Network
GHSC-PSM	Global Health Supply Chain Procurement and Supply Management program
HL7	Health Level Seven®
HSCIS	Health Supply Chain Information System
ICT	Information and Communication Technology
IT	information technology
ITU	International Telecommunication Union
KPI	Key Performance Indicator
MOH	Ministry of Health
NPC	National Product Catalog
NSCA	National Supply Chain Assessment
OpenHIE	Open Health Information Exchange
QA	Quality Assurance
RFP	Request for proposal
RFQ	Request for quote
SC	Supply Chain
SCSA	Supply Chain Systems Architecture
SCISMM	Supply Chain Information Systems Maturity Model
TOGAF	The Open Group Architecture Framework
TOR	Terms of Reference
TSS	Target Software Standards
TWG	Technical Working Group
UNDP	United National Development Programme
USAID	United States Agency for International Development
WFP	World Food Programme
WHO	World Health Organization
WMS	Warehouse Management System

Glossary

Deployment	Making the software system available for use beyond testing purposes.
Digital health	Digital health is the systematic application of information and communications technologies, computer science, and data to support informed decision-making by individuals, the health workforce, and health systems, to strengthen resilience to disease and improve health and wellness.[1] [2]
Digitization	The process of converting and organizing data from manual paper records into a digital format for easier entry, storage and retrieval. Digitization is the initial step towards digital transformation.[3][4]
Digitalization	The process of digitally automating and simplifying processes to streamline individual health programmes and reducing manual efforts for greater efficiency. Digitalization is the second step towards digital transformation.[5] [6]
Digital transformation	The process of digitally optimizing and driving systems-level changes by leveraging innovation, analytics, and feedback mechanisms to improve person centred health systems. Digital technologies are used to fundamentally change and improve how health services are delivered and accessed across all health programme areas.[7] [8] [9]
End-user	People who will be using the digital system(s).
Enterprise architecture	A blueprint of business processes, data, systems and technologies used to help planners, software developers and managers design increasingly complex systems to support the workflow and roles of people in a large enterprise, such as a health system.[10]

[1] World Health Organization et al., Digital Implementation Investment Guide (DIIG): Integrating Digital Interventions into Health Programmes, vol. In Press (Geneva: WORLD HEALTH ORGANIZATION, 2020).

[2] Digital Health and Interoperability Working Group. Annual meeting, Washington (DC), 11 December 2019.

[3] https://www.yokogawa.com/library/resources/white-papers/the-differences-between-digitization-digitalization-and-digital-transformation-in-manufacturing/

[4] https://www.gartner.com/en/information-technology/glossary/digitization

[5] [same as before - https://www.yokogawa.com/library/resources/white-papers/the-differences-between-digitization-digitalization-and-digital-transformation-in-manufacturing/}

[6] https://www.gartner.com/en/information-technology/glossary/digitalization

[7] [same as before - https://www.yokogawa.com/library/resources/white-papers/the-differences-between-digitization-digitalization-and-digital-transformation-in-manufacturing/]

[8] https://www.gartner.com/en/information-technology/glossary/digital-transformation

[9] https://www.unido.org/sites/default/files/files/2021-11/Standards%20and%20Digital%20Transformation_Complete_2021.pdf

[10] Same as footnote 12: World Health Organization et al., Digital Implementation Investment Guide (DIIG): Integrating Digital Interventions into Health Programmes, vol. In Press (Geneva: WORLD HEALTH ORGANIZATION, 2020). https://www.who.int/publications/i/item/9789240056572

Features	The characteristics of a system that include look and feel as well as what the system can do (e.g., "order processing" can be a feature of an order management solution).
Functions	Functions in a system are the different business processes it helps perform (e.g., "receiving inventory" and "picking inventory" are functions of the "warehousing" feature of a warehouse management system).
Functional requirements	Description of what the digital system needs to do to support the tasks that make up the business process and address the identified challenges
Interoperability	Ability of different applications to access, exchange, integrate and use data in a coordinated and consistent manner through the use of shared application interfaces, value sets, concepts and standards, within and across organizational, regional and national boundaries, to provide timely, safe, and seamless portability of information and optimize health outcomes.
Open- source	Open-source software is software with source code that is published and made freely available to the public, enabling anyone to inspect, modify and enhance the code within set guidelines.[11] While the source code is open to everyone, this does not mean that implementation of software is necessarily without costs. An open-source software must have a license approved by the Open-Source Initiative.[12]
Open standards	Standards that are documented and made freely available to the public, which are developed, approved, and maintained via a collaborative and consensus driven process. Open standards facilitate interoperability and data exchange and are intended for widespread adoption.[13]
Registry	A governed, authoritative and centralised information system that captures, stores, and maintains the unique attributes and identifiers of health facilities, health service users, products and/or health workforce using a predefined canonical minimum data set.
SMART Guidelines	**WHO S**tandards-based, **M**achine-readable, **A**daptive, **R**equirements-based, and **T**estable Guidelines are recommended digital capabilities, health and data content. They represent a comprehensive set of reusable digital health components (e.g., interoperability standards, code libraries, algorithms, technical and operational specifications) that transform the guideline adaptation and implementation process to preserve fidelity and accelerate uptake. SMART Guidelines provide a five-step pathway to advance the

[11] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3221346/

[12] https://opensource.org/licenses/

[13] https://www.itu.int/en/ITU-T/ipr/Pages/open.aspx

	adoption of best clinical and data practices, even if a country is not yet fully digital.[14][15]
Systems architecture	The system's technical framework depicted in a conceptual model that defines how the system is structured and how its elements are connected.
Use case	A use case is an example scenario of how the end-user will use the system.
Traceability	The ability to see the movement of health products across the supply chain. Traceability aims to trace the path of healthcare products from manufacturers to patients, identifying ownership changes at different points across the entire supply chain. Traceability additionally aids in tracking the products' whereabouts at any given moment, including their intended route toward the point of dispensing

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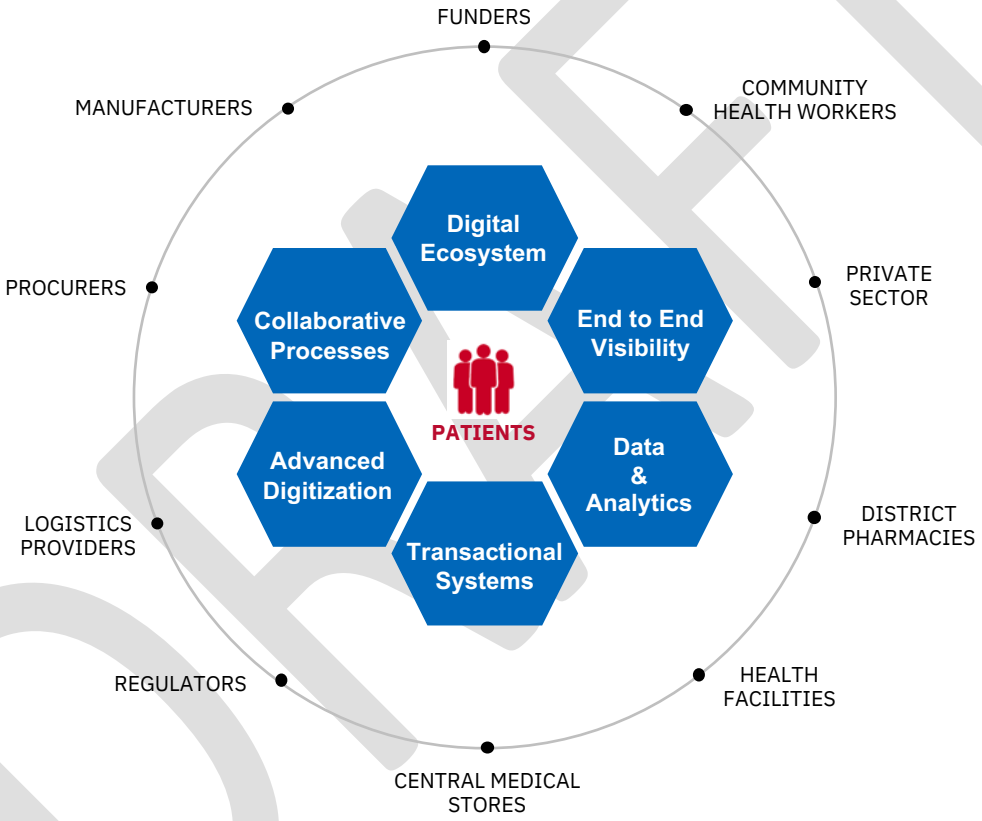
[14] SMART Guidelines (who.int)

[15] WHO SMART guidelines: optimising country-level use of guideline recommendations in the digital age - The Lancet Digital Health

Introduction

Health supply chain processes, which ensure medicines and other medical products are available to deliver health services to patients, are integral to the public healthcare system. Enhancing supply chain processes through the use of digital tools, technologies, and automation offers numerous advantages, benefiting not only organizations, operational staff, and healthcare workers but, most importantly, patients. Supply chain organisations including ministries of health, central medical stores and health facilities benefit from enhanced efficiencies in procurement, planning, inventory management, and distribution as a result of improvements. Health workers and operational staff benefit from reduced manual processes and increased productivity. Ultimately, digitalized processes translate to an efficient and effective supply chain which ensures the availability of high-quality genuine medicines and medical products to patients when and where they need them at the right quantity and at the right cost.

Figure 1: Health supply chain digitalization concept



Digital Health Supply Chain Overview

Within the WHO global strategy on digital health[16] the term 'digital health' refers to 'the field of knowledge and practice associated with any aspect of adopting digital technologies to improve health,'. In the context of digital health, the digital health supply chain is adopting digital technologies to support and improve the health supply chain. Taking a people-centric perspective, this implies application of digital technologies to ensure that right products such as medicines are procured and dispensed to the right patient at the right time, at the right cost and at the right place. In the process, digital technologies should empower individuals, healthcare organizations, and related processes by providing data and the capability to swiftly adapt to continuously evolving changes in the supply chain. The digital health supply chain (DHSC) will ensure this by providing a digital ecosystem that supports collaborative processes

[16] Global strategy on digital health 2020-2025. Geneva: World Health Organization; 2021. Licence: CC BY-NC-SA 3.0 IGO.

across all systems including supply chain, health management and regulatory. A digital ecosystem is realised when advanced automation-driven supply chain processes are integrated to interoperate with each other and with other ecosystems. DHSC, thus ensures availability of timely data, providing end-to-end visibility and effective decision-making.

Several low- and middle-income countries have undertaken initiatives to digitalize their health supply chain. However, there is a lack of a comprehensive and holistic approach to implementing digital health supply chains that aligns with and complements digital health and national information technology architectures. Planning and implementing digital health supply chain requires coordinated effort across various phases and steps within those phases. This handbook offers guidance to countries on the diverse stages involved in formulating a vision and strategy, as well as planning and implementing a scalable and sustainable digital health supply chain. This handbook primarily focuses on outlining architectural approaches that countries can adopt, tailored to their specific contexts, to advance the digitalization of health supply chains. The handbook does not delve into operational intricacies or specific functional specifications of various health supply chain systems but rather offers resources for such references.

SMART Guidelines

This handbook is developed to complement WHO's SMART Guidelines initiative by providing guidance on digital health supply chain implementations that should align with digital health implementations. SMART Guidelines are **S**tandards-based, **M**achine-readable, **A**daptive, **R**equirements-based, and **T**estable recommended digital capabilities, health and data content. SMART guidelines are WHO's approach to systematizing and accelerating the consistent application of recommended, life-saving interventions in the digital age. As countries invest heavily in digital decision-support point of service (DSPOS) solutions, SMART guidelines provide detailed specifications, documentation and encoded content that facilitate accurate incorporation into DSPOS solutions consistent with WHO clinical, public health, data, and interoperability recommendations.

SMART Guidelines are a comprehensive set of reusable digital health components which provide a five-step pathway, with each layer increasing in complexity, to advance the adoption of best clinical and data practices. The five knowledge layers comprise of:

- L1 Narrative: enhanced clinical, public health guidelines and data recommendations.
- L2 Operational: Digital Adaptation Kits (DAKs).
- L3 Machine-readable: machine-readable recommendations.
- L4 Executable: reference applications and services.
- L5 Dynamic: precision health model.

These layers inform guideline developers on how to translate recommendations into specifications and standards, technologists on integrating recommendations into updatable digital systems and countries on how to localize, make interoperable, institutionalize, and update digital systems consistent with evidence-based recommendations.[17]

The SMART Guidelines framework establishes standards of care and represents different operational components as knowledge layers, which serve as a starting point for informing the content of DSPOS that countries can incorporate, adapt and implement into country-specific contexts (see Figure 2).[18]

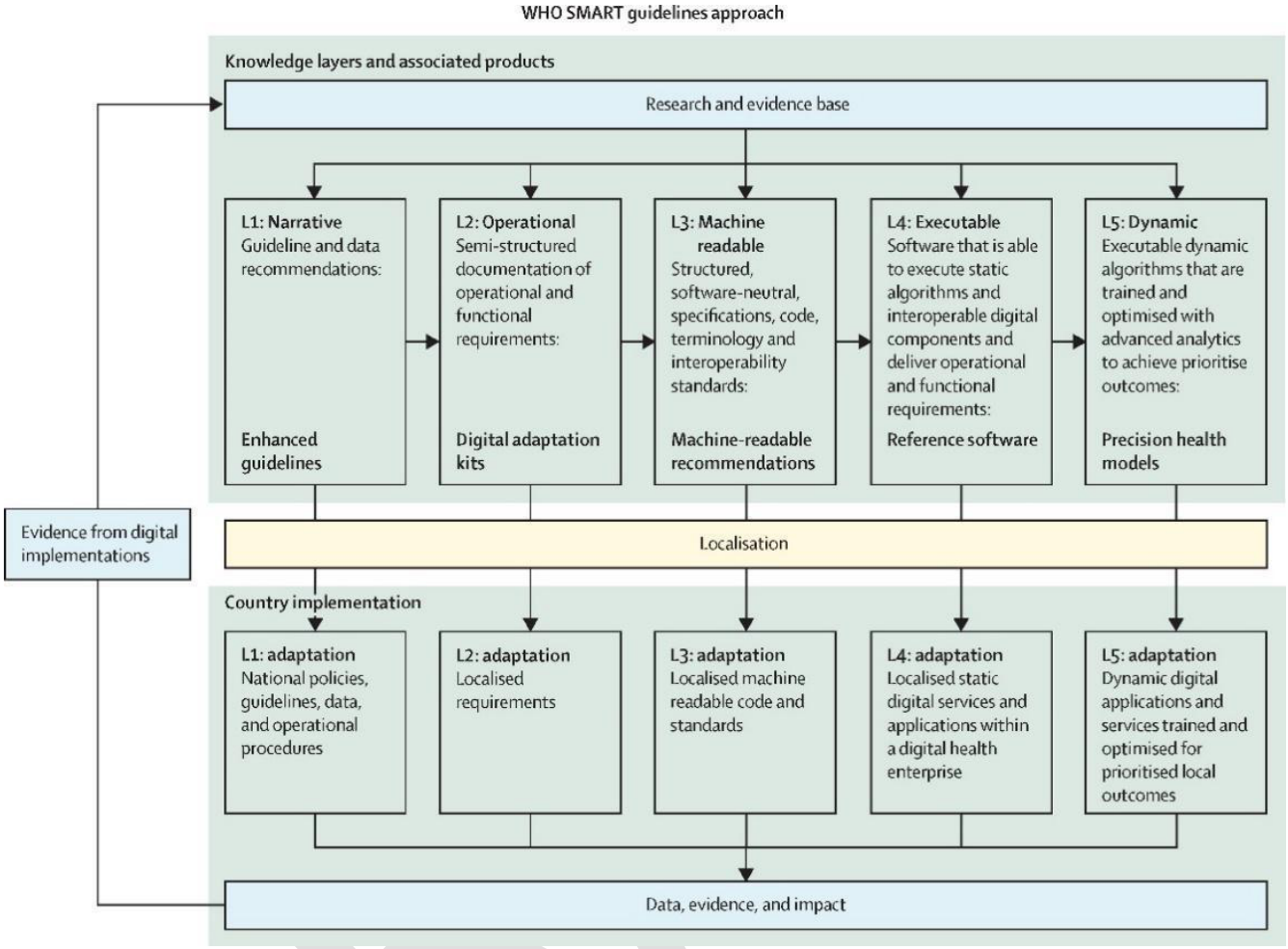
While the primary focus of SMART Guidelines is digital capabilities for healthcare, it acknowledges the importance of supply chain digitalization for healthcare. This handbook complements SMART

[17] WHO SMART guidelines: optimising country-level use of guideline recommendations in the digital age - The Lancet Digital Health

[18] SMART Guidelines (who.int)

Guidelines with digital capabilities for health supply chains and aligns with the “L1 Narrative” knowledge layer providing enhanced guidelines for implementing digital health supply chain.

Figure 2: WHO SMART Guidelines Approach



How this handbook was developed

This handbook was developed from the experiences and feedback of a variety of experts compiled primarily through the digital health supply chain small working group under the digital health and interoperability working group and through a series of consultations and feedback sessions. Furthermore, existing documentation and desk reviews were used to refine this handbook. Insights and templates were also drawn from the practical experiences of digitalizing health supply chain systems across different contexts, including Ethiopia, Nepal, Zambia, Rwanda, and Malawi.

The steps outlined in this handbook are informed by the Principles for Digital Development (Annex 1). Some methodologies and templates have been adapted from prominent sources such as the Digital Implementation Investment Guide (DIIG), WHO/ITU National eHealth strategy toolkit, the Supply Chain Information Systems Maturity Model (SCISMM) and the OpenHIE framework.

How to use this handbook

This handbook provides a stepwise approach to digitalizing health supply chain.

- Chapter 1 provides guidance on defining a holistic vision, strategic goals and objectives for digital health supply chain that aligns with the strategic priorities of national information technology and digital health.
- Chapter 2 outlines multiple approaches that can be adopted to define digital health supply chain architecture, which will be the blueprint to guide various supply chain system implementations.
- Chapter 3 helps plan the implementation and operationalization of health supply chain systems in a sustainable and scalable manner, while considering the human resource and financial aspects.
- Furthermore, the handbook explores in Chapter 4 the role of digital health supply chain in implementing pharmaceutical traceability to enhance patient safety.
- Case studies from countries that are at various stages of implementing digital health supply chains are featured in chapter 5 as practical illustrations.

Targeted users

This handbook has been developed for countries, organizations and teams seeking to plan and implement digitalization of health supply chain. This handbook aims to provide guidance to various target audiences across different phases and areas of digitalization as outlined in the table below.

Handbook Chapters	**Illustrative Target Organizations**	**Illustrative Target User Teams & Roles**	**Benefits**
Chapter 1 - Establish Digital Health Supply Chain vision & strategic goals	Ministry of Health (MOH) Central Medical Stores	Senior Management/Leaders Chief Digital Officers Supply Chain Leaders	Helps in defining the vision and strategic goals to guide the implementation of digital health supply chain
Chapter 2 - Define digital health supply chain architecture	Ministry of Health Central Medical Stores	Chief Digital Officers Technical/System/Enterprise Architects	Helps in defining the digital health supply chain architecture to guide and coordinate all digitalization activities
Chapter 3 - Plan for scalable implementation and sustainable operations	Ministry of Health Central Medical Stores Donors & Funding partners Implementation partners	Chief Digital Officers Project sponsors Project managers Technical/System/Enterprise Architects & Team Supply Chain/Operational Leaders & Team	Helps in considering all the factors such as governance, human resource capacity and infrastructure in developing a viable implementation plan for each DHSC intervention

Chapter 4 - Leverage digital health supply chain to implement traceability	Ministry of Health Central Medical Stores Donors Regulatory Authority Implementation partners	Chief Digital Officers Technical/System/Enterprise Architects & Team Supply Chain/Operational Leaders & Team Regulatory/Monitoring/ Pharmacovigilance teams	Helps in enabling pharmaceutical traceability and verification features utilizing DHSC components

When to use this handbook

This handbook would be a useful resource in the following scenarios.

- When transitioning from paper-based processes or siloed supply chain systems to an exchanged digital health supply chain architecture.
- When taking a comprehensive approach to addressing critical health supply chain challenges that persistently impact delivery of quality healthcare to patients. This includes challenges such as insufficient supply of medicines, frequent stock-outs and prevalence of substandard or falsified medicines.
- When there are several non-aligned health supply chain digitalization initiatives that are duplicative and burdensome to operational staff and healthcare workers. For example, different implementation teams or organizations deploying supply chain systems such as logistics management information systems and facility inventory management systems that overlap in functionalities and do not interoperate, requiring operational staff to enter the same data in multiple systems.

1. Establish Digital Health Supply Chain vision & strategic goals

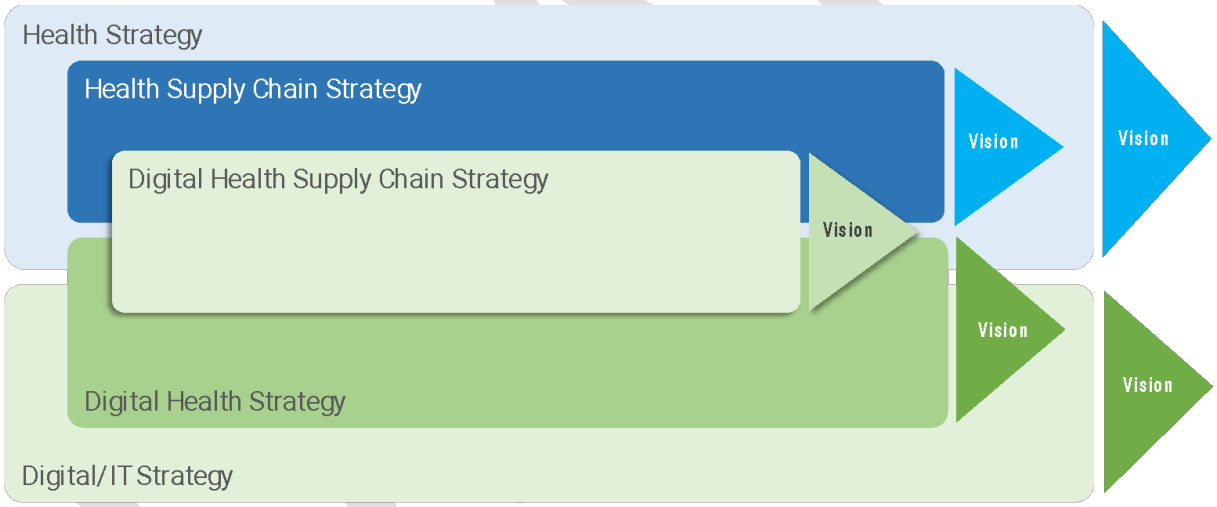
Implementation of tools and technologies to digitally transform the health supply chain cannot happen in isolation. The goals and the intended direction of DHSC should be aligned closely with the country's information technology strategy, health strategy, supply chain strategy and digital health strategy. National priorities should be a driving force behind DHSC implementation initiatives

Call out - Malawi top leadership's emphasis on national health and supply chain digitalization helped accelerate the definition and adoption of a holistic health supply chain systems architecture that provides a blueprint for all system implementation investments.

Why do we need a strategy?

A comprehensive and holistic strategy is essential for DHSC transformation to provide a clear direction that is along the same progressive path as other national strategies. Such a focused vision that aligns with national priorities and strategies ensures synergies across all national transformation initiatives. Strategic planning will provide clarity of measurable objectives and by when to achieve them. A clear vision and its aligned strategic goals, that comprehensively consider future growth needs, will ensure scalable and sustainable digitalization of the health supply chain. Well defined and measurable strategic objectives will help identify and allocate the required resources and track progress against the established vision.

Figure 3: Alignment of national strategies



National health strategy - Health strategies establish the vision and priorities to address the most pressing healthcare challenges and improve healthcare for the population.

National health supply chain strategy - Supplements the health strategy to specifically address the supply chain management of products that support the country's healthcare system.

National digital or information technology (IT) strategy - Defines the vision for the country's IT adoption and offers guidance for progress in IT infrastructure and software deployments and standards.

National digital health strategy - Digital health or eHealth strategy complements the health strategy by establishing the vision to digitize health data and digitalize healthcare processes. It aims to digitally enable health workers, improve data availability and promote interoperability.

National digital health supply chain strategy - Complements both the health supply chain strategy and the digital health strategy. It establishes the vision and priorities to digitalize the supply chain aspects

of the healthcare system. Digital health supply chain strategy could be a referenced strategy for digital health and health supply chain strategies, or it could be integral components of either strategy.

In addition to these, there could be other complementary strategies such as national pharmaceutical traceability strategy to align with. The traceability strategy will rely on the digital health supply chain strategy for digital infrastructure and data to enable track and trace of commodities.

It's crucial to recognize the potential risks such as those listed below when lacking a guiding vision and strategy.

- Fragmented or disconnected implementation of digital tools and technologies for supply chain, resulting in non-interoperable processes and systems.
    - Example – implementing the central warehouse's warehouse management system (WMS) without considering downstream facilities' electronic logistics management information system (eLMIS). This impacts downstream facilities' ability to send stock replenishment requests or orders to the central warehouse electronically, which ultimately impacts process & product traceability.
- Lack of interoperable supply chain systems resulting in time-consuming manual collection of data that is usually required for supply chain analysis, forecasting and supply planning.
    - Example – Central warehouse's WMS using formats for data elements like orders and inventory that is different from those used by downstream facilities' eLMIS will require manual effort to collect and combine data for analysis.
- Fragmented systems impacting the visibility of the supply chain and the ability to address exceptions such as stock-outs, expiries, and product recalls in a timely manner.
    - Example – when different systems across different supply chain (SC) levels do not follow global standards to identify, represent and process health products, aggregation and analysis of data such as inventory to identify potential stock-outs or expiries will be difficult.
- Rework efforts and costs, in the future, if systems need to be redesigned, modified, or repurposed to align with health information systems, regulatory systems, and other systems.
- Non-scalable supply chain systems, which require additional costs to either enhance or replace to meet growing processes, transaction volumes, functionalities, and data needs.
- Misinformed digital investments that do not provide tangible benefits to organisations and more importantly to end users and patients.
- Multiple overlapping technology implementations that result in burdensome duplicate processes for supply chain staff and health workers.

The steps outlined below can be used to define digital health supply chain vision, strategic goals and objectives.

Step 1 - Identify and engage all relevant stakeholders.

Inputs	Steps	Outputs
• National Priority (driving force) – e.g., patient safety, universal	Identify focal points from all stakeholders including government, donors & implementation partners whose inputs will be vital in defining the vision and strategic goals	• DHSC stakeholder matrix • DHSC steering committee –

health access, availability of medicines • Organograms of organizations such as MOH, regulatory & central warehouse ○ To engage teams & staff whose contributions are essential for DHSC	Identify relevant managerial & technical staff from stakeholder organizations that can be available to provide inputs	terms of reference (TOR) • DHSC technical working group – TOR
	Define a stakeholder matrix to clearly establish roles and responsibilities.	
	Establish a technical working group (TWG) and a steering committee to help facilitate analysis and development of the vision, strategic goals, and architecture. • The working group should support the overall governance* and planning of DHSC implementation activities, and the steering committee should provide leadership and oversight for all implementation activities.	

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188 ***What is Governance?**

189 Governance, in the sphere of digital health and supply chain, is the means by which
190 intragovernmental and cross-sectoral collaboration is organized by entities that advise, coordinate,
191 support, regulate, monitor, and implement digital health and digital health supply chain services and
192 applications, and ensure the security of the health and supply chain information exchange. A
193 governance mechanism facilitates the commitment of stakeholders, which is a critical prerequisite for
194 buy-in, ownership, expertise and outreach through communication. Stakeholders in a governance
195 mechanism include, but are not limited to, the public or private sector, academia and professional
196 associations.

197 *Source:* Definition adapted from 'Digital Health: A Call for Government Leadership and Cooperation
198 between ICT and Health'

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Potential Risks	Mitigation	Resources
Lack of engagement and participation from identified stakeholders	Under the leadership of MOH, a steering committee and a technical working group should be established, and regular meetings scheduled.	Steering committee - example structure
	A DHSC sponsor such as a senior leader from MOH should be identified and assigned.	
Unclear approval and decision-making process	TWG should establish a governance process to review and approve DHSC initiatives.	

Relevant stakeholder and/or decision-maker excluded from the TWG or Steering Committee	In addition to organograms, all partners working in or relevant to public health and health supply chain should be listed and be included in the initial meetings to determine appropriate participation in TWG. For e.g., donor organizations, implementation partners, health program teams within the ministry of health.	

Tips/Best Practice (#please add):

- Getting upfront buy-in and support from a senior leader in the MOH who will champion the cause is a critical step. Key donors could support that onboarding process.
- If a TWG already exists for digital health, it will help synergize efforts by incorporating DHSC as an additional task force within the same TWG rather than creating multiple TWGs. This task force can have team members focused on digital and supply chain aspects of public health.

Step 2 - Analyse the current state to identify digitalization priorities.

Inputs	Steps	Resources	Outputs
• National Priority (driving force) – e.g., patient safety, universal health care, availability of medicines • National Health Supply Chain Assessments & pain points identified through assessments • National Supply Chain, Digital Health and Pharmaceutical Traceability Strategies, if available • Supply Chain and any associated digital achievements	Identify health supply chain challenges, pain points, digitalization needs that align with digital health, national supply chain strategy/vision, pharmaceutical traceability strategy/needs and national priorities.	National Supply Chain Assessment toolkit (NSCA)	• Health supply chain digitalization priorities
	Prioritize challenges, pain points and needs that need to be addressed within the defined time frame (e.g., 1 year, 3 year or 5 year).	• Prioritisation template • Template for prioritised challenges and expected future outcomes	

Potential Risks	Mitigation	Resources
Misalignment of technical and political priorities	• Establishing the connection between political and technical priorities, and recognizing the mutual benefits from pursuing the technical priorities • Engaging political leaders and communicating critical health supply chain challenges and their various impacts on the country. • Advocacy with senior leaders to convey the advantages of digitalization and technical priorities in alignment with political goals	
Absence of relevant inputs to inform data driven decisions making priority setting arbitrary e.g., NSCA, or National SC Strategy or National Digital Health Strategy	• Conduct detailed assessments of health supply chain and supply chain systems using tools such as NSCA and SCISMM. • Use outputs from such assessments as key inputs for DHSC	NSCA toolkit SCISMM

Tips/Best Practice (#please add):

- To ensure a comprehensive assessment of the current state consider various factors such as stakeholders, human resource capacity, infrastructure, political priorities, technology maturity and maturity of processes including processes such as regulatory and insurance that impact health supply chain.

Step 3 - Define digital health supply chain vision and strategic goals.

What is a vision?

A vision statement should be a guiding beacon towards the future desired state. The vision should summarise what idealistic future state we would like to achieve and how we would achieve it.

What are strategic goals?

Strategic goals are key milestones that focus on long-term outcomes. Strategic goals should guide the country's actions and decisions to accomplish the vision. Strategic goals should link with the digital health supply chain implementation activities to clearly articulate the approach for achieving the vision.

Inputs	Steps	Outputs
• Vision statements from digital health strategy and	Define a DHSC transformation vision that provides a progressive and a sustainable direction to comprehensively address the identified strategic priorities within a reasonable timeframe.	• DHSC Transformation Vision

national supply chain strategy, if available • Health supply chain digitalization priorities	Define realistic strategic goals that will help achieve the vision within a reasonable timeframe. Each strategic goal may have its own timeline, depending on its priority. • For e.g., strategic goal 1 may be achieved by end of year 2025 whereas strategic goal 2 may be achieved by end of year 2026 depending on the respective priority and dependencies.	• DHSC strategic goals
	Define goals which can translate to detailed measurable objectives and activities.	

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Potential Risks	Mitigation	Resources
Misalignment of technical and political priorities	● Establishing the connection between political and technical priorities, and recognizing the mutual benefits from pursuing the technical priorities ● Engaging political leaders and communicating critical health supply chain challenges and their various impacts on the country. ● Advocacy with senior leaders to convey the advantages of digitalization and technical priorities in alignment with political goals	
Absence of relevant inputs to inform data driven decisions making priority setting arbitrary e.g., NSCA, or National SC Strategy or National Digital Health Strategy	● Conduct detailed assessments of health supply chain and supply chain systems using tools such as NSCA and SCISMM. Use outputs from such assessments as key inputs for DHSC	NSCA toolkit SCISMM
Dependence on senior leaders for key decisions could delay the process of approving and endorsing the strategy	● Ensure stakeholder matrix is updated and appropriate delegation plans are in place to take key decisions if key stakeholders are not available ● Identify alternate focal points or decision makers that key decision making can be delegated to in the absence of primary decision makers	

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226 **Tips/Best Practice** (#please add):

- Identify and engage key stakeholders, including management and technical personnel that can help define DHSC vision and goals.
- Conduct a visioning workshop to optimise stakeholder engagement and manage their time better.

Step 4 - Define strategic objectives for each strategic goal

What are strategic objectives?

Strategic objectives are measurable targets under strategic goals. Specific strategic objectives help achieve the long-term outcomes outlined by the strategic goals.

Inputs	Steps	Resources	Outputs
• DHSC Transformation Vision • DHSC strategic goals	Define strategic objectives under each goal. The objectives should inform the definition of the architecture and link with the architecture implementation activities.		• DHSC Transformation Vision • DHSC strategic goals
	Define measures for each of the objective to track progress.	•	

Step 5 - Define strategic roadmap and measures of performance.

What is a strategic roadmap?

A strategic roadmap includes timelines and milestones for achieving strategic objectives. It should serve as a guide for the country to stay focused on the strategic goals, allocate resources and track progress.

Inputs	Steps	Resources	Outputs
• DHSC strategic goals • Timelines of other initiatives and priorities like digital strategy, IT strategy, supply chain strategy	Define a strategic roadmap that outlines the high-level timeline for achieving the strategic objectives.		• DHSC strategic roadmap • Performance indicators
	Define performance indicators for all the strategic objectives to measure progress and effectiveness.		

Potential Risks	Mitigation	Resources

Absence of dedicated human resources to develop and monitor performance indicators	• Establish indicators by utilizing and tailoring available resources such as NSCA key performance indicators (KPIs), through a cross-organization collaborative effort • Incorporate the identified KPIs into ongoing operational processes, where feasible into system workflows, to minimize manual data collection and analysis	NSCA KPIs
Funding gaps to advance strategic goals	• Adopt a phased approach to achieving the goals. Define phases that are manageable from a funding and capacity perspective. • Engage and collaborate with multiple partners and donors to identify funding opportunities.	
Availability of funding does not align with the established timeline	Develop the roadmap iteratively in close collaboration with funding partners to incorporate their feedback and ensure alignment.	

Tips/Best Practice (#please add):

- Capture baseline performance for comparison against improvements after implementation, aiding in assessing return on investment, value, and the progress's impact.

Guiding Principles

The following principles, informed by the '**Principles for Digital Development**', should guide the development of DHSC vision and strategic goals.

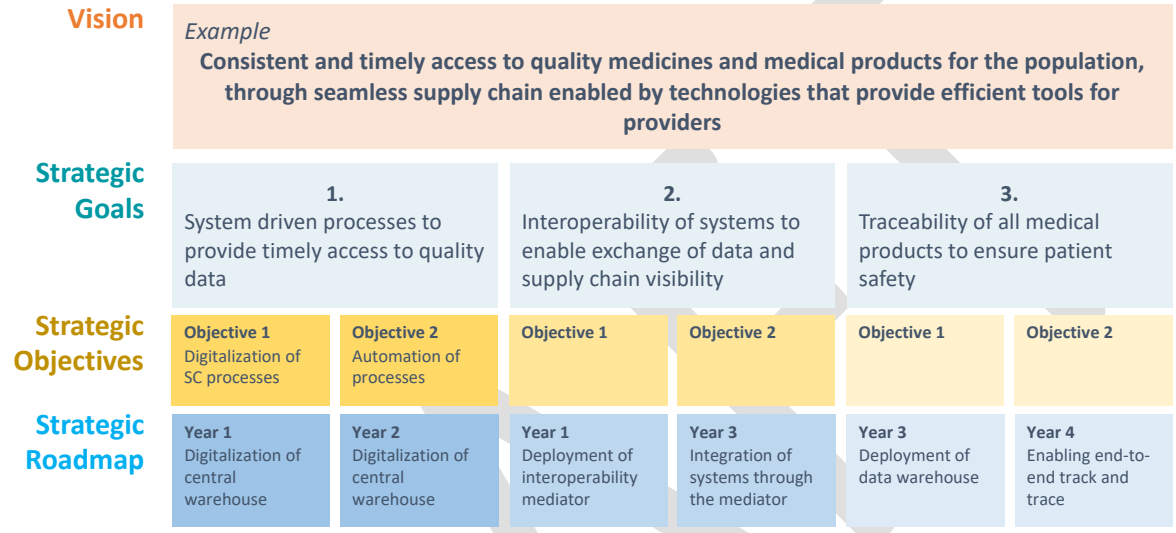
- Align with a relevant national priority (examples – patient safety, universal health care, access to medicines etc. #please share examples)
- Take a user centred approach.
- Strive for an ecosystem of interoperability and collaboration.
- Continuously engage all stakeholders
- Leverage, reuse and enhance existing resources, assets and capabilities.
- Aim for scalability and sustainability.

Progress Check

After finishing the steps outlined in this chapter, you should have,

- ❑ DHSC vision
- ❑ DHSC strategic goals
- ❑ DHSC strategic objectives
- ❑ DHSC strategic roadmap

Figure 4: Illustrative example of outputs from this chapter



2. Define digital health supply chain architecture

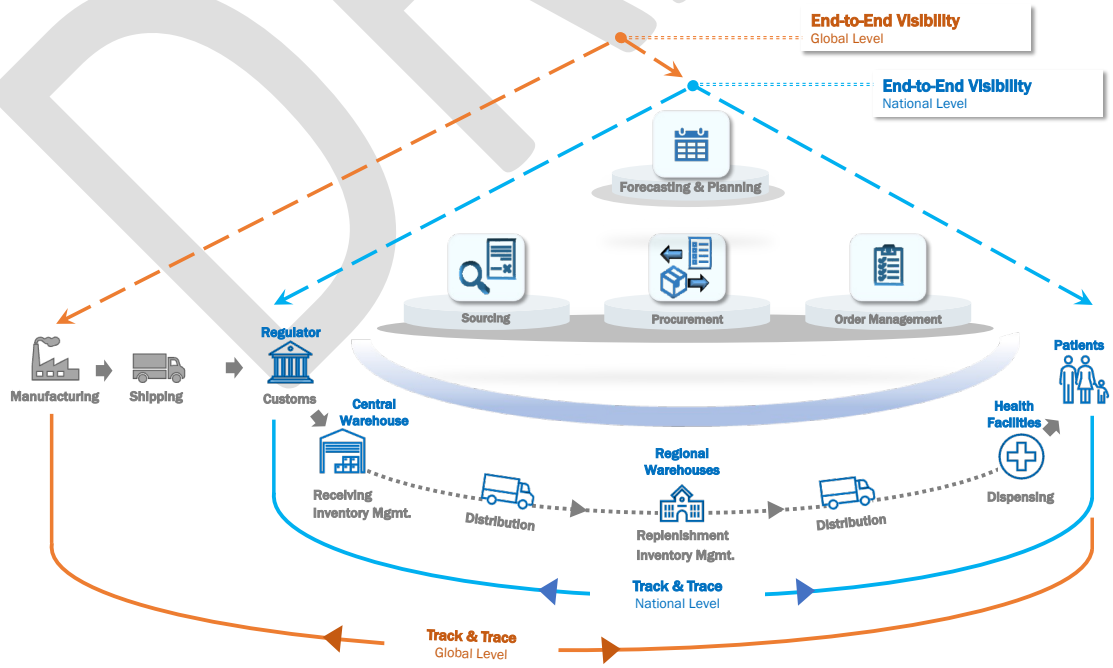
An architecture provides a blueprint of foundational systems and functional applications that are building blocks for a digital health supply chain. The architecture should comprehensively support all the supply chain functions, their data needs and their need to interoperate. DHSC architecture should support the interoperability of not only various supply chain functions but also of the entire ecosystem where supply chain functions interoperate with digital health systems, health financing and insurance systems, regulatory systems, and other systems. DHSC architecture should align with the country's IT and Information and Communications Technology (ICT) architectural priorities and the digital health architecture.

Why do we need an architecture?

The health supply chain comprises several business processes that ensure the availability of health products to patients. Forecasting and supply planning ensure appropriate levels of demand are considered to plan adequate supply. Procurement and distribution processes ensure health products are delivered to the right locations and are available to patients when needed. It is important that health supply chains can quickly respond to exceptions such as stock outs and quality issues like product recalls. More importantly, health supply chains should support patient safety by ensuring that the products dispensed to and consumed by patients are genuine. Processes and supporting systems need to operate together by exchanging data to ensure efficient and effective delivery of health products to end consumers. The DHSC architecture provides the essential blueprint outlining the different systems that support health supply chain processes. The architecture will clearly illustrate how the systems will interoperate and exchange data. The DHSC architecture should provide the necessary foundation and digital components for the country to achieve,

- Timely visibility of the end-to-end health supply chain, such that supply chain leaders can make informed decisions to deliver health products to end consumers when and where they need them.
- The ability to track, trace, and verify health products, such that supply chain leaders can ensure genuine and safe products are delivered to end consumers and mitigate quality issues swiftly.

Figure 5: Health supply chain end-to-end visibility and traceability



Within countries, the architectural blueprint provides a framework for implementation and operation of digital health supply chain systems and interaction of national and sub-national level systems that need to work together to support movement of products and data between supply chain nodes and process actors.

At the national level, the DHSC architecture should define minimum functional, technical, interoperability and data capture capabilities required from systems that support master data management, forecasting and supply planning, procurement, order management, warehouse management, and other supply chain functions. At sub-national level, capabilities, data and interoperability needs should be articulated for requisitioning, inventory management, dispensing, and other last mile supply chain functions.

At a global level, various digital systems used by manufacturers, and logistics providers for health products require standards for harmonized product identification and traceability. The architectural blueprint identifies the need to consider these standards to allow for a seamless flow of products from manufacturers to patients.

It's crucial to recognize the potential risks such as those listed below when lacking an overarching digital health supply chain architecture.

- Siloed, and duplicative systems that lack the ability to adapt and scale, requiring more effort and money to maintain and sustain
- Lack of compliance to global and open standards resulting in the lack of interoperability among processes, systems and data. This in turn impacts timely availability of aggregated data for visibility, analysis, exception management, reporting and decision making.
- Laborious manual processes to aggregate, reconcile, and triangulate data for accurate forecasting and planning potentially resulting in insufficient supply of products
- Limited ability to track & trace commodities and verify the authenticity of products
- The risk of having numerous applications geared towards specific functions, lacking a comprehensive solutions perspective. This scenario may result in isolated data, making it challenging for other applications to access and consequently impacting their effectiveness in decision-making, service delivery, and achieving positive health outcomes.
- Inability to achieve desired level of digital transformation and systems maturity

The steps outlined here provide a streamlined approach to defining an overarching digital health supply chain architecture.

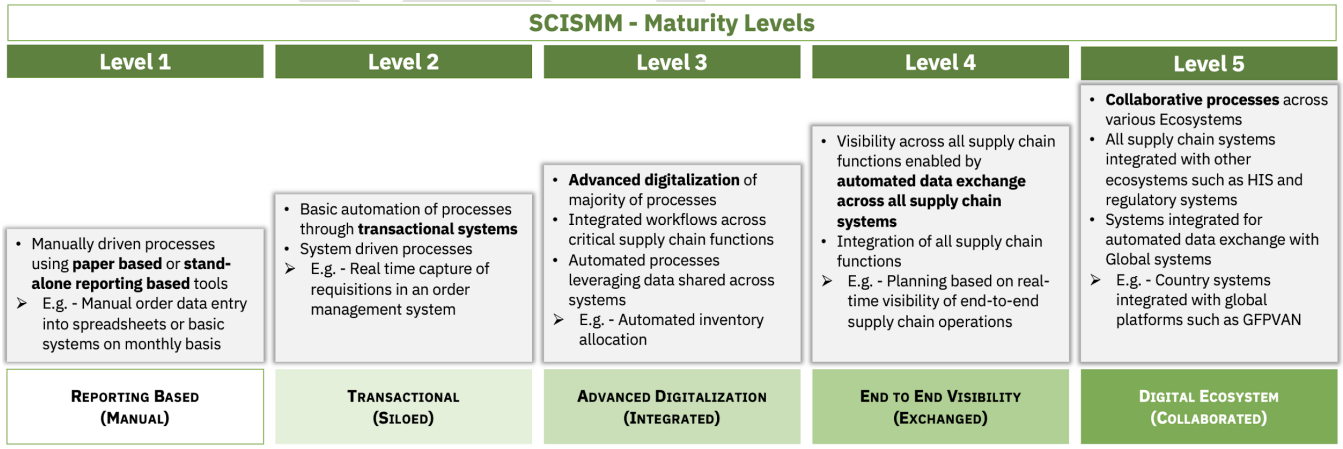
Step 1 - Assess the current state of health supply chain systems.

Inputs	Steps	Resources	Outputs
• NSCA Outcomes (if available) • Supply Chain Information Systems Maturity Model (SCISMM) assessment outcomes (if available) • DHSC Strategic Goals	Gather the list and details of existing health supply chain systems and map them to appropriate services such as supply chain functions, master data management and analytics.	Health supply chain systems list template	• List of existing health supply chain systems • SCISMM assessment report (if conducted as part of this step) • HSCIS gaps, that need to be addressed to
	Conduct SCISMM assessment if not already done	SCISMM tool	
	Analyse SCISMM assessment outputs to identify health supply chain information	Country SCISMM assessment	

• DHSC strategic objectives • National Digital Health Strategy • Landscape analysis of existing hardware, current state of infrastructure such as electricity, internet etc., existing software technologies, and current state of master data management such as product and facility data	system (HSCIS) gaps, that need to be addressed to achieve the DHSC strategic goals and objectives	reports in SCISMM webpage	achieve the DHSC strategic goals and objectives

Defining an appropriate digital health supply chain architecture should consider the current maturity and the state of the supply chain services and applications that support those services. Tools such as the 'Supply Chain Information System Maturity Model'[19] (SCISMM) should be considered in assessing the current maturity of various health supply chain systems. SCISMM provides a continuum of maturity, as shown below, for systems that support health supply chain services.

Figure 6: SCISMM maturity levels for health supply chain systems



Using the SCISMM to conduct a maturity assessment will help countries identify the current level of automation and digitalization of processes that are supported by health supply chain information systems (HSCIS). SCISSM assessment will help countries decide which maturity level to advance to depending on their priorities and readiness.

Potential Risks	Mitigation	Resources

[19] *GHSC-PSM, "Supply Chain Information Systems Maturity Model, Version 2.0", Mar 2021, (https://www.ghsupplychain.org/supply-chain-information-systems)*

No partner or funding to execute the SCISMM	Identify such assessment activities during annual work planning process to budget for and identify and request funding from partners	
Master data not identified as an essential building block as part of current state assessment	Conduct holistic assessments such as SCISMM to identify master data management gaps and highlight how it impacts interoperability, data quality, supply chain visibility and the ability to track and trace.	SCISMM tool
Some HSCISs over allotted importance for inclusion in the architecture whilst user adoption and efficacy is low	Plan and perform assessments such as SCISMM on a regular basis (annual) to analyse utilization gaps and identify ways to mitigate gaps through continuous user training and making use of systems the only way to perform processes etc.	

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341 ## Step 2 – Define a digital health supply chain target architecture.

Inputs	Steps	Resources	Outputs
• List of existing health supply chain systems • SCISMM assessment report • HSCIS gaps, that need to be addressed to achieve the DHSC strategic goals	Define current state of the health supply chain system architecture by mapping existing systems against the DHSC architecture framework	DHSC Architecture Framework (elaborated in this section) Country Case Studies	• Current state health SC systems architecture • Future state DHSC architecture
	Identify gaps and the necessary digital interventions based on the current state	SCISMM tool & TSS v2	
	Define future state of DHSC architecture, that considers core supply chain functionalities and foundational components while ensuring reuse of existing digital assets	SCISMM tool TSS v2 DHSC Architecture Framework (elaborated in this section) Country Case Studies	

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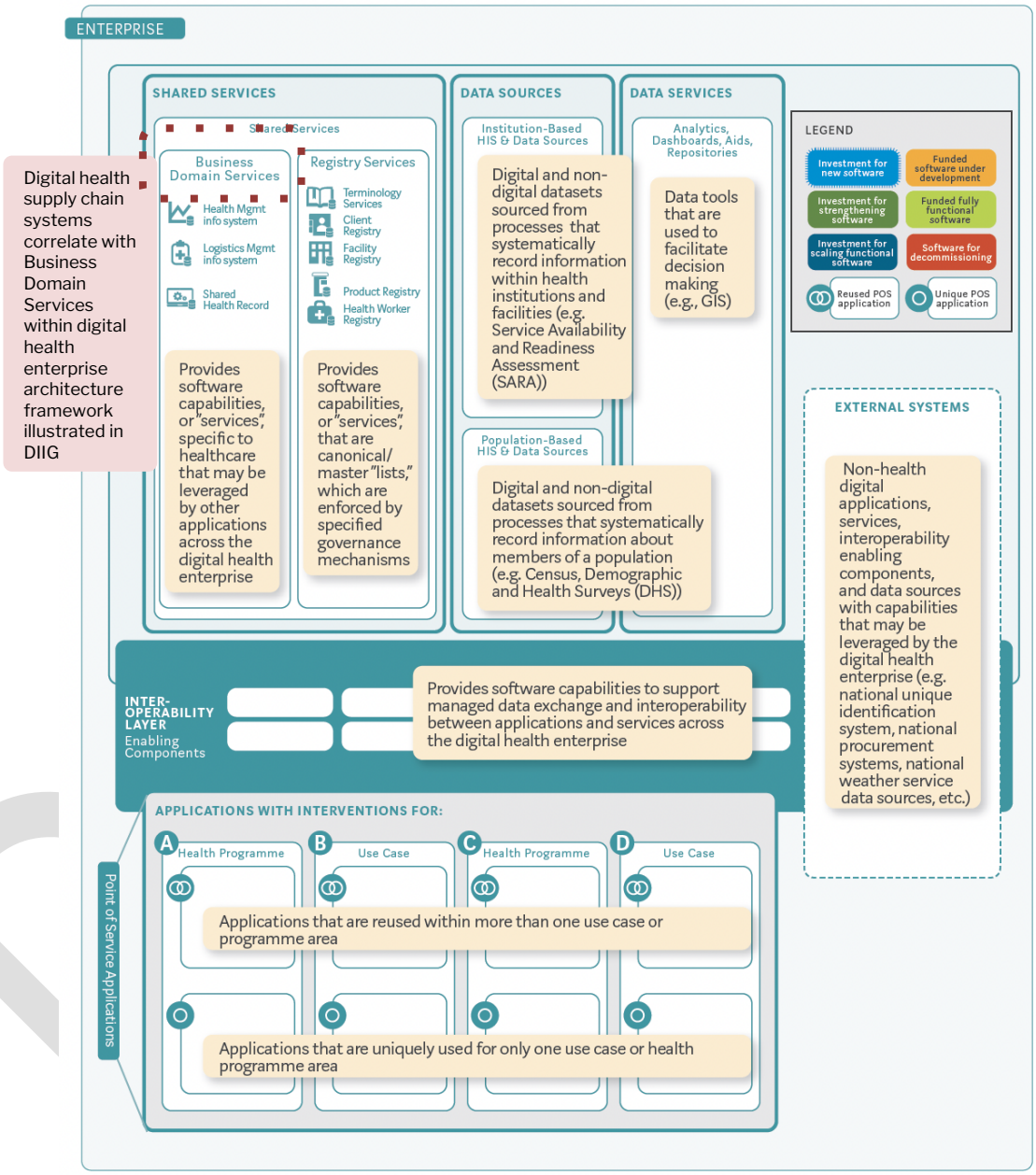
DHSC Architecture Framework

The DIIG outlines the components within the digital health enterprise architecture as shown in the following figure. Digital health supply chain architectural components complement the business domain services within the digital health enterprise architecture.

Figure 7: Digital Health Enterprise Architecture Reference from DIIG

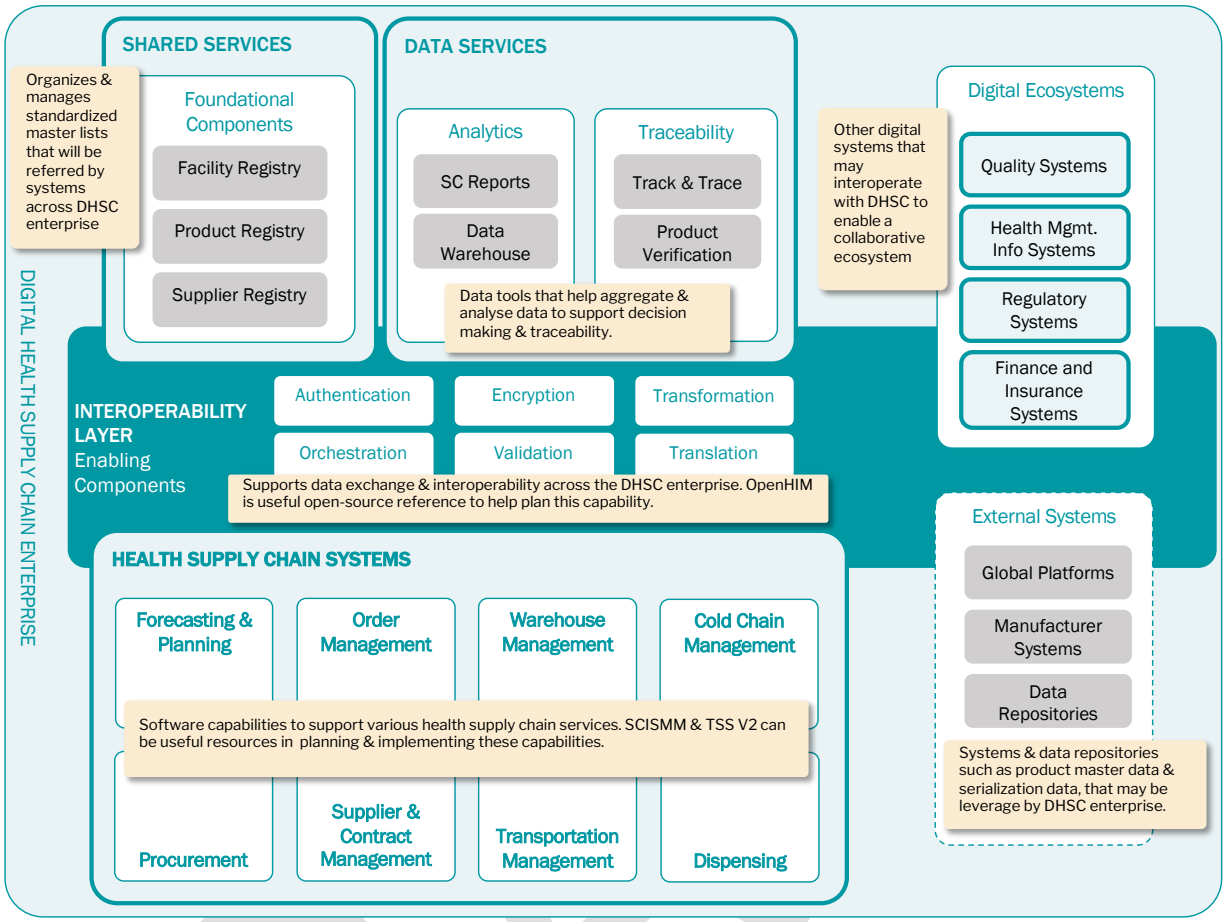


The following figure provides a digital health supply chain architectural framework that outlines components that support various services such as foundational, supply chain functional, analytics, interoperability and traceability. This digital health supply chain architectural framework is based on the guiding principles of The Open Group Architecture Framework (TOGAF[20]) and the OpenHIE[21] framework.

[20] The TOGAF Standard: version 9.2. The Open Group; 2018 (https://www.opengroup.org/togaf/, accessed 16 November 2023).

[21] OpenHIE [website] (https://ohie.org/, accessed 16 November 2023).

Figure 8: Digital health supply chain architecture framework



Key components of digital health supply chain architecture:

- Foundational components - These are components that provide system capabilities to organize and manage master data such as product, facility and supplier. These complement with other registries such as client registry and terminology services in the digital health enterprise architecture. These components are foundational in enabling interoperability of transactional data across health supply chain systems and processes. These components ensure a uniform and standardized referencing of products, facilities, and suppliers across various processes, including planning, order management, and warehouse management.
- Interoperability layer - This component facilitates exchange of data across various systems. Interoperability of DSHC systems and DHSC with other digital ecosystems is essential to ensure seamless data exchange that facilitates efficient SC operations and guarantees patient safety by enabling commodity traceability. The use of an interoperability layer will eliminate the need for point-to-point integrations of systems, which over time are not sustainable and expensive to maintain. With the interoperability layer systems sharing data with other systems need to publish data just once. The interoperability layer can transform data as needed and route it to multiple consuming systems. Any future integrations, as a result of new systems being implemented, can be accomplished by integrating with the interoperability layer without disrupting existing systems and their integrations.
- Health supply chain systems - these systems support various supply chain processes. It should be noted that one system or digital platform could support one or more supply chain processes. For example, an enterprise resource planning system could support procurement, order management and warehouse management processes.

    - Resources such as SCISMM, TSS v2 and IHE white paper on supply of products for healthcare can be referenced to learn more about the functional and non-functional specifications of various health supply chain systems as well as foundational, and data management capabilities like product master data management and interoperability.
- Data services - These include components that support data aggregation and analysis. Digital infrastructure such as data warehouse and reporting and analytics tools would be part of the analytical components with these services. These also include traceability services that leverage the aggregated supply chain data to enable health product tracking, tracing and verification. Refer to section 4 for further details on leveraging digital health supply chain to enable traceability capabilities.
- External systems - These include systems that are outside the public health ecosystem but may integrate to exchange data. Systems such as manufacturers' systems, global platforms developed by funders or procurement agencies and global or regional data repositories that aggregate master or transactional data.
- Digital ecosystems - These are other digital ecosystems that benefit from health supply chain data.
    - Example - regulatory systems leveraging supply chain data from dispensing system to combine with health information and patient data to conduct post market surveillance and pharmacovigilance.
    - Example - regulatory systems leveraging supply chain data such as inventory in various facilities or products dispensed, to perform product recalls in the event of quality issues.
    - Example - Finance and insurance systems combining data from dispensing system with patient information to verify and process insurance claims.
    - Example - Laboratory or quality monitoring systems integrating with health supply chain systems to alert quality issues and trigger swift product quarantines or recalls.

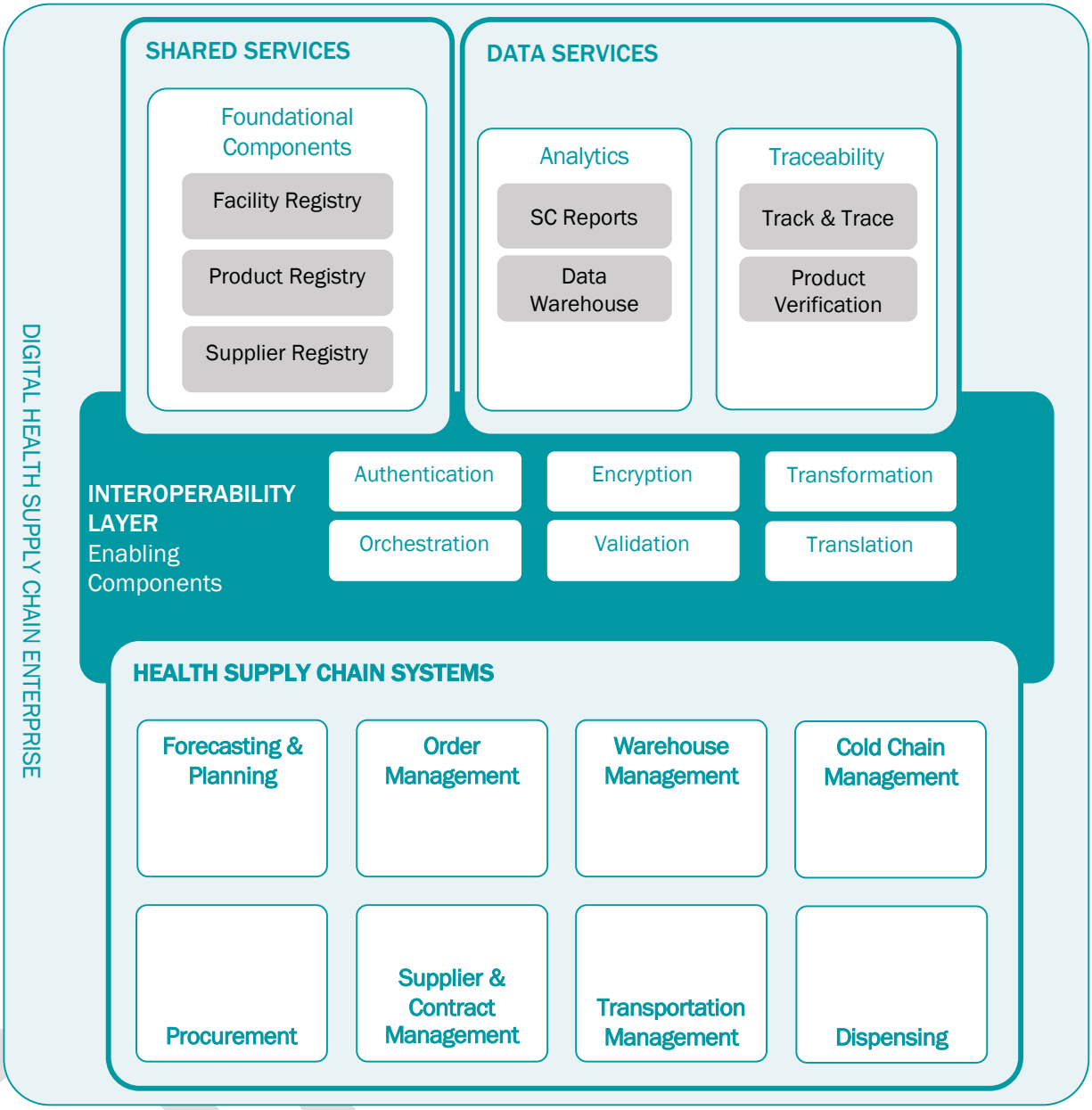
Tip/Best-Practice: While upstream health supply chain levels such as central medical stores leverage advanced systems to manage inventory and distribution, it is important to have sufficient system coverage at the lowest SC level to capture actual consumption. Typically, health supply chains rely on inventory distribution data from warehouses or inventory issues data from pharmacies to determine consumption. However, what gets used or consumed by patients could vary based on factors such as expiries, wastages and inventory shrinkage. Having a system that captures details of batches and serial numbers of products dispensed to patients will provide accurate visibility to actual consumption.

The digital health supply chain architectural framework can be adopted by countries using appropriate approaches depending on their supply chain design and digital maturity. A few illustrative examples of these approaches are provided below.

Illustrative architectural approaches:

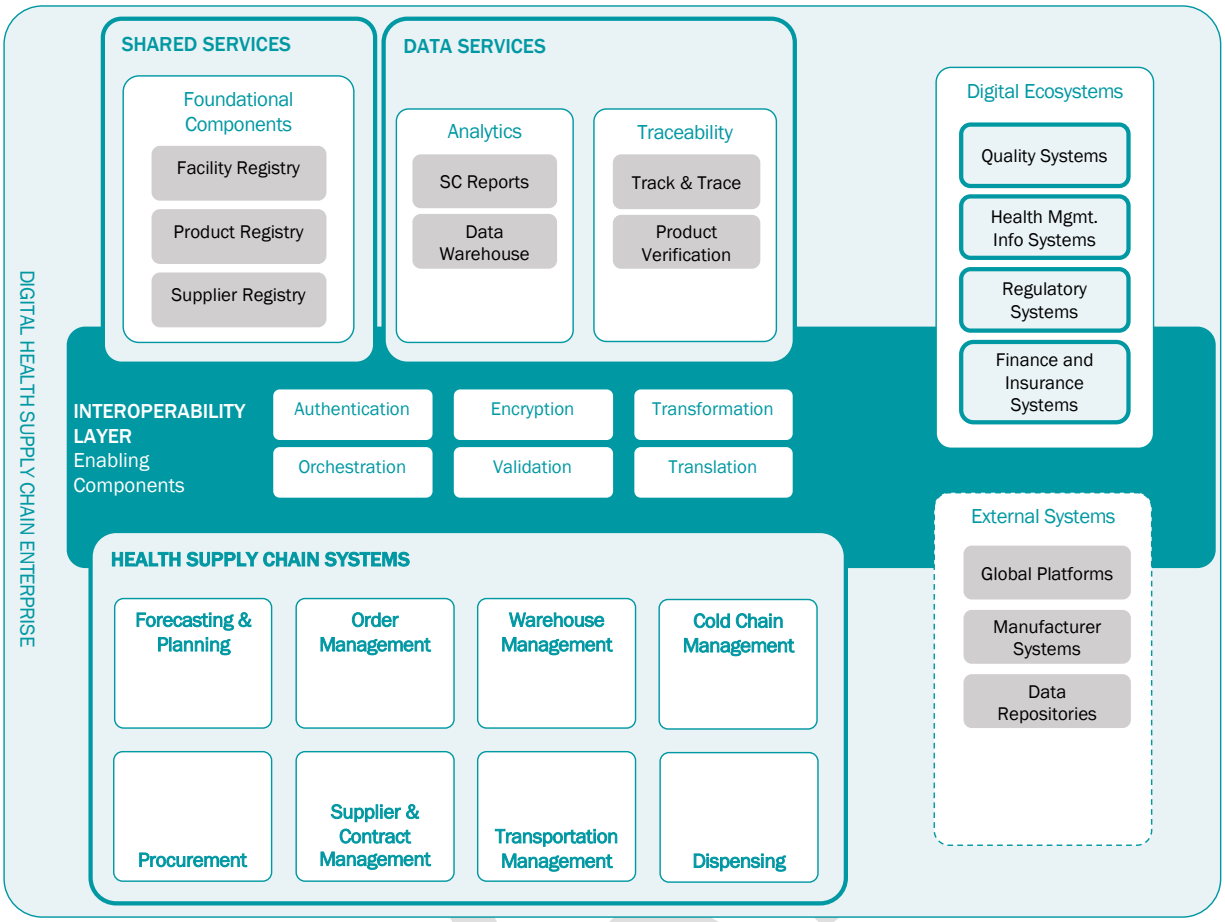
- **Based on maturity**
    A. Countries planning to advance their digital health supply chain systems from an integrated to an exchanged architecture along the SCISMM maturity continuum, can adopt the following architectural approach. This architectural approach will help focus on digitalizing key health SC processes. It will ensure that systems supporting the health SC services interoperate with one another to exchange data and orchestrate processes.

Figure 9: A - Illustrative digital health supply chain architecture based on maturity



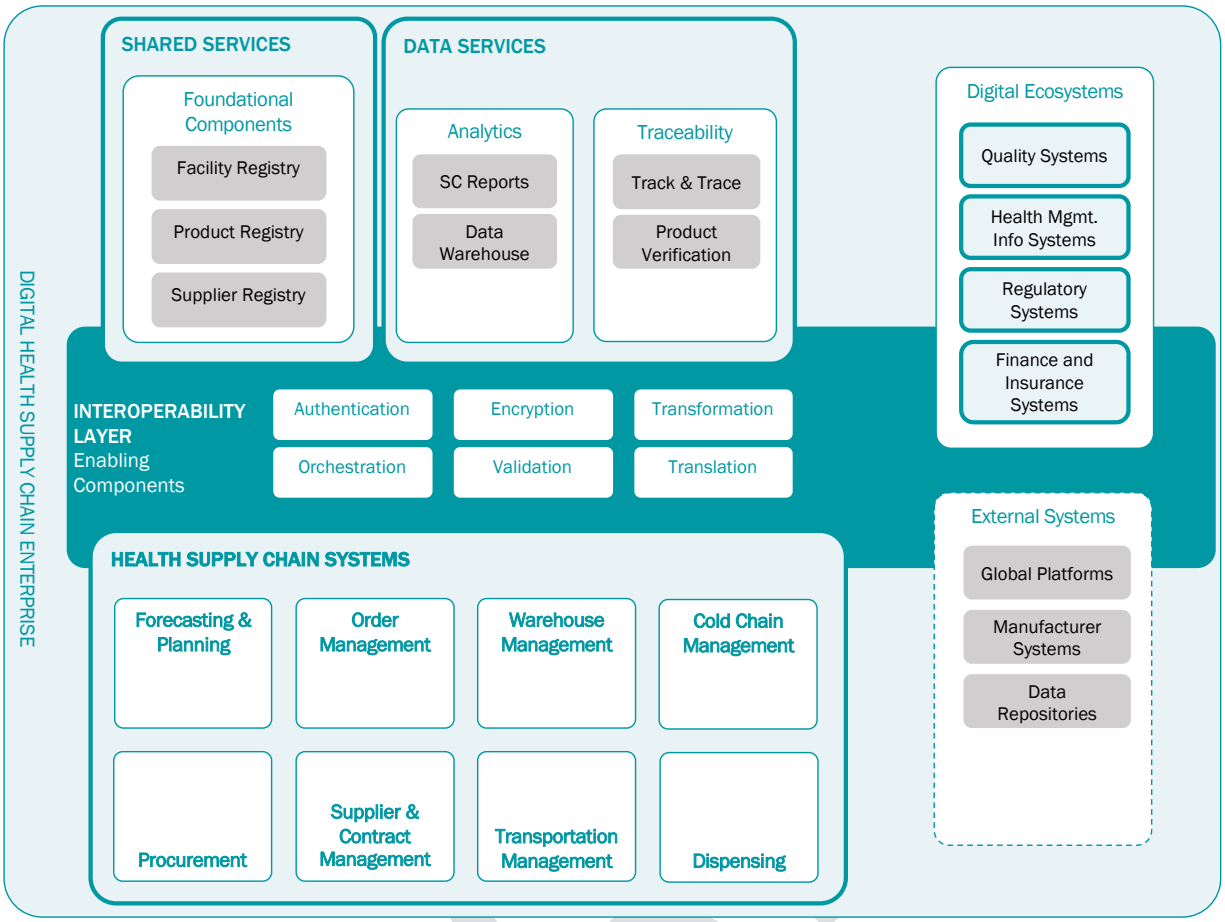
B. Countries planning to advance their digital health supply chain from an exchanged architecture to a collaborative ecosystem along the SCISMM maturity continuum, can adopt the following architectural approach. With this approach DHSC systems interoperate not only with each other but also with other digital ecosystems such as health information systems, finance and insurance systems and regulatory systems. This approach also promotes integrations with external systems such as manufacturer systems and global platforms of donors such as the global family planning visibility and analytics platform (GFPVAN).

Figure 10: B - Illustrative digital health supply chain architecture based on maturity



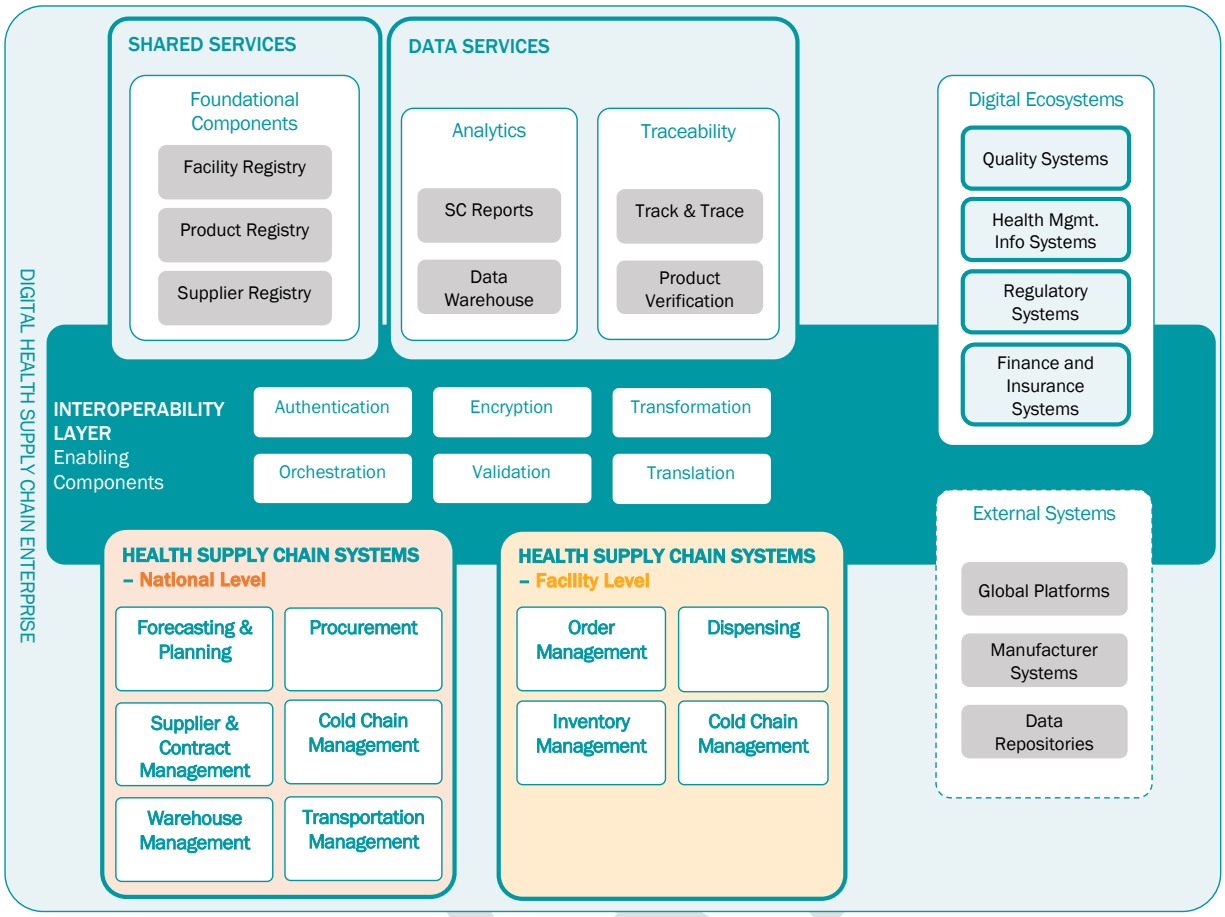
- **Based on supply chain design**
  A. Countries where health supply chain management is managed centrally can adopt the following architectural approach, which resembles the general framework. All the health supply chain services, including those used by district and service delivery point facilities will be centrally managed in this approach. This approach would be suitable where central warehouses manage when and how much inventory to push to downstream facilities.

Figure 11: A - Illustrative digital health supply chain architecture based on supply chain design



B. Countries where health supply chain is managed separately at the central level and at the facility level can adopt the following architectural approach. Health supply chain services such as forecasting & planning, procurement and supplier & contract management are managed at central level. Downstream facilities in this approach are typically managed by an organization different from the one that manages central warehouses. So, the health supply chain services used by facilities will be managed separately from those used at central level. Such an approach caters to supply chain design where downstream facilities order pharmaceutical products through a pull mechanism from central levels to replenish.

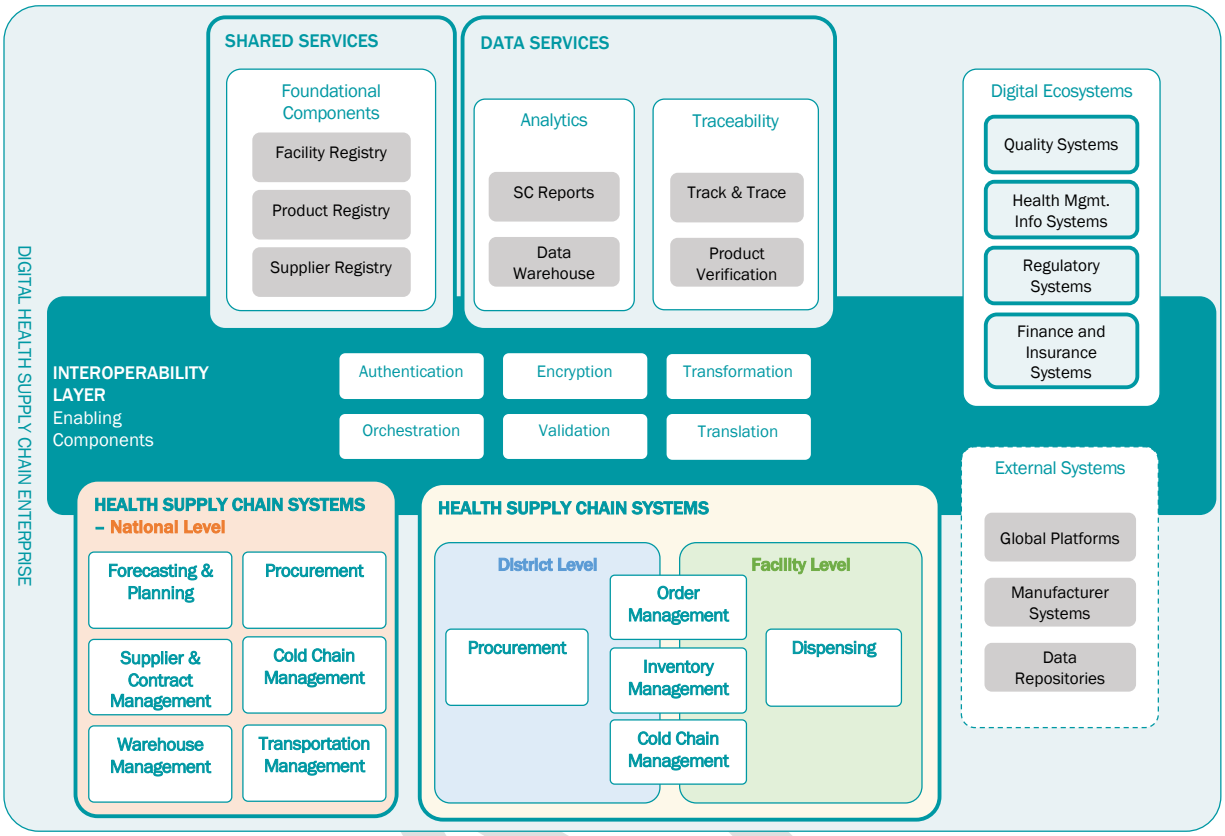
Figure 12: B - Illustrative digital health supply chain architecture based on supply chain design



Based of supply chain design - B

C. The following is a variation of the above decentralized approach where district level SC organizations are allowed to procure from sources other than central warehouses and therefore maintain a procurement system separate from the one used at national level.

Figure 13: C - Illustrative digital health supply chain architecture based on supply chain design



Useful resources for guidance on essential health supply chain features:

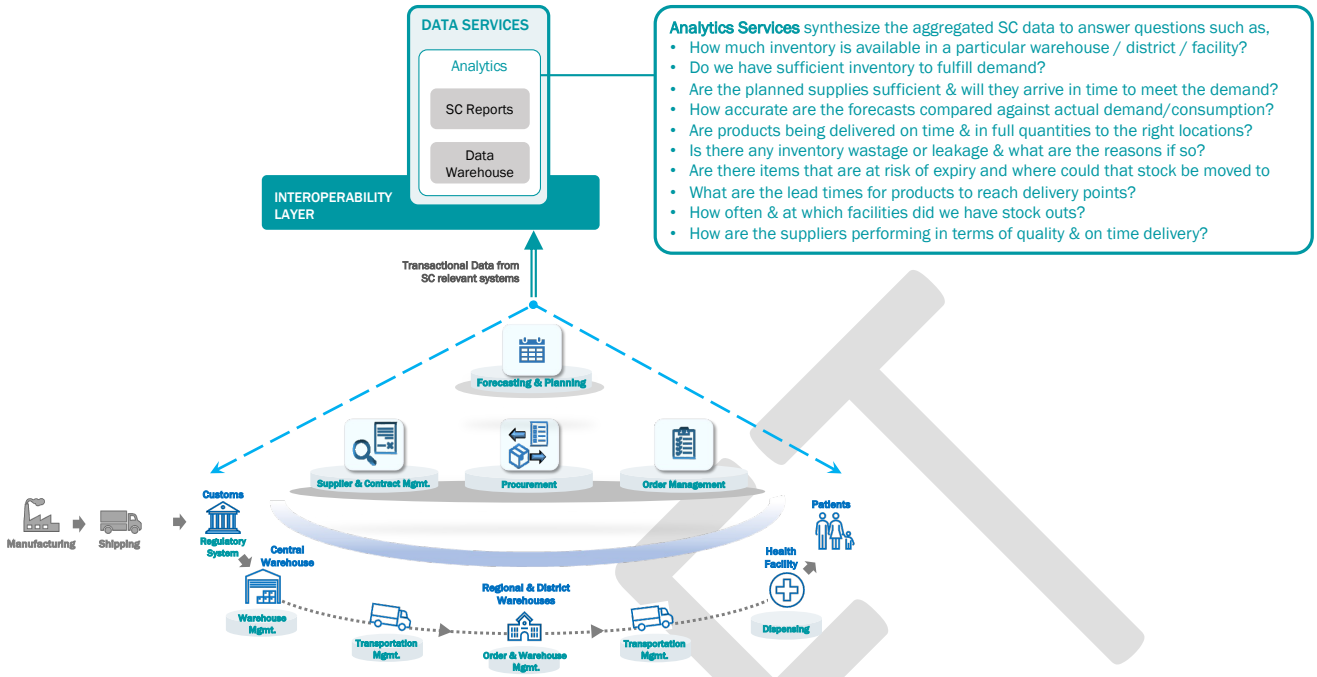
In addition to the architectural approaches, the SCISMM, TSS v2 and IHE white paper resources can be referred for guidance on the various health supply chain processes that information systems should support, to minimize manual work of supply chain personnel and improve data quality and availability. These resources can help countries choose the level of advancements for HSCIS depending on their readiness.

As noted earlier, one of the benefits that DHSC architecture should deliver is the timely visibility of the end-to-end health supply chain, such that leaders can make informed decisions to deliver health products to end consumers when and where they need them.

The following figure depicts how DHSC systems can support various SC processes. The data from these systems contribute to enabling comprehensive end-to-end visibility of the supply chain, thus helping supply chain leaders,

- make effective supply decisions.
- take corrective actions to address exceptions such as stock-outs, product recalls and expiries.
- ensure availability of medicines when and where needed.

Figure 14: Achieving supply chain visibility through DHSC architectural components



Potential Risks	Mitigation	Resources
Foundational integrity of the design not grounded in best practice	• Leverage resources such as this handbook, SCISMM and TSS, in additional to principles such as the 'Principles for Digital Development' and the TOGAF[22] and the OpenHIE[23] framework to ensure alignment with best practices. • Engage with the practitioners' community through groups such as the digital health supply chain small working group to seek feedback on design.	SCISMM tool & TSS v2

Step 3 – Identify implementation activities and map to strategic goals.

Inputs	Steps	Outputs
	Prioritise DHSC interventions based on strategic goals	

[22] The TOGAF Standard: version 9.2. The Open Group; 2018 (https://www.opengroup.org/togaf/, accessed 16 November 2023).

[23] OpenHIE [website] (https://ohie.org/, accessed 16 November 2023).

• Current state health SC systems architecture • Future state DHSC architecture • DHSC Strategic Goals	Define the implementation activities for the prioritised DHSC interventions	• List of DHSC implementation activities mapped to strategic goals. • High-level roadmap of DHSC implementations
	Develop a high-level roadmap of the implementation activities	

Potential Risks	Mitigation	Resources
Activities are not rationalized to the DHSC strategic goals	Identify and plan implementation activities after the vision, strategy and architecture have been developed and approved. Review any ongoing activities and adjust them to ensure alignment with DHSC goals and priorities.	

Guiding Principles

The following principles, informed by the '**Principles for Digital Development**', should guide the development of DHSC architecture

- Align with other architectures such as digital health architecture and IT architecture
- Define an architecture that improves the end-user experience, enhances operational efficiency, and contributes to delivering high-quality service to patients
- Strive for an ecosystem of cross-functional collaboration and interoperability
- Leverage, reuse and enhance existing resources, assets and capabilities
- Guarantee the ability to scale the architecture to accommodate future adaptations and adjustments in response to evolving needs and emerging technology trends
- Incorporate inclusive architectural and technology approaches that consider infrastructural challenges such as unreliable network connectivity in remote supply chain locations.
- Adopt open standards and open-source tools wherever feasible

Progress Check

After finishing the steps outlined in this chapter, the following outputs should be available:

- ❑ Future state DHSC architecture
- ❑ List of DHSC implementation activities mapped to strategic goals
- ❑ High-level roadmap of DHSC implementation activities

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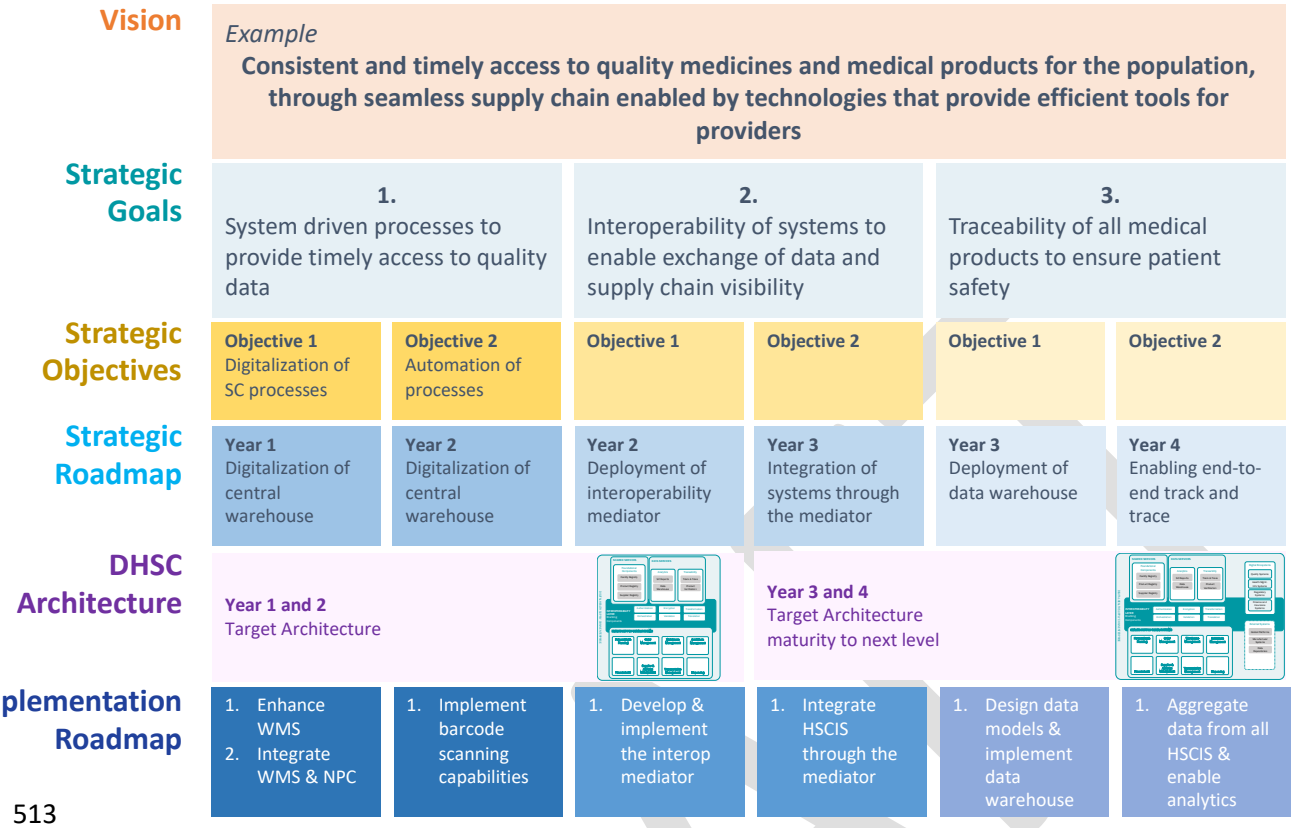
512 **Figure 15:** Illustrative example of outcomes from this chapter



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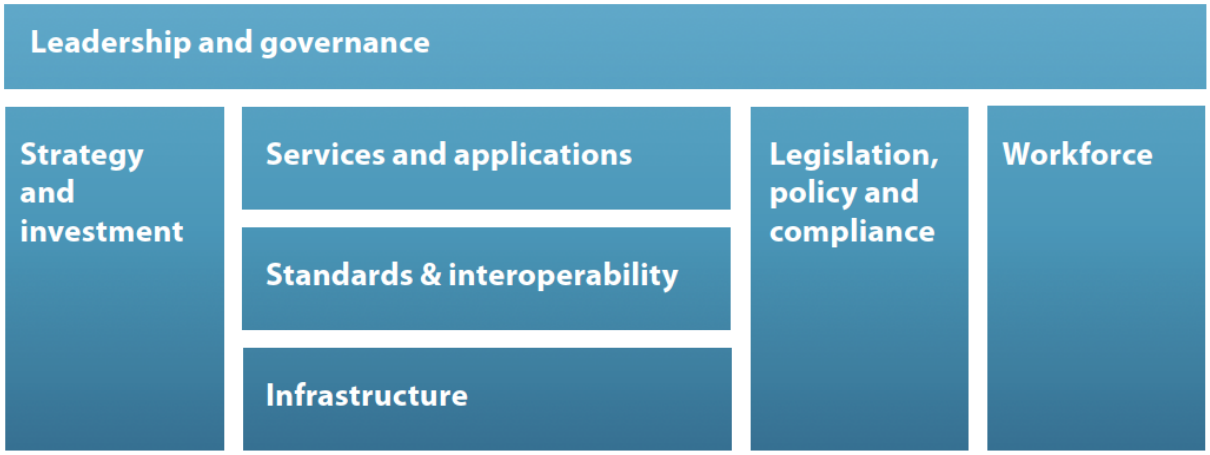
3. Plan for scalable implementation and sustainable operations

The previous chapters helped define the vision, strategic goals, objectives and architecture for the digital health supply chain. This chapter outlines key considerations to realize the digital health supply chain vision, strategic goals and objectives. It elaborates on how to plan the implementation and operationalization of the DHSC architectural components.

The key considerations for DHSC implementation are derived from the seven foundational building blocks of digital health as outlined in the National eHealth Strategy Toolkit.

Figure 16: Building blocks of digital health and digital health supply chain implementation



Source: WHO/ITU National eHealth strategy toolkit, 2012.

The following table provides illustrative considerations across each building block that can help guide the DHSC implementation. Considerations across these building blocks are essential to ensure successful implementation of DHSC.

	Factor	Illustrative Considerations	
		What is the current state?	What is needed?
Enabling Environment	**Leadership and governance**	• Are there national priorities that align with DHSC to secure support from senior leadership? • Does a dedicated department oversee health ICT, digital health & digital health supply chain? • Is there a national digital governance framework such as TWGs?	• DHSC strongly connected to a national priority to guarantee senior leadership focus and momentum to drive the implementation. • Establishing digital department which includes mandate to drive DHSC implementations. • Ensuring DHSC implementations are governed by either a dedicated technical working group or a subcommittee within digital health working group, if one exists
	Strategy and investment	• Is the DHSC strategy endorsed and agreed upon by all stakeholders? • What investments in DHSC are currently ongoing? What additional investments are planned?	• Consensus among senior leadership and all stakeholders regarding the DHSC vision and strategic roadmap, to ensure alignment of all stakeholder investments with DHSC architecture.

			• DHSC investment roadmap to help identify funding needs and potential sources of funding.
	Legislation, policy and compliance	• Are there legislations to support data sharing, data standardization and traceability of pharmaceutical products? • Are there policies for data storage, usage, retention and security? • Do established mechanisms exist to ensure compliance with legislations and policies?	• Legislations providing guidelines to manufacturers and other supply chain partners for product data standardization, labelling, data sharing and pharmaceutical traceability. • Guidelines for manufacturers & supply chain partners to achieve compliance in phases. • Procedures to monitor and promote compliance with legislations and policies
	Workforce	• Do we have individuals in supply chain operational and technical roles, possessing the necessary skillsets? • Are there knowledge management mechanisms, such as ongoing training and information sharing programs? • Is there a strategy in place for incremental capacity development and talent retention?	• List of roles across areas such as management, functional, technology and operations with job descriptions and necessary skillsets • Knowledge management procedures that include targeted training programs, visual job aids, advocacy material and video tutorials • Capacity-building strategy that involves engaging in technical cooperation with and fostering the development of the private sector to acquire the required skillsets.
	Standards and interoperability	• Are there standardized reusable components such as facility registry, product registry and supplier registry? • Is there an interoperability framework providing guidance on how systems should integrate and exchange data? • Does an interoperability mediator exist which supports data orchestration, translation & integrations? • Are there standardized protocols for data exchange between systems? • Have global and open standards been adopted for data management and exchange?	• List of essential reusable components that are absent and needs to be developed as part of DHSC implementation. Such components should be part of the DHSC architecture. • An interoperability framework that includes guidelines for data exchange, standardization and adoption of open standards as well as a plan for interoperability mediator, if one does not exist. • Harmonized master data registries • Adoption of global and open standards such as HL7 FHIR to promote interoperability among systems, processes and data
ICT Environment	**Services and applications**	• What supply chain applications exist that can be enhanced and reused? • Are there processes in place to maintain and update software applications? Is there a framework to engage private sector in software application maintenance and upgrades?	• DHSC strategy and architecture to indicate existing reusable applications along with new applications. This should include the necessary changes required for existing applications. • Procedures governing application maintenance, including the responsible organization for hardware and software maintenance, criteria for upgrades or replacements, and the framework for

			involving the private sector in maintenance and improvements.
	Infrastructure	• What are the electricity conditions across all supply chain facilities and at data centres where servers will be located? • How is network connectivity and bandwidth across supply chain facilities such as central warehouses, district pharmacies and service delivery points? • Do potential users of DHSC applications have the necessary devices? If not, what additional devices such as computers, tablets or smartphones are needed?	• Budgeted plan to establish the required infrastructure for electricity and network connectivity at the designated sites and facilities. • Budgeted plan to acquire the required devices for supply chain users. • Including infrastructure requirements in government budgets, highlighting potential funding requirements.

Table - Illustrative implementation considerations for digital health supply chain

Source: Adapted from WHO/ITU National eHealth strategy toolkit, 2012 (3); The MAPS toolkit, 2015 (29).

In addition to the considerations across the building blocks, DHSC should include detailed plan for each application implementation or initiative. As outlined in the steps below, each DHSC intervention should include a project implementation plan, an operational plan and a budget that considers the total cost of ownership.

Step 1 - Plan each DHSC implementation.

Inputs	Steps	Resources	Outputs
• Prioritised DHSC interventions • List of DHSC implementation activities	Develop a project charter[1]		• Project charter • Project management plan • TOR for steering committee & TWG • Project performance monitoring & analysis framework
	Develop a project management plan[2.]	Risk register template	
	Establish a project governance & reporting mechanism through steering committee and/or TWG		
	Define project performance monitoring & analysis framework[3]		

[1]Project charter should include details of,

- scope
- stakeholders
- timeline
- budget
- risks
- deliverables

- quality criteria and
- governance mechanism

[2]Project management plan should include,

- detailed project implementation plan with activities, timelines & milestones for each phase such as design, development, testing & deployment.
- stakeholder matrix with responsibilities & accountabilities (RACI matrix - responsible, accountable, consulted, informed)
- resource details including people, hardware & software.
- budget details for phases
- communication plan, including frequency of project management and technical meetings, issue management & escalation process.
- risk register with mitigations.
- change control process.
- change management including training & rollout plan.
- quality management and closure plan

[3]Project performance monitoring and analysis framework should include,

- project baseline such as initial schedule, budget and indicators related to the supply chain process that is being digitalized through the implementation.
- reporting schedule, mechanism and template that includes various aspects such as schedule, quality, budget and risk.

Step 2 - Develop an operational plan for each DHSC implementation.

Inputs	Steps	Outputs
• List of DHSC implementation activities • DHSC Stakeholder matrix	Update the stakeholder matrix, if required, to establish system owner/custodian and system users	• Updated DHSC stakeholder matrix to include operations management. • Operations and sustainability plan • Operational performance monitoring & evaluation framework
	Identify required operational resources such as maintenance personnel, hardware, network infrastructure and backup power.	
	Develop an operations and sustainability plan[4].	
	Develop an operational performance monitoring & evaluation framework[5]	

[4]Operations and sustainability plan should include,

- details of stakeholders that will own and maintain the DHSC system/application.
- required resources such as maintenance personnel, hardware, network infrastructure and backup power.

- recurring knowledge management needs including training, updating job aids, recruitments and job rotations.
- recurring costs for the required resources, system subscriptions, knowledge management, monitoring & evaluation and efforts to maintain and operate the application.
- plan for data backups and system redundancy to mitigate impact of system failures.
- change management and governance process for new requirements arising from evolving needs.
- financial strategy to cover all recurring operational costs.

[5]Operational performance monitoring and analysis framework should include,

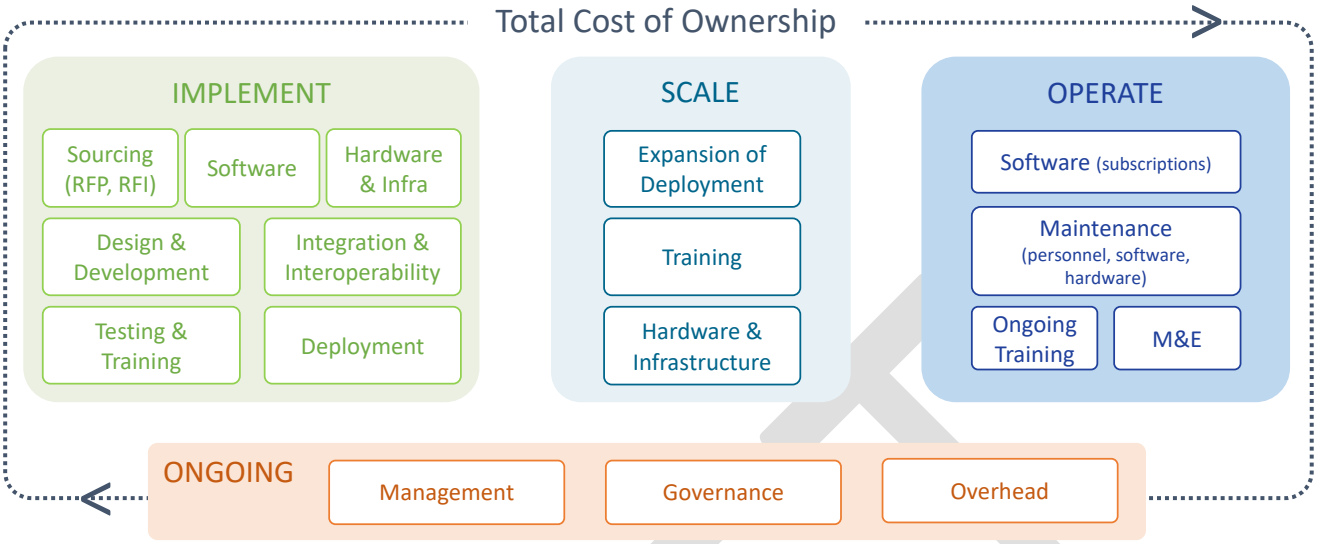
- baseline key performance indicators related to the supply chain process being digitalized through the implementation.
- reporting schedule, mechanism and template that includes various aspects such as operational costs, risks, KPIs, and any constraints & issues.

Step 3 - Develop a budget for each DHSC intervention.

Inputs	Steps	Resources	Outputs
• Project management plan for the implementation • Operations and sustainability plan • Historical budgets and costs, if available	Identify all cost drivers[7]		• Total cost of ownership[6] • Budget matrix • Funding needs
	Determine all implementation costs		
	Determine all operational costs for the life of the DHSC intervention, which could typically be 5 years		
	Develop a budget matrix for the life of the DHSC intervention	Budget matrix template (from DIIG)	
	Identify funding sources and potential funding needs		

[6]Total cost of ownership: The figure below illustrates the various costs that should be considered as part of the total cost of ownership.

Figure 17: Cost components to determine 'total cost of ownership'



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592 *Sources: Adapted from Digital implementation investment guide (DIIG), 2020*

593 [7]Illustrative Cost drivers:

	Cost Categories	Cost Drivers
ONGOING (recurring)	**Management**	• Complexity of intervention • Full-time equivalents (FTEs) needed. • Turnover • Staff capacity
	Governance	• Number of stakeholders needed for co-ordination. • Time needed for approvals. • Amount of travel and meetings required for buy-in, co-ordination, and approvals.
	Overhead	• Logistical costs such as per diems, meeting rooms and stationery • Administrative costs
IMPLEMENT (Upfront)	**Sourcing**	• Complexity of features and functionality required. • Local capacity and if international sources need to be explored. • Procedural requirements around governmental approvals, and competitive evaluations
	Software	• Licensing model and associated cost. • Scale of implementation (i.e., number of end users, number of devices, etc.)
	Hardware and Infrastructure	• Devices, servers and other infrastructure needed. • Sophistication of devices needed depending on system availability needs, data retention policies etc. • Reliability of electricity in country and alternatives needed. • Infrastructure to support reliable internet connectivity.

	Design and Development	• Customizations and localizations like language translations needed. • Local capacity with required skillsets • Technical trainings needed.
	Integration and Interoperability	• Maturity of interoperability standards • Use of standards or lack thereof • Existing data sharing policies • Licensing fees associated with standard use. • Availability of interoperability mediator and requirements to use it.
	Testing and Training	• Amount of travel and meetings required. • Number of end users, testing users and trainers • Scale and frequency of training • Existing capacity gaps
	Deployment	• Number of end users • Number of facilities
SCALE (Upfront)	**Expansion of Deployment**	• Number of end users • Number of facilities
	Training	• Amount of travel and meetings required. • Number of end users, testing users and trainers • Scale and frequency of training
	Hardware and Infrastructure	• Devices, servers and other infrastructure needed. • Sophistication of devices needed depending on system availability needs, data retention policies etc. • Reliability of electricity in country and alternatives needed. • Infrastructure to support reliable internet connectivity.
OPERATE (recurring)	**Software**	• Annual or per user subscription/licence fees.
	Maintenance	• Amount of bug fixes needed. • Anticipated updates released per year. • Amount of travel needed for on-site maintenance support. • Number of end users and devices managed. • Utility costs related to hardware
	Ongoing Training	• On the job training vs. formal training mechanism • Turnover
	Monitoring and Evaluation	• Complexity and scope of intervention. • FTEs needed to support monitoring and evaluation activities. • Amount of data needed to be collected manually vs. data available electronically through automated processes. • Size and complexity of data collected; number of systems that data is collected from. • Amount of information needed to disseminate.

Table - Illustrative cost drivers

595 *Source: Adapted from Principles for Digital Development: How to calculate total lifetime costs of enterprise*
596 *software solutions (94).*

597 Step 4 - Implement the DHSC application.

Inputs	Steps	Resources	Outputs
• Prioritised DHSC interventions • List of DHSC implementation activities	Define functional and non-functional requirements for the DHSC application being implemented	SCISMM tool & TSS v2	• DHSC application functional and non-functional requirements • Sourcing documents such as RFP and RFQ • Contracts for software and implementation • Solution design specifications • DHSC application components • System, integration and user acceptance test scripts • User training materials • DHSC application issues log
	Identify the implementation partner/vendor through appropriate sourcing mechanisms (request for proposal (RFP), request for quote (RFQ) etc.)		
	Develop the application's design and integration specifications to fulfil the functional and non-functional requirements		
	Develop and/or configure the application		
	Integrate the application with other applications through appropriate interoperability platform, if available		
	Validate the application through system, integration and user acceptance testing		
	Train the users		
	Rollout the application		

598

Potential Risks	Mitigation	Resources
Cost estimates not considering total cost of ownership, impacting sustainability	Use guidance provided in this section to estimate all cost elements including operational costs to help budget and identify funding sources to ensure successful implementation and continuous operations	

• Human resource capacity constraints. • Not having people with the appropriate skillsets. • Lack of awareness of the required skillsets	Identify the required roles and necessary skillsets early on. Use multiple strategies to onboard capacity - such as outsourcing, recruiting, availing part-time consultants etc. Budget for the necessary additional human resource capacity and identify funding sources to bridge the capacity gaps. Plan for roll out of systems in a phased manner to align with availability of funding and human resource capacity	Resource matrix with necessary roles & responsibilities across various phases of implementation and operations
If training does not contain appropriate content depending on level of skillsets it could result in poor adoption and use of systems	• Perform a skills assessment for each user prior to completing the training plan • Complete a training needs assessment before conducting training • Target and adapt training to meet the needs of the training audience	
Lack of reliable infrastructure such as electricity, internet connectivity and computers as HSCIS are rolled out to downstream facilities	• Determine the needs across all supply chain facilities and develop a detailed budget that includes operational costs • Adopt a phased approach to roll out systems across SC facilities • Align funding and other financial resources with the planned roll out phases	
Inconsistent SC processes across SC levels and facilities that result in inconsistent use of systems impacting data quality, interoperability, aggregation, and on-time data availability	• Conduct a SC system and process maturity assessment such as SCISMM to identify process gaps and inconsistencies • Address such gaps during system design phase and ensure consistent training of all SC levels' staff for uniform adoption and use of system	
Saturation of existing digital tools and HSCIS resulting from a lack of embracing emerging technology trends and implementing required enhancements to meet evolving business needs	• Conduct regular assessments using tools such as SCISMM to identify any new or potential gaps and improvement opportunities • Plan to enhance or upgrade existing tools in a phased manner to fulfil changing SC needs	

Guiding Principles

The following principles, informed by the '**Principles for Digital Development**', should guide the implementation.

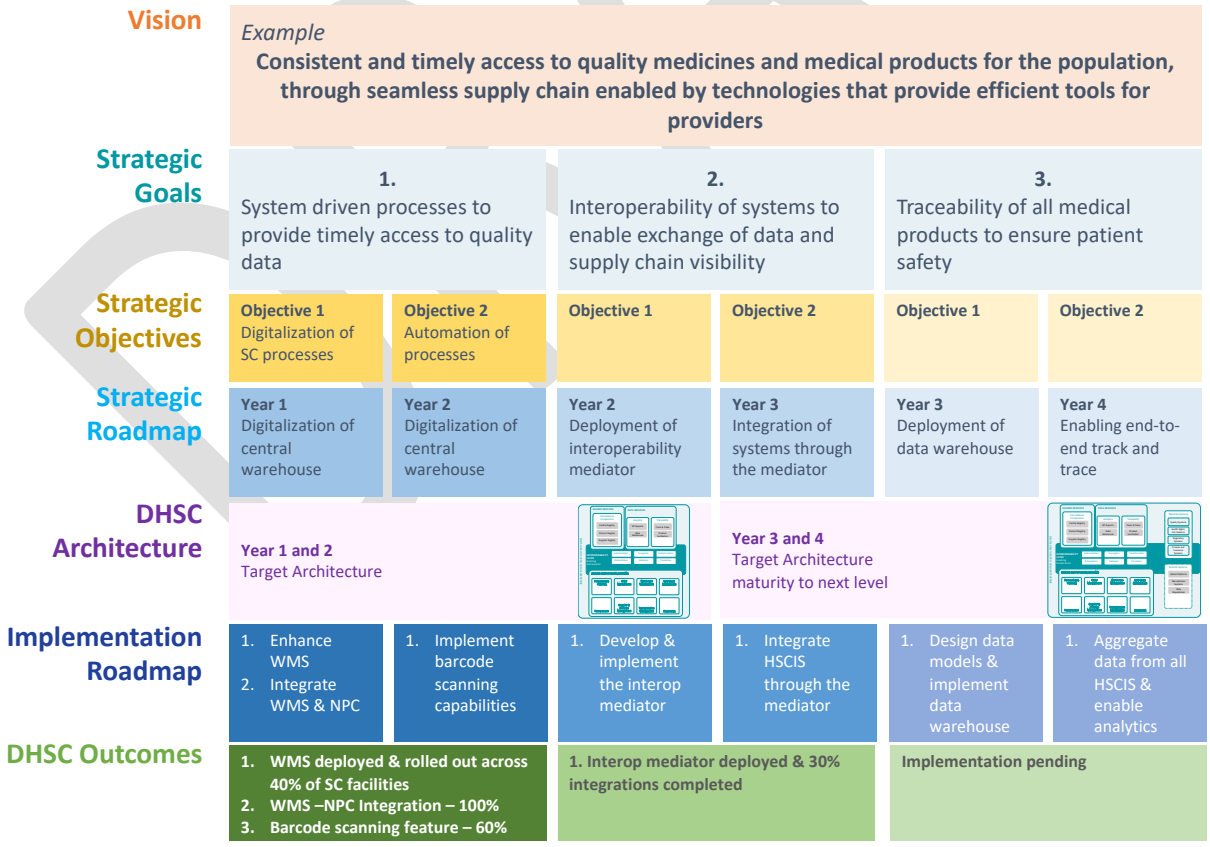
- Plan for sustainability from the start
- Engage local resources to build capacity
- Promote collaboration across implementation partners to align, synergize and complement efforts
- Develop plans grounded in local context to set realistic expectations and milestones

Progress Check

After finishing the steps outlined in this chapter, the following key outputs should be expected:

- ❑ Detailed project management plans for each implementation activity
- ❑ Stakeholder matrix to manage operations.
- ❑ Operations sustainability plan
- ❑ Implementation and operations performance monitoring & evaluation framework
- ❑ DHSC implementation materials such as requirements, specifications, test scripts and job aids
- ❑ Developed DHSC applications

Figure 18: Illustrative example of outcomes from this chapter



4. Leverage digital health supply chain to implement traceability

One of the essential benefits that DHSC architecture delivers is the ability to track, trace and verify health products. Traceability of health products is an important capability for countries to mitigate the risk of falsified medicines and ensure patient safety and quality healthcare. This section illustrates the application of DHSC architectural framework to implement the traceability use case. Implementing and institutionalising traceability requires efforts across various areas such as regulatory, human resources and processes (e.g., procurement, customs). However, this section focuses mainly on the deployment of technologies that leverage DHSC architectural framework to support traceability use cases.

What is traceability?

Before outlining the technological deployment for traceability that leverages DHSC architecture, it is important to understand what traceability is and why it is important. The global standards organisation, GS1[24] describes traceability as the ability 'to see the movement of health products across the supply chain'. Traceability aims to trace the path of healthcare products from manufacturers to patients, identifying ownership changes at different points across the entire supply chain. Traceability additionally aids in tracking the products' whereabouts at any given moment, including their intended route toward the point of dispensing.

Why is traceability important?

Tracing and tracking products enhances efficiency and integrity of the health supply chain. By providing global visibility into every change of ownership along the supply chain, traceability helps identify substandard and falsified health products and prevents their dispensation to patients – amongst other benefits such as efficiencies in inventory management, prevention of medicine shortages - ultimately ensuring patient safety. Traceability thus plays an important role in ensuring quality healthcare to patients.

Traceability also supports the ability to manage product recalls in the event of confirmed or potential quality issues. By gaining visibility to product movements and whereabouts, healthcare personnel will be better equipped to swiftly locate the products of a batch and initiate recall.

Today most of the traceability systems for health products are based on regulatory requirements. To ensure effective implementation of these requirements, global harmonization and alignment with the global framework[25] of health products' identification, marking, and data sharing is critical. In this context, it is important to note that traceability systems are developed gradually and are based on maximizing the capability and potential of existing digital systems used in a country or region. The common denominator to ensure interoperability across national traceability systems is the use of global standards for traceability.

Traceability Models

There are mainly three architectural models for implementing traceability - Centralised, Semi-centralized and Distributed models. The difference in these systems is mostly characterised by how

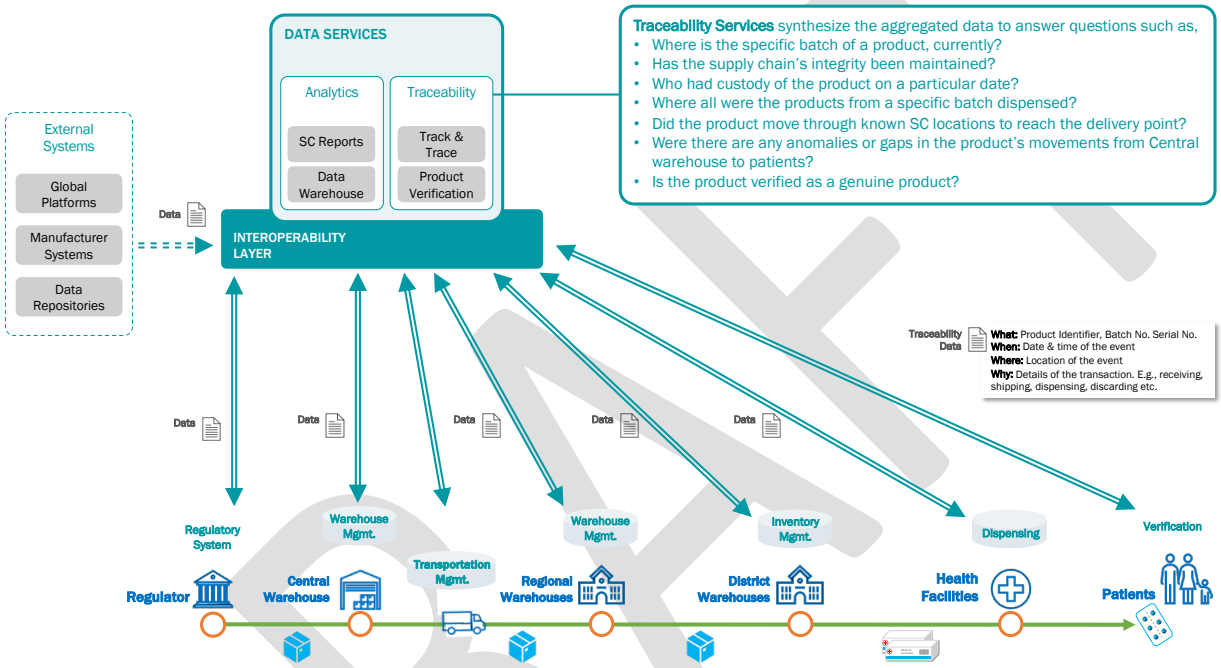
[24] https://www.gs1.org/industries/healthcare/traceability

[25] https://www.who.int/publications/i/item/policy-paper-on-traceability-of-medical-products

the data is stored and shared with the competent health authority and across actors in the supply chain. A Centralized model involves a single database or repository to store all traceability data. In a semi-centralized model, the traceability data is spread across multiple databases or repositories. In distributed model traceability data is maintained separately by each supply chain partner. Further details of the traceability models are available in the WHO Policy Paper[26] and ICMRA guidance on traceability[27].

This handbook considers the centralised model, which is the most widely implemented model, to illustrate the traceability use case leveraging DHSC architectural framework.

Figure 19: Achieving track and trace capabilities through DHSC architectural components



For a centralized traceability model, the following technology components will be essential. It is important to note that many essential components required for enabling tracking, tracing, and verification capabilities can utilize existing supply chain systems and architectural elements.

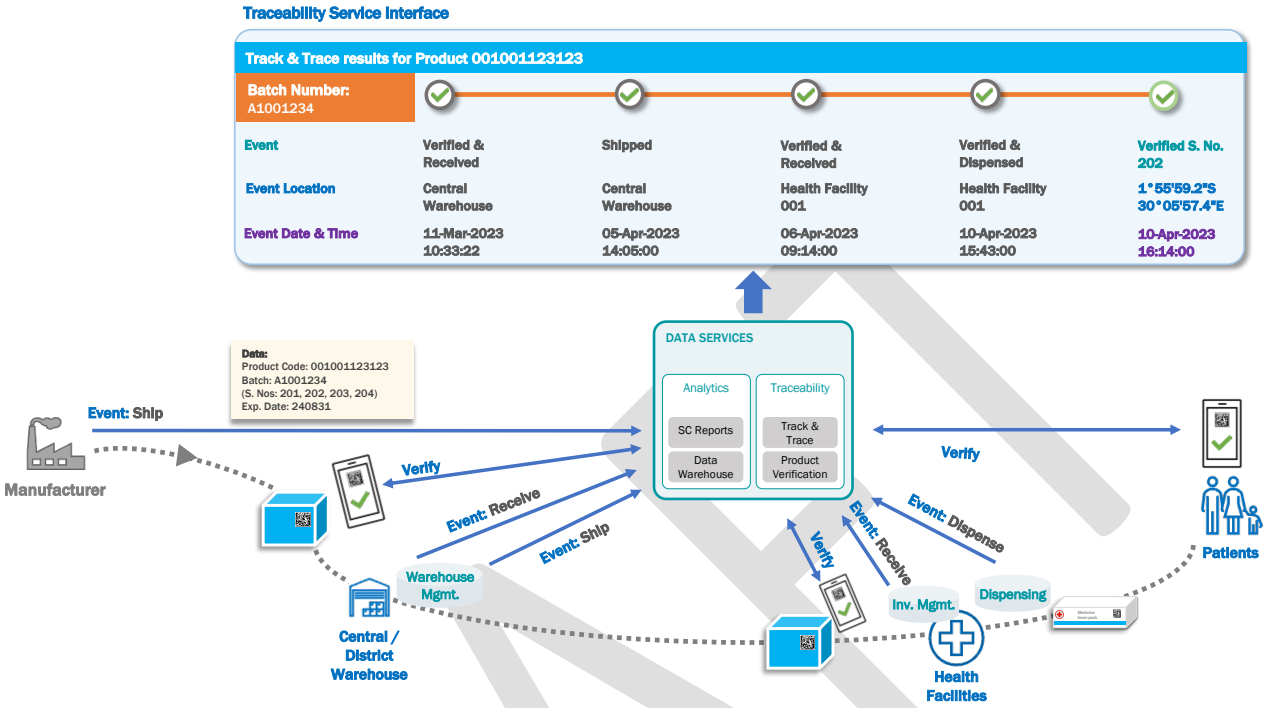
- foundational components - namely globally unique identification of facility and of product based on global standards and captured in a data carrier such as a barcode, as well as supplier master registries to provide master data that helps combine data from disparate systems and derive traceability by providing the foundational layer for interoperability
- database or repository - to aggregate and organize master data, transactional data and SC events data from various systems.
- interoperability layer - to facilitate data exchange and orchestration to and from various disparate systems to enable data sharing and data querying.
- health supply chain systems - to share data related to SC transactions and events.
- traceability and analytical components - to synthesize the aggregated data and generate results for track, trace and verification queries. The analytical capabilities of existing reporting or business intelligence tools can be utilized for this. In addition, these components include tools such as web-based and mobile applications that end-users and patients can use to track, trace or verify health products.

[26] https://www.who.int/publications/i/item/policy-paper-on-traceability-of-medical-products

[27] https://www.icmra.info/drupal/sites/default/files/2021-08/recommendations_on_common_technical_denominators_for_T&T_systems_to_allow_for_interoperability_final.pdf

The following visual depicts how SC transactional data and event data can be aggregated from existing health SC systems in the data repository to provide verification service and track and trace services.

Figure 20: Illustrative example of traceability service interface



Considerations:

- While the institutionalization of traceability could be long-drawn intensive process, the use of existing technology assets where feasible can minimize the costs around system development and implementation.
- Designing the exchange of traceability data requires technical understanding of applicable standards as well as a structured methodology. Traceability processes should be designed according to a structured architecture independent of the technology used to capture and share data. This independence is crucial to the flexibility and scalability of the system (i.e., the ecosystem and the technology may evolve, while the design of the traceability data content stays the same).
- One of the most important and challenging areas related to the implementation of traceability, or any digital health supply chain process, is the quality of master data. In a traceability model, as data is shared across all stakeholders of the supply chain, it creates an information flow that precedes the physical flow of the product. This creates a data chain-of-custody effect that requires each stakeholder in the process to share responsibility for maintaining data integrity and quality. It is important that the data required is limited to the master data effectively needed for the traceability system and is defined in consultation with the stakeholders.
- While the tracking and tracing of a product is predominantly conducted in country – it is important to note that traceability does in fact commence before the product reaches a particular country. For example, manufacturers identify and mark the product using global standards and store traceability data in their databases – data which is transferred to a recipient country of the product to support the local processes.

5. Sharing country experiences

Malawi Case Study

Digital Health Supply Chain - Malawi Case Study

About Malawi

Area: 118,484 Km²
Land: 94,080 Km²
Water: 24,404 Km²

Population: 21.2 million (2020 est.)
Population Growth: 3.31% (2020 est.)

Public Health Supply Chain Structure

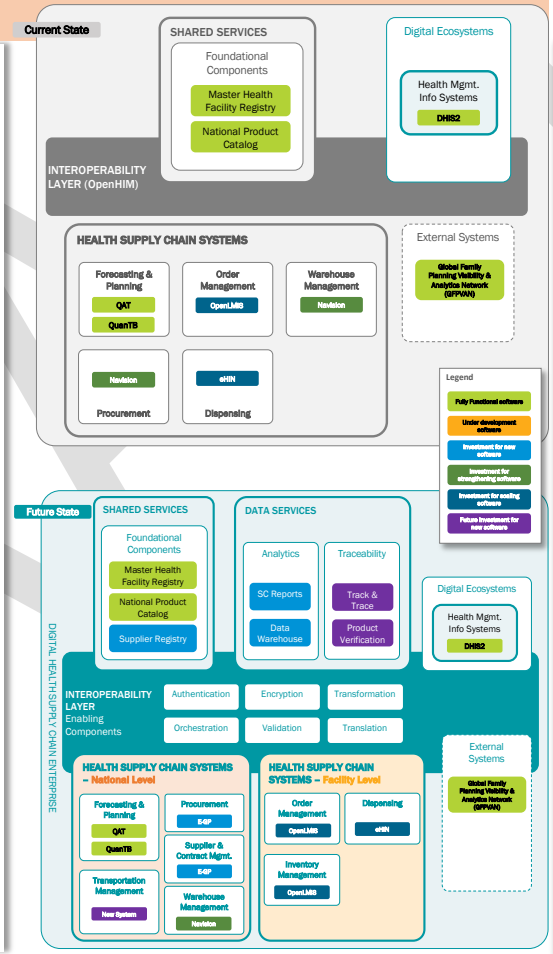
Central Warehouse: 1
Branch Warehouses: 3
District Health Offices: 29
Health Centres: 720
Parallel Supply Chain: 2 3PLs

Status Supply chain systems architecture (SCSA) was collaboratively developed in 2021 under the leadership of Health Technical Support Services division within MOH. SCSA was approved by the honorable deputy minister of health in September 2022.

Process SCSA was developed with support from USAID through GHSC-PSM. Outputs of a SCISMM assessment helped shape the SCSA. An initial workshop was conducted in October 2021 with various stakeholders such as MOH, CMST, DHD, PMRA and partners such as USAID, UNDP, CDC, WFP. The workshop helped shape the vision, strategy and architecture for Malawi health supply chain (HSC) systems. SCSA was updated based on feedback from the workshop and subsequent reviews. A second workshop in September 2022 helped review and approve the final version.

Current state (as of Dec 2023) Before SCSA there were various systems without clarity on specific supply chain functions they fulfilled, sometimes resulting in overlaps. Refer current state architecture.

Future state SCSA provides a comprehensive architectural framework clearly outlining various HSC systems and how they will function together leveraging shared services such as NPC. SCSA considers the difference between national level and facility level systems and aligns with the Master Supply Chain Transformation Plan. Refer future state architecture



Insights

- Syncing digital health supply chain priorities with Malawi's national agenda as directed by its top leadership facilitated momentum and ensured cohesion among all stakeholders
- HTSS, MOH leading the effort ensured comprehensive collaboration and engagement of all stakeholders. This helps sustainably advancing the efforts of SCSA implementations.
- A steering committee that was initiated following SCSA launch helps provide governance and ensures alignment of all digital health supply chain initiatives.
- Engaging all stakeholders including government organizations such as MOH and supply chain partners such as CMST, donors, implementation partners from the beginning ensures a collaborative and aligned effort with optimal use of resources.
- An overarching strategy and architecture such as SCSA ensures all donors' and partners' efforts are synergized and working towards a common national vision.
- Holistic assessments such as SCISMM provide insights into gaps and opportunities for health supply chain digitalization.

Additional Case Studies (to be added)

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Annexes

Annex 1. Principles for Digital Development

	Design with the user	User-centred design starts with getting to know the people you are designing for through conversation, observation and co-creation.
	Understand the existing ecosystem	Well-designed initiatives and digital tools consider the particular structures and needs that exist in each country, region and community.
	Design for scale	Achieving scale requires adoption beyond an initiative's pilot population and often necessitates securing funding or partners that take the initiative to new communities or regions.
	Build for sustainability	Building sustainable programmes, platforms and digital tools is essential to maintain user and stakeholder support, as well as to maximize long-term impact.
	Be data-driven	When an initiative is data driven, quality information is available to the right people when they need it, and they are using those data to take action.
	Use open standards, open data, open-source and open innovation	An open approach to digital development can help to increase collaboration in the digital development community and avoid duplicating work that has already been done.
	Reuse and improve	Reusing and improving is about taking the work of the global development community further than any organization or programme can do alone.
	Address privacy and security	Addressing privacy and security in digital development involves careful consideration of which data are collected and how data are acquired, used, stored and shared.
	Be collaborative	Being collaborative means sharing information, insights, strategies and resources across projects, organizations and sectors, leading to increased efficiency and impact.

Source: Principles for Digital Development under a Creative Commons Attribution-ShareAlike 4.0 International License.[28]

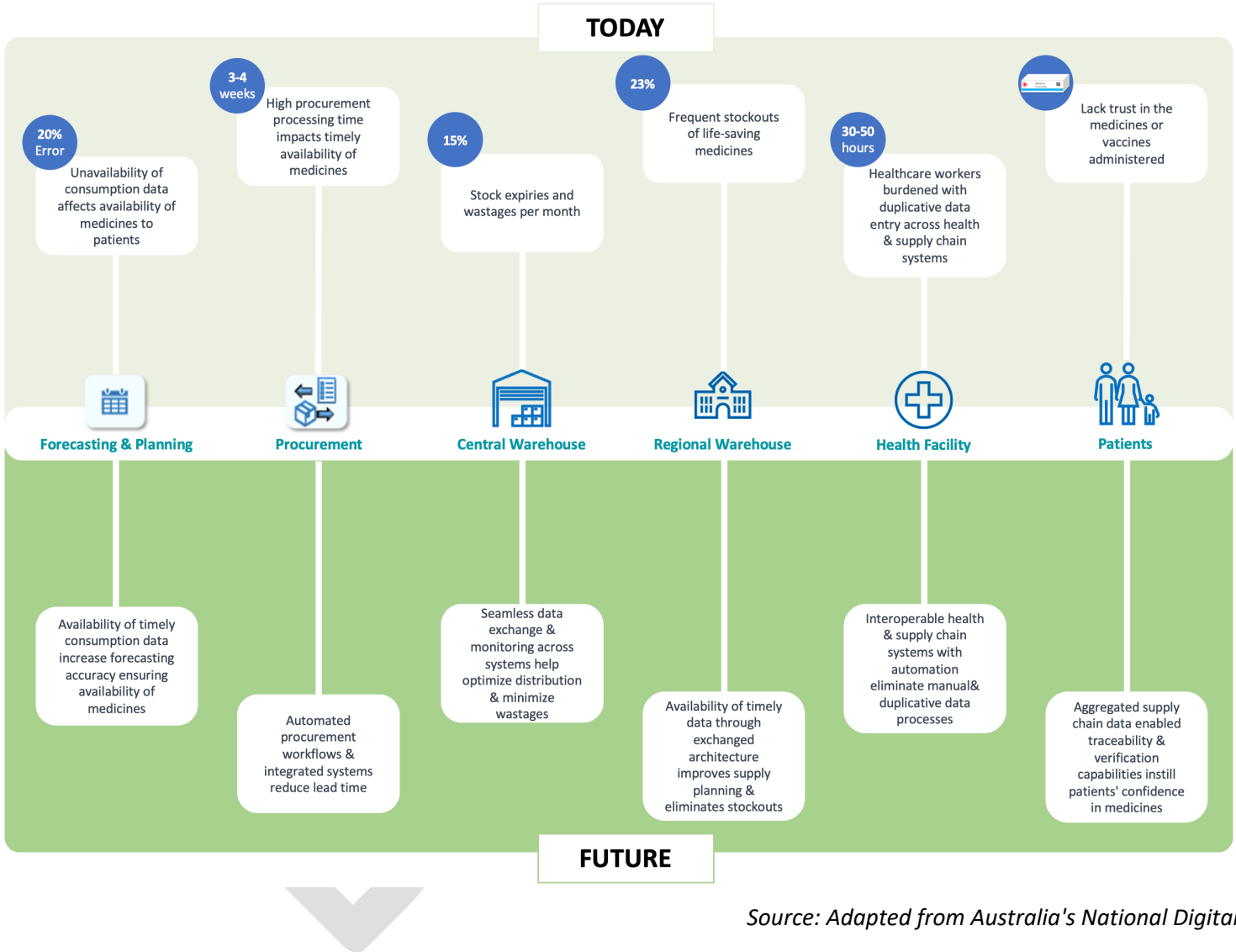
[28] Principles for Digital Development [website]. New York, NY: United Nations Foundation; no date (https://digitalprinciples.org, accessed 10 January 2020). Licence: https://creativecommons.org/licenses/by-sa/4.0.

Annex 2. Digital health supply chain challenges - prioritization template

Bottleneck	1. How much impact does this bottleneck have on the process? (1–3)	2. What is the likelihood of overcoming this bottleneck? (1–3)	3. Is this important to a wide range of stakeholders? (1–3)	Score	Prioritized Ranking
Example Unavailability of timely consumption data resulting in inaccurate forecasts and frequent stockouts	Low (1)	High potential (3)	Yes (3)	1+3+3=7	**HIGHEST**
Example Aggregating data from paper forms is burdensome and rarely done correctly.	Medium (2)	Medium potential (2)	Some (2)	2+2+2=6	**MEDIUM**

Source: *Adapted from Digital Implementation Investment Guide (DIIG), 2020*

Annex 3. Illustrative template to map current prioritised challenges vs future outcomes



Source: Adapted from Australia's National Digital Health Strategy

Annex 4. Risk Register Template

#	Risk Title	Risk Description	Priority	Impact	Probability	Status	Mitigation Steps	Owner	Raised	Reviewed	Closed
001	Inadequate training	IF system training is not delivered with appropriate content for the audience THEN the adoption and use of the system may fail	Low	Major	Medium	Mitigate	- Perform a skills assessment for each user prior to completing the training plan - Complete a training needs assessment before conducting training - Target and adapt training to meet the needs of the training audience		2018-01-28	2019-08-16	
			Low	Moderate	Medium				2018-01-28	2019-08-16	

Annex 5. Health Supply Chain Information Systems List - Template

	Ministry of Health	Regulatory Authority	Central Warehouse	Branch Warehouse	Service Delivery Point	Community Health Worker	Patients
Forecasting & Planning	Planning System						
Procurement Management							
Supplier & Contract Management							
Order Management			OpenLMIS	OpenLMIS	OpenLMIS		
Warehouse Management			ERP			RapidSMS	
Transportation Management							
Dispensing					OpenClinic		
Analytics	Health Analytics Platform						
Track & Trace							NPC Mobile App
Cold Chain Management							
Foundational Components	NPC						
Regulatory		Registration System					
		NPC Mobile App					

In Progress

Deployed

Annex 6. Budget matrix

Budgeting category	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year total
Ongoing/all phases						
Development and setup						
Deployment						
Integration and interoperability						
Scale						
Sustained operations						
TOTAL						

Source: Adapted from Principles for Digital Development: How to calculate total lifetime costs of enterprise software solutions

Annex 7. Resource Matrix for DHSC Implementation

Role Category	Roles	Phase Required In		Position Type	Skillsets	Responsibilities
		Deployment	Operation			

Leadership	Chief Technology Officer / Chief Information Officer / Chief Digital Officer	Y	Y	Permanent	- Leadership skills - ability to manage multiple IT teams & provide guidance on digital initiatives - Strategy skills - ability to perform strategic planning for IT initiatives & provide oversight to ensure strategic objectives are met - Technology skills - knowledge of latest technologies & trends, understanding of enterprise architecture & data management - Interpersonal skills - communication & presentation skills, relationship & team development skills	- Liaise with senior technical leadership across different organizations to facilitate IT work planning & budgeting - Facilitate approvals of workplans, budgets & funding requests - Develop & implement IT policies & standards - Manage multiple IT teams including implementation teams, infrastructure personnel & IT manager - Oversee key IT initiatives & ensure successful deployments in line with strategic objectives - Lead vendor management
Leadership	Information Technology Manager	Y	Y	Permanent	- Leadership skills - ability to manage technical teams - Strategy skills - ability to support strategic planning for IT initiatives - Technology skills - knowledge of existing technologies used in-country & latest trends, understanding of data management & application support needs - Interpersonal skills - communication & presentation skills, relationship & team development skills	- Liaise with senior leadership to facilitate IT work planning & budgeting - Implement IT policies & standards - Manage IT personnel - Oversee day to day operations of IT tools - Identify IT improvement opportunities - Liaise with IT vendors when required to facilitate troubleshooting or enhancements
Leadership	Project Manager	Y	N	Contracted/ Temporary	- Understanding of business requirements & high-level IT architectures/solutions - Project management skills such as planning, budgeting, risk management, team management & time management - Experience in various project management methodologies such as agile, waterfall & software development lifecycle - Ability to coordinate with & manage multiple stakeholders	- Set project objectives & charter - Develop project plan to manage resources, timeline within the allotted budget - Regularly provide status updates to team & senior leadership - Identify & assess risks & develop mitigation strategies - Coordinate efforts of all team members to meet project objectives

					- Interpersonal skills such as communication, presentation & team development	- Monitor & manage project performance & progress
Leadership	Solution Architect	Y	N	Contracted/ Temporary	- Knowledge of various technology options & trends such as cloud services, software as a service, open source etc. - Experience in software design & architecture - Knowledge of IT infrastructure - Technical leadership skills such as providing technical guidance & vision - Ability to understand business requirements & map it technology solutions - Understanding of best practices in software development, architecture & IT deployments - Analytical & problem solving skills	- Gather business requirements to define scope & develop technology solutions & architecture to satisfy requirements - Prepare technology specifications to implement, utilizing best-practices - Analyse existing systems & identify improvements & integration requirements - Guide technical team members in implementation of technology solutions - Coordinate with various technical teams such as integration specialists, infrastructure specialists & QA personnel to guide on various aspects of IT implementation - Coordinate with senior leadership to communicate on technology options, cost impact & budget needs

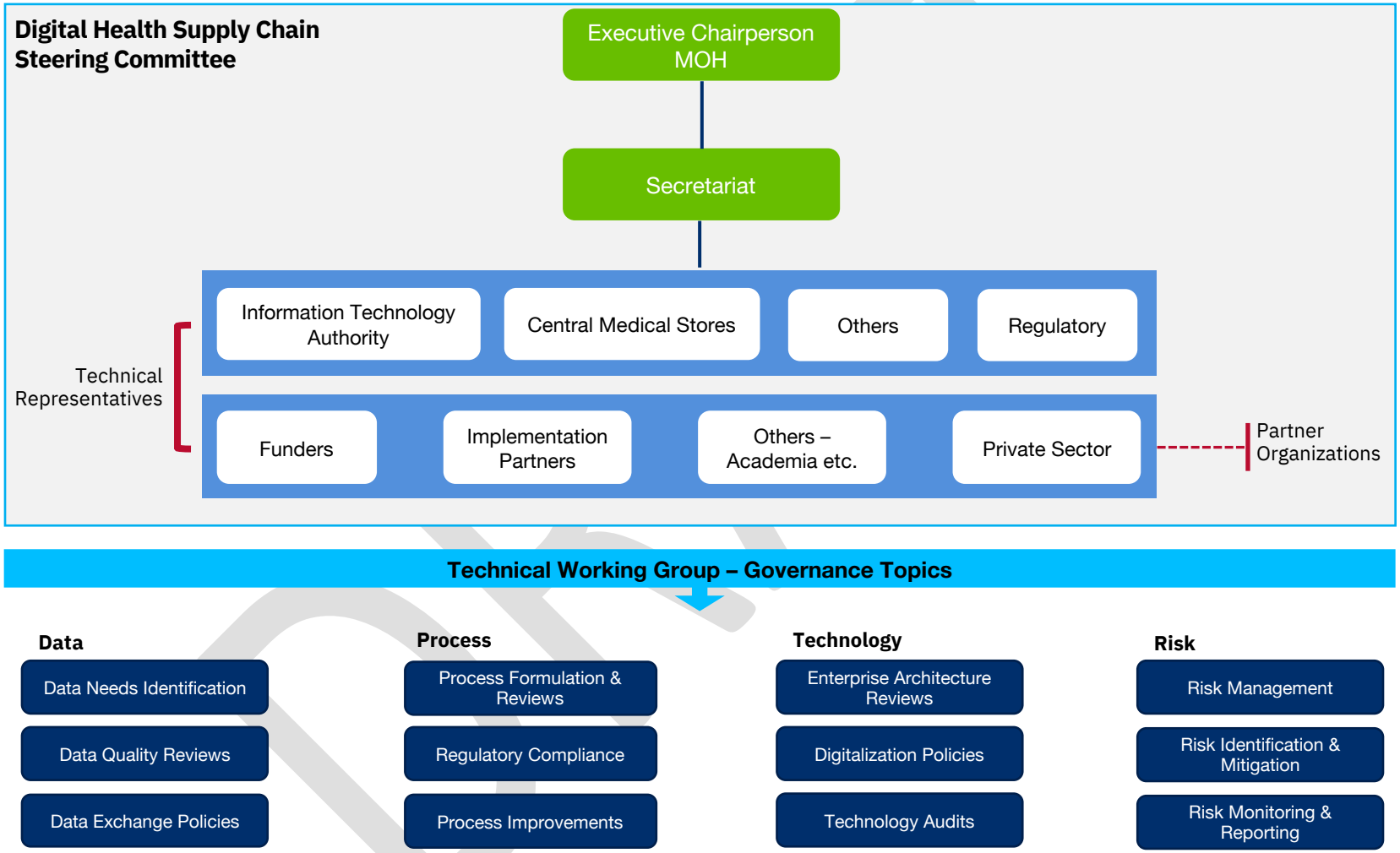
Technical	Business Analyst	Y	N	Contracted/ Temporary	- Analytical & problem-solving skills - Writing & communication skills - Ability to understand & gather business requirements - Knowledge of supply chain processes - Interpersonal skills such as coordination across various teams & stakeholders	- Gather & analyse business requirements & map business processes - Collaborate with technical teams to translate business needs into technical requirements - Develop use case or user stories to convey business needs to technical teams - Coordinate with QA team to ensure test cases to validate technical solutions are developed according to business needs - Collaborate with multiple technical & business teams - Collaborate with QA & training teams to prepare test cases & training material
Technical	Developer / Programmer	s	N	Contracted/ Temporary	- Knowledge of & experience in various programming languages such as Java, Python, C++ etc. - Knowledge of & experience in various technology options such as relational databases, web frameworks, object oriented development etc. - Ability to understand business requirements & develop programs to meet requirements - Interpersonal skills such as coordination with various technical & process teams - Analytical & problem solving skills - Experience in developing software solutions using open source tools	- Design & develop software programs that meet business requirements - Deploy the developed software across multiple environments such as test, staging, production - Troubleshoot & fix bugs in software programs - Collaborate with QA & training teams to prepare test cases & training material

Technical	Integration Specialist	Y	N	Contracted/ Temporary	- Knowledge of & experience in ETL (Extract, Transform & Load) tools - Knowledge of & experience in SQL - Knowledge of & experience in service-oriented architecture - Knowledge pf & experience in various data transfer protocols, schemas & formats - Knowledge of available data transformation & interoperability tools and experience in at least 2 tools	- Design integration solutions to utilize interoperability features across multiple systems - Develop integration standards & protocols - Coordinate with implementation team members such as architects & programmers to develop application integrations - Maintain the developed integrations & troubleshoot issues
Technical	Database Administrator	Y	Y	Permanent	- Knowledge of various database tools - Data modelling - Database management, including performance monitoring, optimizing & tuning - Database backup & recovery - Data security	- Advise on relevant database (DB) tools to use - Support database activities such as data modelling, performance monitoring, data cleansing & tuning - Monitor databases to ensure timely backup & recovery when required - Ensure security of databases & administer relevant access to appropriate users - Coordinate with various IT tools' deployment teams to support DB activities
Technical	Infrastructure Specialist	Y	Y	Permanent		
Leadership	QA/Test Manager	Y	N	Contracted/ Temporary	- Knowledge of software implementation methodologies including agile, waterfall. - Knowledge of & experience in various automated testing tools - Experience in testing large scale IT tools, managing test teams & troubleshooting test scenarios & technical issues - Experience in various testing phases such as system testing, performance testing, user acceptance testing & integration testing	- Manage testing teams to perform different test scenarios such as system testing & user acceptance testing etc. - Develop & guide the team to develop test cases & scripts based on business requirements - Develop test management plans that includes resource plan, risk management, timeline & scope - Coordinate across multiple teams such as development team, infrastructure team etc

					- Experience in test case development, test results reporting and stakeholder management - Experience in & knowledge of various defect tracking tools such as JIRA	to manage testing of IT tools at different intervals of the implementation - Monitor testing progress and provide status reports to senior leadership
Technical	Test Analyst	Y	N	Contracted/ Temporary	- Knowledge of software implementation methodologies including agile, waterfall. - Knowledge of & experience in various automated testing tools - Experience in testing large scale IT tools & troubleshooting test scenarios & technical issues - Experience in various testing phases such as system testing, performance testing, user acceptance testing & integration testing - Experience in test case development & test scripting - Experience in & knowledge of various defect tracking tools such as JIRA	- Develop test cases & scripts based on business requirements - Conduct testing across different phases such as system testing, performance testing & user acceptance testing and capture test results - Coordinate across multiple teams such as development team, infrastructure team etc to manage testing of IT tools at different intervals of the implementation
Technical	System Administrator	N	Y	Permanent	- Experience in IT tools' system, network & database administration - Knowledge of, experience in & certifications in various operating systems - Experience in various system administrative tools such as virtualization, VMware etc. - Experience in networking (WAN/LAN), hardware & scripting tools (Python, Perl etc) - Experience in & knowledge of IT helpdesk activities such as data security, user management - Troubleshooting skills	- Support installation of IT tools/software & hardware (servers etc.) - Monitor performance of systems & ensure uptime - Manage various servers, networks & other technology tools to maintain operations of IT applications - Monitor for technical issues & troubleshoot - Ensure data security by adding/modifying/deleting user accounts & providing users with appropriate access to data

						- Apply version updates, hot fixes & any other software/hardware revisions required for all the applicable tools
Technical	Support Engineer	N	Y	Permanent OR Contracted/ Temporary	- Knowledge of & experience in supply chain software - Knowledge of networking & hardware setup - Experience in software support activities such as troubleshooting, coordinating with users & vendors, applying fixes - Proficiency in remote setup/virtual tools to troubleshoot technical issues - Knowledge of various defect tracking tools such as JIRA	- Providing day-to-day support to users of software tools in troubleshooting any issues - Monitoring performance of software tools & ensuring uptime - Providing regular maintenance of software tools & applying version updates, hot fixes etc. - Capturing technical issues & resolutions for status reporting
Technical	Super User / Trainer	Y	Y	Permanent	- Knowledge of supply chain processes & features within relevant software tools - Experience using 2 or more supply chain software tools - Experience training end users	- Train end users on various functionalities & features in supply chain software tools - Assist users in system administrative activities that can be managed by end users such as password change etc. - Perform simple & basic configuration of systems where applicable to enhance or add features to software tools

Annex 8. Steering committee - example structure



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